Developing an Ontology-Based Classification for Mobility among Individuals with Acquired Brain Injury (ABI)

By

Rehab Alhasani, B.Sc. (PT), M.Sc.

School of Physical and Occupational Therapy

Faculty of Medicine

McGill University, Montréal, Québec, Canada

June 2021

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of Doctor of Philosophy (Rehabilitation Sciences)

Dedication

"And my guidance cannot come, except from Allah, in Him I put my trust, and unto Him I repent"

Surah HUD - 11:88

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

10MWT	Ten-meter walking test
6MWT	Six-meter walking test
ABI	Acquired Brain Injury
AI	Artificial Intelligent
BBS	Berg Balance Scale
BERT	Bidirectional Encoder Representations from Transformers
BI	Barthel Index
BRILLIANT	Biomedical Research and Informatics Living Laboratory for Innovations Advances of New Technologies in Community Mobility Rehabilitation Research Program
CAT	Computerised Adaptive Testing
ClinRO	Clinician-reported outcome
COSMIN	Consensus-based Standards for the Selection of Health Measurement Instrument
CPA	Canadian Physiotherapy Association
CRIR	Centre for Interdisciplinary Research in Rehabilitation of Greater Montreal
DQN	Deep Q-Network
EHR	Electronic Health Record
FAI	Frenchay Activities Index
GPS	Global Positioning System
GRADE	Grading of Recommendations Assessment, Development, and Evaluation
ICF	International Classification, Functioning, Disability, and Health framework
IOM	Institute of Medicine
IRT	Item Response Theory
JBI	Joanna Briggs Institute
ML	Machine Learning
MeSH	Medical Subjects Headings
Neuro-QoL	Quality of life Neurological Disorders
NLP	Natural Language Processing
ObserO	Observation reported outcome
PCA	Principal Component Analysis
PerfO	Performance-reported outcome
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PRO	Patient-reported outcome
PROMIS	Patient-Reported Outcomes Measurement Information System
ProxO	Proxy reported outcome
RMI	Rivermead mobility index
SARSA	Q-learning state-action-reward-state-action
SI	Supplementary Information
SIS	Stroke impact scale
SOI	Source of information
SRO	Self-report outcome
SRO	Self-reported outcome
TBI	Traumatic Brain Injury
TBI-QoL	Traumatic Brain Injury Quality of Life
TechO	Technology-reported outcome
URI	Uniform Resources Identifier

ABSTRACT

Acquired brain injury (ABI), including traumatic brain injury (TBI) and stroke, is a leading cause of disability in Canada. Statistics Canada indicates that 100,000 Canadians will experience a stroke (59%) or a TBI (71%) each year. Over 60% of the 1.5 million Canadians with ABI that go through the care continuum annually report ongoing restrictions in mobility and participation in societal roles. Planning rehabilitation intervention requires an understanding of the nature and severity of mobility challenges among individuals with ABI through a comprehensive evaluation of mobility. Thus, this PhD work comprises four studies, all addressing the global objective "to provide a common language and taxonomy of mobility to help compare and select mobility measures for clinical care and research among individuals with ABI (Stroke and TBI)". The objective of Manuscript 1 was to synthesize the measurement properties, the interpretability, and the feasibility of mobility measures, from various sources of information (patients, clinicians, technology), through an umbrella review of published systematic reviews among individuals with ABI.

Given that the umbrella review may not cover all measures that evaluate the determinants influencing mobility, focus group discussions were conducted among clinicians, individuals with ABI, and their caregivers. Thus, the objective of Manuscript 2 was to identify factors influencing mobility which need to be considered while evaluating mobility, and incorporating patients' needs and preferences into individualized care management plans, as perceived by clinicians, individuals with ABI, and their caregivers. Results of the focus groups identified the measures used in clinical practice and the determinants that influence mobility among individuals with ABI. Given that the care process emerged when we explored factors influencing mobility evaluation with clinicians, individuals with ABI, and their caregivers, Manuscript 3 aimed to explore the care experiences and service design related to rehabilitation for mobility and participation in the community among individuals with ABI, as perceived by clinicians, individuals with ABI, and their caregivers. Perspectives from clinicians, individuals with ABI, and their caregivers identified mobility factors related to service provisions, which are classified as environmental factors in the ICF that may improve mobility rehabilitation from the acute level of care to community re-integration among individuals with ABI.

Manuscripts 1 and 2 synthesized critical information to define the breadth of mobility measures; Manuscripts 2 and 3 identified determinants that influence mobility, reflecting that mobility is a multidimensional construct affected by the interactions between Body Functions, Activity and Participation, and Contextual Factors.

This complexity of measuring mobility, given that it is a multidimensional construct, requires robust strategies for organizing and effectively curating scientific knowledge to enable aggregation and comparison of findings across research studies. Natural language processing (NLP) is one approach that can be used to properly classify pre-defined content (i.e. domains and items) from mobility measures to understand knowledge evolution and correctly reflect and evolve our understanding of mobility. Thus, the objective of Manuscript 4 was to identify a comprehensive outcome set, and develop preliminary banks of item of mobility among individuals with ABI, using NLP.

Results of all Manuscripts will generate scientific evidence of useful knowledge related to standardizing terms and labels for mobility (common language) that will inform the creation of a Core Outcome Set and develop the ontology for mobility. The ontology of mobility will help reduce heterogeneity in terms related to mobility, making it easier for researchers, clinicians, and patients to identify a Core Outcome Set of mobility domains important to measure in clinical care and research.

This work will contribute to the literature and scientific community a common language of mobility concepts and their interrelationships (i.e. sharing a common understanding of mobility through developing an ontology for mobility). A common language about mobility domains can facilitate the selection and application of outcome measures to evaluate particular combinations of interventions and the mechanisms of action of the components of such interventions, as moderated by contextual factors, populations, and settings. There is also a direct application of the results of all studies in this thesis to the BRILLIANT (Biomedical Research and Informatics Living Laboratory for Innovative Advances of New Technologies in Community Mobility Rehabilitation) research program. BRILLIANT aims to develop digital platforms for patients and clinicians. To build these platforms correctly, a common language of the information collected in these systems is important to ensure that data can be used to evaluate changes within and between patients. The mobility ontology will provide the domain and item names to classify mobility measures and interventions in digital health platforms, making it easier to use the collected data. The thesis work will also inform the optimal mobility outcome measures to include in the BRILLIANT digital health platforms to collect relevant mobility outcome measures, using different sources of information (patient, clinicians and technology) in clinical practice and research.

RÉSUMÉ

Les lésions cérébrales acquises (LCA), y compris les lésions cérébrales traumatiques (TCC) et les accidents vasculaires cérébraux (AVC), sont une des principales causes d'invalidité au Canada. Statistiques Canada indique que 100,000 Canadiens subiront un AVC (59 %) ou un TCC (71 %) chaque année. Plus de 60 % des 1,5 millions de Canadiens souffrant de TCC qui passent par le continuum de soins chaque année signalent des restrictions continues de leur mobilité et de leur participation aux rôles sociaux. La planification d'une intervention de réadaptation nécessite une compréhension de la nature et de la gravité des défis de mobilité chez les personnes atteintes de TCC par le biais d'une évaluation complète de la mobilité. Ainsi, ce travail de doctorat comprend quatre études qui répondent toutes à l'objectif global de "fournir un langage commun et une taxonomie de la mobilité pour aider à comparer et à sélectionner les mesures de la mobilité pour les soins cliniques et la recherche chez les personnes atteintes de lésions cérébrales acquises (AVC et TCC)". L'objectif du Manuscrit 1 était de synthétiser les propriétés de mesure, l'interprétabilité et la faisabilité des mesures de la mobilité, à partir de diverses sources d'information (patients, cliniciens, technologie), par le biais d'une revue générale des revues systématiques publiées sur les personnes atteintes de lésions cérébrales acquises.

Étant donné que la revue générale ne couvre pas nécessairement toutes les mesures qui évaluent les déterminants de la mobilité, des groupes de discussion ont été organisés entre des cliniciens, des personnes souffrant d'LCA, et leurs soignants. Ainsi, l'objectif du Manuscrit 2 était d'identifier les facteurs influençant la mobilité qui doivent être pris en compte lors de l'évaluation de la mobilité et de l'intégration des besoins et des préférences des patients dans les plans d'intervention individualisés chez les personnes avec une limitation de la mobilité, tels que perçus par les cliniciens, les personnes avec une limitation de la mobilité, et leurs soignants. Étant donné que le processus de soins a émergé lorsque nous avons exploré les facteurs influençant l'évaluation de la mobilité avec des cliniciens, des personnes avec une limitation de la mobilité et leurs soignants, le Manuscrit 3 visait à explorer les expériences de soins et la conception des services liés à la réadaptation pour la mobilité et la participation dans la communauté chez les personnes avec une limitation de la mobilité, telles que perçues par les cliniciens, les personnes avec une limitation de la mobilité, et leurs soignants. Les résultats des groupes de discussion ont permis d'identifier les mesures utilisées dans la pratique clinique et les déterminants qui influencent la mobilité des personnes atteintes d'une limitation de la mobilité. De plus, les cliniciens, les personnes souffrant d'un TCC et leurs soignants ont identifié les facteurs de mobilité liés à la prestation de services, qui sont classés comme des facteurs

environnementaux dans l'ICF et qui peuvent améliorer la réadaptation de la mobilité des personnes souffrant d'un TCC, depuis le niveau de soins actifs jusqu'à la réintégration dans la communauté.

Les manuscrits 1 et 2 ont synthétisé des informations essentielles pour définir l'étendue des mesures de la mobilité ; les manuscrits 2 et 3 ont identifié les déterminants qui influencent la mobilité, reflétant le fait que la mobilité est un concept multidimensionnel affecté par les interactions entre les fonctions corporelles, l'activité et la participation, et les facteurs contextuels. La complexité de la mesure de la mobilité, étant donné qu'il s'agit d'un concept multidimensionnel, nécessite des stratégies solides pour organiser et conserver efficacement les connaissances scientifiques afin de permettre l'agrégation et la comparaison des résultats entre les études de recherche. Le traitement du langage naturel est une approche qui peut être utilisée pour classer correctement le contenu prédéfini (c'est-à-dire les domaines et les éléments) des mesures de la mobilité afin de comprendre l'évolution des connaissances pour refléter correctement et faire évoluer notre compréhension de la mobilité. Ainsi, l'objectif du Manuscrit 4 était d'identifier un ensemble complet de résultats, et de développer des banques d'items préliminaires de la mobilité chez les personnes atteintes d'LCA, en utilisant le langage naturel.

Les résultats de tous les manuscrits produiront des preuves scientifiques de connaissances utiles liées à la normalisation des termes et des étiquettes de la mobilité (langage commun) qui serviront à la création d'un ensemble de résultats de base et au développement de l'ontologie de la mobilité. L'ontologie de la mobilité contribuera à réduire l'hétérogénéité des termes liés à la mobilité, ce qui permettra aux chercheurs, aux cliniciens et aux patients d'identifier plus facilement un ensemble de résultats de base dans les domaines de la mobilité qu'il est important de mesurer dans les soins cliniques et la recherche.

Ce travail contribuera à l'élaboration d'un langage commun des concepts de mobilité et de leurs interrelations dans la littérature et la communauté scientifique (c'est-à-dire le partage d'une compréhension commune de la mobilité par le développement d'une ontologie de la mobilité). Un langage commun sur les domaines de la mobilité peut faciliter la sélection et l'application de mesures de résultats à utiliser pour évaluer des combinaisons particulières d'interventions et les mécanismes d'action des composants de ces interventions, tels que modérés par des facteurs contextuels, des populations, et des milieux. Il existe également une application directe des résultats de toutes les études de cette thèse au programme de recherche BRILLIANT (Laboratoire vivant de recherche biomédicale et d'informatique pour les avancées innovantes des nouvelles technologies en mobilité). BRILLIANT vise à développer des plateformes numériques pour les patients et les cliniciens. Pour construire

correctement ces plateformes, il est important de disposer d'un langage commun des informations collectées dans ces systèmes afin de s'assurer que les données peuvent être utilisées pour évaluer les changements au sein des patients et entre eux. L'ontologie de la mobilité fournira les noms de domaine et d'élément pour classer les mesures et les interventions de mobilité dans les plateformes numériques de santé, ce qui facilitera l'utilisation des données collectées. Le travail de thèse permettra également de déterminer les mesures optimales de la mobilité à inclure dans les plateformes numériques de santé BRILLIANT pour collecter des mesures pertinentes de la mobilité, en utilisant différentes sources d'information (patient, cliniciens, et technologie), dans la pratique clinique et la recherche.

ACKNOWLEDGEMENTS

After this long journey, I would like first to thank my God, who gives me the strength, patience, and guidance to overcome all issues I have been through to achieve my goals.

During my graduate studies, I was blessed to work with exceptional people who helped me grow as a researcher. It is a pleasure to take this opportunity to acknowledge their contributions. Special thanks go to my academic supervisor, Dr. Sara Ahmed, who guided and supported me to achieve my PhD. It was also a great privilege for me to work with my thesis committee, Dr. Claudine Auger and Dr. Anouk Lamontagne, for their continuous support and guidance and their insights and priceless critique that have enriched the manuscripts of this thesis. My supervisor and my committee's contributions have truly strengthened my research ideas, methodologies, and interpretation of results through constant feedback and key insights.

This thesis is dedicated to my parents, to my father, Salem Alhasani, may he rest in peace, the person who I really miss in this life, and to my mother for her endless support, unconditional love, and sustained encouragement; her sacrifices have made me who I am today. I would also like to thank my siblings for their continuous support.

Also, I would like to thank my friends and colleagues for their unconditional support and friendship. Special thanks to Anne DeChavigny, an English editor, for her assistance in reviewing the manuscripts. She always found the time to review my manuscripts, no matter how busy she is.

Finally, I also want to thank the Saudi Arabian Cultural Bureau (SACB) award that facilitated my academic life and gave me the chance to continue my studies.

Thesis organization and overview

This PhD thesis includes four Manuscripts, which the Overall Objective was to provide a common language and taxonomy of mobility to help compare and select mobility measures for clinical care and research among individuals with ABI (Stroke and TBI). All studies in this thesis were guided by the International Classification of Functioning, Health, and Disability (ICF) to define the scope of the ontology.

The *First Manuscript* aimed to synthesize the measurement properties, the interpretability, and the feasibility of mobility measures, from various sources of information (patients, clinicians, technology), through an umbrella review of published systematic reviews among individuals with ABI (stroke, TBI). The *Second Manuscript* aimed to identify factors influencing mobility that need to be considered while evaluating mobility, and incorporating patients' needs and preferences into individualized care management plans among individuals with ABI (stroke, TBI), as perceived by clinicians, individuals with ABI, and their caregivers. The *Third Manuscript* aimed to explore the care experiences and service design related to rehabilitation for mobility and participation in the community among individuals with ABI (stroke, TBI), as perceived by clinicians, individuals with ABI, and their caregivers. The *Fourth Manuscript* aimed to identify a comprehensive outcome set of mobility, and develop preliminary banks of items of mobility among individuals with ABI, using Natural Language Processing.

Chapter 1 presents the introduction and literature review on ABI (Stroke and TBI) and mobility; definition of mobility; measuring mobility; the role of ontology-based classification to provide a common language for mobility; and the role of Natural Language Processing in developing the ontology.

Chapter 2 outlines the rationale and objective of each Manuscript.

Chapter 3 presents the first Manuscript, which is titled "Quality of Mobility Measures among Individuals with Acquired Brain Injury: An Umbrella Review"

Chapter 4 presents the integration of Manuscripts 1 and 2.

Chapter 5 presents the second Manuscript, which is titled " Clinicians', Patients', and Caregivers' Perspectives about Factors that Influence Mobility: Creating a Core Set of Mobility Domains among Individuals with Acquired Brain Injury"

Chapter 6 presents the integration of Manuscripts 2 and 3.

Chapter 7 presents the third Manuscript, which is titled " Clinicians', Patients', and Caregivers' Perspectives about Service Provision across the Continuum of Care to Improve Mobility and Participation among Individuals with Acquired Brain Injury"

Chapter 8 presents the integration of Manuscripts 3 and 4.

Chapter 9 presents the fourth Manuscript, which is titled "Informing the Development of an Outcome Set and Banks of Items to Measure Mobility among Individuals with Acquired Brain Injury using Natural Language Processing"

Chapter 10 presents the conclusions of the thesis.

Contribution of co-authors

There is a direct application of the results from this PhD thesis to the BRILLIANT (Biomedical Research and Informatics Living Laboratory for Innovative Advances of New Technologies in Community Mobility Rehabilitation) research program funded by the BRILLIANT CFI (Nominated PI: Dr. Sara Ahmed). The doctoral candidate conducted the write-up for all Manuscripts and the statistical analyses under the supervision of her academic supervisor, Dr. Sara Ahmed. The Manuscripts included in this thesis are the candidate's work with extensive feedback from Dr. Sara Ahmed, Dr. Claudine Auger, and Dr. Anouk Lamontagne. In particular, Dr. Claudine Auger was a co-author on all Manuscripts in this thesis, and provided feedback on the Manuscripts. Also, she provided feedback on interview guide questionnaires for Manuscripts 2 and 3 and contributed to reviewing the results for Manuscripts 2, 3 and 4. Dr. Anouk Lamontagne was a co-author in Manuscripts 2, 3, and 4 on this thesis, and provided feedback on the Manuscripts. Also, she contributed to reviewing the results for Manuscripts 2, 3 and 4. Finally, the doctoral candidate performed the data collection for the second and third Manuscripts.

Miss Mushirah Hossenbaccus facilitated the recruitment of patients/caregivers and clinicians at each participating site for both Manuscripts 2 and 3. She translated the demographic questionnaires and the interview guide questionnaire from English to French. She also contributed to taking notes during focus groups for Manuscripts 2 and 3. Dennis Radman was a second coder for the thematic analyses and a co-author for Manuscripts 2 and 3. He also contributed to taking notes and being an observer during focus groups for Manuscripts 2 and 3. Dr. Aliki Thomas contributed to being a co-moderator for one of the focus groups. Miss Nicole Gorge, Dina Gaid and Mrs Lina Petrella contributed to taking notes during focus groups for Manuscripts 2 and 3. Dr. Audrey Durand was a co-author for Manuscript 4. She supervised the analysis that used machine learning algorithms and provided

feedback on Manuscript 4. Lastly, Mr. Mathieu Godbout was a co-author for Manuscript 4. He contributed to developing the machine-learning algorithm to analyze the data, and provided feedback on Manuscript 4.

In summary, the doctoral candidate was responsible for designing the study, data collection, defining statistical methods, preparing the data for analysis, performing the statistical analyses, and interpreting the findings and writing of the Manuscripts. The co-authors functioned in consultant roles, providing feedback on the study design, the analyses, and the final draft of each Manuscript.

Statement of originality

This is to certify that to the best of my knowledge, the content of this PhD thesis is my own original work with guidance from my supervisor Dr. Sara Ahmed and the supervisory committee Dr. Claudine Auger, and Dr. Anouk Lamontagne. This thesis has not been submitted for any degree or other purposes. I certify that the intellectual content of this thesis is the product of my own work and that all the assistance received in preparing this thesis and sources have been acknowledged. Chapters 3, 5, 7, and 9 are the original material and contribute to knowledge in the field of Rehabilitation in Canada. The originality of this thesis lies in the new insights gained on generating scientific evidence of useful knowledge related to standardizing terms and labels for mobility (common language) that will inform the development of the ontology (knowledge representation) for mobility to eliminate the terminologies heterogeneity, and enable the use of knowledge reasoning that can explain variability in mobility among individuals with ABI. There is a direct application of the results of all studies in the BRILLIANT (Biomedical Research and Informatics Living Laboratory for Innovative Advances of New Technologies in Community Mobility Rehabilitation) research program. The results of this PhD thesis will inform the optimal mobility outcome measures to include in the BRILLIANT health informatics solutions to collect relevant mobility outcome measures, using different sources of information (patient, clinician, and technology) in clinical practice and research. This work will contribute to the literature and scientific community a common language of mobility concepts and their interrelationships (i.e. sharing a common understanding of mobility through developing an ontology for mobility) that will facilitate predicting combinations of intervention content and mechanisms of action, as moderated by contextual factors, population characteristics, and settings. This thesis has not been submitted for any degree or other purposes. I certify that the intellectual content of this thesis is the product of my own work and that all the assistance received in preparing this thesis and sources have been acknowledged.

CHAPTER 1 LITERATURE REVIEW

1.1 Acquired brain injury and mobility

Among various causes of acquired brain injury (ABI), traumatic brain injury (TBI) and stroke are the leading causes of disability worldwide [1-3]. According to the World Health Organization (WHO), the global incidence of all-cause, all-severity TBI is estimated at 69 million people worldwide each year. Mild TBI affects approximately 55.9 million people each year, whereas 5.48 million people are estimated to suffer severe TBI each year. The incidence of TBI is highest in the region of the Americas–United States and Canada (1299 cases per 100,000 people) and the European region (1012 cases per 100,000 people) [4]. On the other hand, 15 million people suffer a stroke worldwide each year, as the incidence of stroke is highest in the region of the Americas–United States and Canada (1015 cases per 100 000 people), followed by the European region (range from 95 to 290 cases per 100,000) [5, 6].

Statistics Canada indicates that 100,000 Canadians will experience ABI each year (Stroke: 59%; TBI: 71%) [5]. Approximately 1.5 million Canadians with ABI go through the acute and rehabilitation care continuum annually and over 60% report restrictions in participation in societal roles [5], costing the health system more than $26.8 billion annually [7]. Consequently, the number of individuals with a mobility limitation and participation restrictions are on the rise [8, 9]. This trend impacts the individual, society, and demand for scarce health care resources [8, 10-12]. At the individual level, an inability to ambulate adequately can lead to de-conditioning and diminishing quality of life. At the society level, mobility limitations will lead to restricted participation in meaningful activities at school, leisure, or work. At the economic level, mobility limitations will increase costs and burden on the health care system [8, 10-12].

1.2 Definition of mobility

Definition of mobility

In general, mobility is defined as a persons' ability to move independently and safely from one point to another [8, 13]. It is the process of changing and maintaining postures [14], moving around the bed, from one chair to another (transfers), using a wheelchair and all aspects of walking [15]. It is the fundamental part of activities of daily living (ADL), including basic-ADL and instrumental-ADL [13]. Also, it can be described in cognitive, emotional, social and physical terms [16]. When mobility is defined more broadly, it also includes movement outdoors and beyond the home using of some form of transportation [17, 18]. Stalvey et al. [18], defined mobility as

"the spatial extent of one's travel within the environment," encompassing "travel in, around, and outside the home as one conducts the business and social aspects of everyday life". The World Health Organization's International Classification of Functioning, Disability and Health (WHO's ICF) also recognize a broad explanation of mobility, including both indoor and outdoor movement and the use of assistive devices and transportation [19].

Since mobility is multi-dimensional, it is important to understand mobility in a holistic way. Webber et al. [20] defined mobility holistically based on the life-space literature [18, 21-23] and environment on mobility continuum [24-26] as the ability to move oneself (either independently or by using assistive devices or transportation) within environments that expand from one's home to the neighbourhood and to regions beyond. Vehicles and other forms of transportation are required to maintain access to essential services, activities, and people [27].

1.3   Conceptual framework relevant to mobility

The complexity of mobility is also observed through several frameworks. Carp and Frances [28] present conceptual model of mobility to determine whether life-maintenance needs (e.g., food, clothing, health care) are met independently, and whether higher order needs (e.g., social relationships, recreational activities) are fulfilled to promote well-being. Rose [29] proposed a theoretical framework for balance and mobility that considered of the interrelationships among individual capabilities, environmental constraints, and task demands. Shumway-Cook et al. [24], present a conceptual model named person-environment model of mobility in which attributes of the physical environment are categorized into eight dimensions including, distance, temporal, ambient, terrain, physical load, attention, postural transitions, and density. These dimensions represent the external demands required for an individual to be mobile within a particular environment. Fuller [30] proposed a theory of driver behavior including driving task demands and driver capabilities (e.g., physical, cognitive, and psychological characteristics) and recognizes that environmental factors, compensatory strategies, and driver perceptions influence driver action. Tsai [31] presents a conceptual model of walking, physical activity and life-space mobility, in which walking represents the smallest circle within the physical activity as it includes the least variety of movement (e.g., walking or changing position). The physical activity represents the mid-layer circle, including a wider range of daily activities and relationships with family, and community life. Life-space mobility, the outer circle, is the largest concept of the three, encompassing all movements within the environment, including the use of transportation.

In order to conceptualize mobility more comprehensibly, Webber et al. [20], presented a framework that links factors relevant to walking, wheeling, driving, and taking alternate forms of transportation within different life-spaces. The framework includes concentric areas of expanding locations from home with increasing requirements for independent mobility that expands from ones' home to the outdoor area surrounding the home, the neighborhood, the service community, the surrounding area, and the world (Figure 1). At all life-space levels portrayed in the vertical order, five "key" interrelated determinants, namely cognitive, psychosocial, physical, environmental, and financial, influence mobility. Cognitive determinants include a broad range of factors such as mental status, memory, and executive functioning, whereas psychosocial determinants include factors such as self-efficacy, coping behaviors, depression, fear, mood, and relationships. The relative importance of different factors depends on the specific mobility context for an individual as one moves farther from home. In addition, personal factors, including gender, culture, and biography shape individuals' experiences, opportunities, and behaviors and therefore act as cross-cutting influences on mobility [32].

The broadness of all domains that encompass mobility is also observed when applying the International Classification, Functioning, Disability, and Health framework (ICF) [19]. It classifies mobility under body function, activity and participation and environmental factors. In the body section, mobility is seen as the motion of all body bones and joints (codes: b7, b710, b7100, b7101, b7102, b7108, b7109, b720, b7200, b7201, b7203, b7208, b7209). In the activities and participation section, mobility is given an entire chapter (d4), and it is about moving by changing body position or location (d410-d429); or by transferring from one place to another, by carrying, moving or manipulating objects (d430-d449), by walking, running or climbing, and by using various forms of transportation (d470-d489). In the environmental factors section, mobility is classified as products, devices, domesticated animals, and services used for transportation (codes: e120, e1200, e1201, e1208, e1209, e1401, e350, e5100) (Figure 2).

1.4 Measuring mobility

Since mobility is multi-dimensional, there is not one reliable and comprehensive measure to evaluate the myriad of personal and environmental factors that influence mobility for individuals with ABI [19, 33]. Further, to measure mobility in research, we rely on expensive laboratory technologies [34-36] and performance-based tools [37] that are burdensome in terms of setting up, staff time for administration, and analysis. Notably, these tools may not be readily applied in "real-life" community contexts. Further, electronic platforms that can collect real-time patient-reported and clinician-reported data are in their early stages [38], particularly in rehabilitation. To build these

platforms correctly, a common language of the information collected in these systems is important to ensure that data can be used to evaluate changes within and between patients. Therefore, to plan rehabilitation effectively and compare between different interventions, an understanding of the nature and severity of mobility among individuals with ABI is needed, which requires a comprehensive evaluation of mobility.

Evaluation of the effectiveness of rehabilitation interventions after ABI is highly prioritized [39]. However, selection of a suitable outcome measure can pose a challenge to both researchers and clinicians, as the range of outcome measures available in the clinical research literature is vast, and distinctions between them are often not clear. Despite consensus in nationally published guidelines recommending the use of valid, reliable, and responsive assessment instruments, further direction does not extend to which outcome measures are optimal for particular evaluative needs among the ABI population [40, 41]. For example, reviews give guidance in criteria for selection, with critical appraisal of psychometric properties of outcome measures commonly used in stroke research to capture aspects of body function, activity, and participation [42-44]. However, researchers and clinicians also need to consider the content of measures and whether the domains evaluated match research and clinical objectives.

Indeed, numerous studies focusing on mobility outcome measures have been published, many studies highlighting the need for standardized definitions and higher consensus and guidance in outcome selection [39]. The focus of published validity evidence for mobility outcome measures has been on a limited range of quantitative psychometric tests applied to the outcome measure despite its source of information. Usually, quantitative testing includes the estimation of scale reliability, using available factor analysis, and fitting a confirmatory factor analysis model to data from a conveniently accessible sample of typical respondents. In addition, the application of qualitative methodology has been used commonly to generate target constructs or to test items of the measure cognitively. However, the current validity testing theory highlights that validity is not just about item content and psychometric properties. It is about the ongoing evaluation of valid evidence sources to support the data interpretations and uses of test scores in each new context [45-48].

There is little evidence of this thinking being applied in the rehabilitation field [45], as few publications describe the iterative and comprehensive testing of the validity of the interpretations of the outcome measure data for the intended purposes [45]. This gap in the research is essential to be considered because validity evidence extends beyond the statistical properties of the outcome measure [45, 49, 50] to the accuracy of data interpretations to enhance clinical decision-making among individuals with ABI [45, 46]. Thus, a more comprehensive approach to

validity testing of outcome measure with application to the relatively new measurement area in health care is needed.

There is a solid and long history of validation theory and methodology in the fields of education and psychology [47, 51-54] to develop theory and methods for validity testing of how the data are interpreted and used for decision-making in specified contexts and not only focused on the measurement tools [47, 55]. The validation theory and methodology focuses on the iterative evaluation of sources of validity evidence for the data interpretation in each new context [47, 56]. The valid interpretation of data from the outcome measure is essential when the decisions emphasise the individual's health [48]. The psychometric properties of a measurement tool are an integral component of the validity of the inferences drawn from its data in its development context. Still, they do not guarantee valid data interpretation in other contexts [45, 57, 58].

A more uniform reporting of outcome measure in ABI studies would allow comparison between studies and enable data pooling from different studies for evidence synthesis. An example of improving standardization of outcomes across several research areas is the Core Outcome Measures in Effectiveness Trials (COMET) initiative, which aims to improve development and application of agreed-upon standardized sets of outcomes, the "Core Outcome Sets". This initiative has recently launched a database containing more than 500 references, but only a few of these targets the ABI population, and mobility function is not yet covered [59]. Furthermore, the existing ICF Core Sets for both stroke and TBI are still limited in term of mobility [60-64].

The application of different models and/or frameworks to select outcomes measures varies. The outcome measures need to be multi-dimensional, in order to include functioning at different levels of body function that refer to impairment, and activity and participation that refer to limitation. Equal emphasis should be placed on determining the influence of personal and environmental elements on a person's overall health and well-being [19]. This necessitates the use of more comprehensive models that can locate mobility within a framework to identify all the relevant outcomes and the linkage between them.

1.4.1 Mobility and the International Classification of Functioning, Disability and Health Framework

In rehabilitation, the ICF was developed to help researchers, clinicians, and patients reach a broader biological and psychosocial understanding of impairment [19]. The ICF framework is commonly used to guide the measurement of function and disability among different professionals [19]. It provides a unified and standardized language for describing and classifying health outcomes. Furthermore, the ICF can provide a basis to examine

mobility, as it provides a standardized common language across the world to effectively communicate information among various disciplines [19]. In the ICF, mobility is classified within the component of activity and participation. In addition, the ICF components of body function, and contextual factors can be applied to mobility [19]. Linking using the ICF framework is a method of content analysis that has been used to link items of a measurement tool to ICF components [65].

The ICF is a classification framework that describes the relationships among various factors that interact to effect health and function [19], and it organizes this information in two parts: Part 1- Functioning and Disability, and Part 2- Contextual factors (Figure 3). These two parts are each further subdivided into two components. The components of Part 1 are (1) Body Functions defined as the "physiological functions of body systems (including psychological functions) [19]" and Body Structures as the "anatomical parts of the body such as organs, limbs and their components [19]"; (2) and Activity and Participation, in which Activity is defined "as the execution of a task or action by an individual [19]", whereas Participation is defined "as involvement in a life situation [19]".

The components of Part 2 are: (1) Environmental Factors, which refer to all aspects of the external or extrinsic world that form the context of an individual's life and, as such, have an impact on that person's functioning [19]". Environmental factors can be classified into individual and societal. The individual level encompasses the immediate environment of the individual [19], while the societal level refers to "formal and informal social structures, services, and overarching approaches or systems in the community or society that impact the individual [19]"; (2) Personal Factors represent influences on functioning particular to the individual [19]. Given the large variation in society and culture and a lack of clarity with respect to these factors, they are not classified within the ICF, but the ICF acknowledges Personal Factors and their impact on the health condition. While developing a classification for personal factors can be challenging, including this type of information in data collection could assist investigators in providing "empirical background for the future development of personal factors in the ICF [19]", and codifying personal factors in the ICF could help in conveying "information important for a complete description of the functioning profile [19]" Examples of Personal Factors that may affect functioning include gender, race, ethnicity, age, social and educational background, past and current experiences and life events, behavior patterns, and psychological assets [19].

The ICF framework acknowledges the interplay between functioning, disability and contextual factors [19]. For example, any mobility impairment can potentially affect activity and participation capacity, which in turn can

also be influenced by the contextual factors. Each of the four components is further subdivided into domains and then categories. Domains are the first level of classification and form the chapters of ICF. Categories form the lowest level and are the basic units of classification in ICF. Each chapter comprises second-level, third-level, and in certain cases, fourth-level categories (Figure 4) [19]. For example, the component of Activity and Participation comprises nine domains, including d1: Learning and applying knowledge; d2: General tasks and demands; d3: Communication; d4: Mobility; d5: Self-care; d6: Domestic life; d7: Interpersonal interactions and relationships; d8: Major life areas; and d9: Community, social and civic life. Each domain is then classified into categories, which are the units of ICF classification. For example, the domain of Mobility (d4) consists of categories including walking and moving, changing body positions, and moving around using transportation. When coding using the ICF framework, components, domains and categories are coded up to three or four levels. The code starts with the relevant component prefix, that is, b, s, d or e, which is followed by an up to four-digit code representing the relevant domain and category. For example, the task of "walking long distances" can be coded as:

d- Activities and participation (component)

d4- Mobility (first-level/domain)

d450- Walking (second-level/category)

d4501- Walking long distances (third-level/category)

A number of codes can be utilized at each level of classification. Generally, the exhaustive third-level codes have been recommended for linking rehabilitation outcome measures [19].

In rehabilitation science, the ICF presents itself as a synthesis of two models of human functioning and disability: the biomedical model and the bio-psychosocial model [19]. Addressing the bio-psychosocial and biomedical models is essential to encourage a more comprehensive understanding of illness, injury, activity limitation, and participation restriction between the person and the environment [66, 67]. The importance of the bio-psychosocial model is not solely in understanding disability but, more importantly, in clearly identifying environmental factors as potential determinants that influence mobility. For example, participation of individuals with disabilities in society is dependent on the use of accessible designs to remove physical environmental barriers in public and private facilities, while reasonable accommodations are crucial for achieving complete participation in the workplace [68]. This bring us to discuss the important philosophical shift in how health professionals understand, respect and support impairment improve an individual's health independence and agency [69-71], in

which this has created a patient-centred care (PCC) approach. The Institute of Medicine (IOM) defined PCC as "care that is respectful of and responsive to individual patient preferences, needs, and values" and that ensures "that patient values guide all clinical decisions [68]". This definition highlights the importance of facilitating shared decision making (SDM) between clinicians and patients to produce the best mobility outcomes possible [72]. Also, PCC focuses on environmental factors at societal level in which healthcare services received fully integrates the patient's perspectives, experiences, and needs into every phase of medical consultation, evaluation, treatment and follow-up [73]. Thus, the benefits of PCC are conclusive, including essential aspects such as patient satisfaction, greater enablement, more significant improvement in symptom burden, and positive health outcomes [72].

The ICF linking process

The ICF provides a common language to describe health and health-related status [19]. The ICF linking is a rigorous process, whereby a scale or sub-scale of the measures are linked to the most precise ICF category [61, 74]. To facilitate comparability of health outcome measures, a set of rules has been developed for linking outcome measures to ICF [65]. Ten rules have been established for the ICF linking process (Table 1) [65]. The ICF linking process consists of identifying the main construct of the domains and items of the measures to be linked to the most precise ICF category (Figure 5). The ICF linking provides a process to explore, analyze and compare measurement tools [65, 74]. Understanding of the content of measures using ICF linking in combination with the psychometric properties of the measure would assist researchers and clinicians to choose an appropriate measurement tool of mobility to evaluate individuals with ABI.

1.4.2   Sources of information

An important point in selecting outcome measures is methods of collecting data using a different source of information [75]. A number of outcomes can only be measured using clinical examination or technology, especially when it is related to impairment and disability. Clinically Reported Outcomes (ClinROs) are "*evaluations from a trained professional after observation of a patient's health condition and involve clinical judgment or interpretation of the observable signs, behaviours, or other physical manifestations* [75]". Performance-Reported Outcomes (PerfOs) require patient cooperation and motivation, and include tests of walking, dexterity, and cognition [75]. Key outcomes that are assessed using technology which defined as "*fully realized products and systems, created by people for an identified purpose through technological practice* [76]", and involves for example technology that can be used to assess physical activity [34], and community mobility [36].

Participation and quality of life can only be assessed by asking the person directly. These outcomes are

termed Patient-Reported Outcomes (PROs) or Self-Reported Outcomes (SROs) [43, 44] in which PROs defined as

"*any report of the status of a patient's health condition that comes directly from the patient, without interpretation of*

the patient's response by a clinician or anyone else" while SROs are defined as "*any status reported by the patient*

that can concur with performance-based assessments [75]". SROs are not the same as PROs because the

interpretation of what the patient says they can do may be amended based on other information that may not have

been provided by the patient. For example, mobility can be self-reported, and for most individuals, self-reports can

be in accord with performance-based assessments [77, 78]. When outcomes are used to determine safety, general

health or level of care, it is essential to combine SROs with other sources of information [75].

Patient-reported outcomes are limited in providing information when cognition impairments are present.

For example, in a large study that administered quality of life questionnaires by mail, around 50% of the patients

with stroke were unable to complete the questionnaires by themselves, because of cognition impairment, which

results in seriously compromised and misleading results [79]. Therefore, the inclusion of Proxy-Reported Outcome

(ProxO) is needed. The ProxO represents a special kind of observer who shared the same experience of the patient

(e.g. family member, friend or caregiver), and can report on the outcome. To note, ProxO is not Observer-Reported

Outcomes (ObsROs), which are outcomes assessed by an expert who is observing a certain behavior [75]. Using

ProxOs would benefit in increasing sample size, improving generalizability, and reducing sample bias. Proxy

respondents may be rating actual, observable performance, whereas patients may rate their perceived capability in

what they think they are capable of doing, rather than what they actually do.

1.6   The role of ontology-based classification to provide a common language for mobility

Generally, any rehabilitation intervention plan begins with a comprehensive assessment of impairments,

activity limitations, and participation restrictions. Choosing the most suitable intervention for individuals with ABI

with mobility limitation requires a comprehensive evaluation of mobility. The intervention plan varies depending on

the patients' personal context goals and the complex interplay of the factors that influence mobility. Thus, optimal

measures will result in an individualized treatment plan that targets patients' needs.

There is a challenge in achieving a consensus concerning definitions of mobility because it is a latent

construct reflected by many terms. The lack of common terms is evident when examining the proliferation of

theoretical frameworks related to mobility in the literature [24, 28-31]. These theoretical frameworks tend to be

overlapping and underspecified, as they often use different names for the same construct of mobility, measure the same construct of mobility using differing items, and inadequately define the construct of mobility and its relationships. Based on mixing of labels and the definition of the construct of mobility, it appeared that researchers were using different terms to refer to the construct of mobility, and vice versa. The ICF framework and Webber's framework for mobility [19, 20] were used in this thesis to set out a comprehensive conceptualisation of the construct of mobility and the interrelationships between domains.

The lack of common terms and shared definitions for mobility related to mechanisms of action, outcome measures, the individuals they target, and environmental contexts, makes it challenging to advance rehabilitation interventions for mobility. These inconsistencies limit the precise specification of theoretical constructs of mobility, how they are measured, and the relationships between different mobility domains and their mechanisms of action. These challenges, in turn, limit our capacity to efficiently integrate and summarize available evidence linked to theoretical frameworks and to apply these to make a decision in choosing the outcome measures to evaluate and compare interventions and then disseminate evidence on the effectiveness of interventions. Given the "black box" nature of the variety of different intervention plans concerning mobility, and inconsistency and incompleteness in reporting of study methods and findings in the rehabilitation literature, one strategy named "ontology" can be used to support an efficient knowledge representation with considerable potential.

1.6.1   What is an ontology?

The term "ontology" is defined in philosophy as the study of the kinds of things that can exist and their relations to each other [80]. In information science, ontologies are data structures that define classes and the relations between those classes (Figure 6) [81]. In this PhD thesis, ontology is defined as a formal, explicit description of the construct of mobility (i.e. entities or classes), properties of each domain describing various features and attributes of the concept of mobility (slots sometimes called roles or properties), restrictions on slots or properties (i.e. facets (sometimes called role restrictions)) and specified relationships between the entities or classes (i.e. taxonomies) [81].

The labels and definitions of entities/classes and relationships in a given ontology make up a 'controlled vocabulary'. Controlled vocabularies are collections of preferred classes that are used to promote consistent description and retrieval of data. Controlled vocabularies provide listings of synonyms and antonyms for the defined terms [81]. The development of controlled vocabularies is usually based on expert consensus to review and refine

definitions of the terms included to reflect changes in the domain over time. Once developed, controlled

vocabularies can be used to annotate or "tag" information. For example, the Medical Subject Headings (MeSH)

terms used in PubMed include a controlled vocabulary organized into taxonomy that allows annotation of the

scientific literature [82]. The terms in a controlled vocabulary are usually structured as a hierarchical taxonomy,

which specifies, for example, "walking-stroke" relationships between higher level and lower level classes.

Ontologies build on the logic of taxonomies, but they are more flexible as they allow more than one type of

relationship or taxonomy [81]. For example, in taxonomy, the "walking-balance" relationship could be expressed as

"mobility", but in ontologies, other relationships could also exist (e.g., mobility can be measured by different

sources: patient, clinician, technology). This highlights an essential distinction between taxonomy and ontology:

taxonomies define single "walking-balance" relationships. Ontologies allow for individual classes to have relations

to more than one other class, and these relations may be either the walking-balance (is_a) relationship or a variety of

other types of relations (such as is_measured_by and/or is_part_of). Therefore, having a mutually agreed upon

terminology enables better knowledge sharing and diffusion of information about mobility and will carve the way

for a standardized and comprehensive evaluation process [83].

Ideally, ontologies are codified into a computer-readable format, enabling computers to "understand" the

link between the different classes as well as the language used to define a class. Also, each class needs to have a

unique, unambiguous Uniform Resource Identifier (URIs) following best practices [84]. URIs are strings of

characters used to identify an entity or a class, for example, 'BFO_0000023' representing the entity "role" in the

Basic Formal Ontology (BFO) [81, 83]. This, for example, enables Natural Language Processing approaches to use

the ontology (along with its list of synonyms and antonyms) to detect instances of classes (described below in

Section 7.1). A commonly used ontology format is the Web Ontology Language (OWL) [85] and a system

commonly used for encoding an ontology in OWL is Protégé, an open-source ontology editor [86]. Once developed,

ontologies can be shared via publicly available portals such as https://bioportal.bioontology.org/ Table 2 contains a

guide of terms used in the ontology.

1.6.2   Best practices for developing ontologies

Noy and McGuinness [87], as well as Larsen [88], published step by step guidelines in developing and refining

ontologies for best practices, including:

1.   Define the scope of the ontology.

2.	Develop the controlled vocabulary of classes and their properties.

3.	Develop a taxonomy that defines, for example, "walking-stroke" relationships between classes.

4.	Expand on the single "walking-stroke" relationships described in the taxonomy to define all relevant relationships between different classes including the "walking-stroke" relationships described by the taxonomy.

5.	 Codify the ontology into a computer-readable format.

Ontologies have been used to transform knowledge in large areas. Most notably evidence is the comprehensive, computational model of biological systems, the Gene Ontology (http://www.geneontology.org/) [89]. The Gene Ontology is an updated and openly searchable source of knowledge about the biology of genes among all species using agreed-upon classes/entities, taxonomies, and relationships within the growing field of molecular biology. The Gene Ontology has been used to annotate more than 100,000 peer-reviewed scientific publications to provide a knowledge base that would not be possible without the ontology [90]. In addition, several ontologies have been developed for public health [91] and mental entities such as emotions [92], mental disorders and mental functioning [78]. Also, medical ontologies such as OpenGALEN [93], SNOMED-CT [94] and UMLS [95] are used in the healthcare practice. The OpenGALEN ontology was used in urology to develop a decision support system to treat patients with urinary tract infections [96]. Moreover, Jannin and Morandi [97] designed surgical models of neurosurgery using an ontology model describing 106 surgical cases which facilitate the surgical decision-making process and surgical planning.

In rehabilitation sciences, ICF is WHO's framework for describing and measuring health and disability at both individual and population levels, and it has been adopted by WHO Member States as a standard [19]. ICF is freely available at https://apps.who.int/classifications/icfbrowser/. It is divided into four main components that depend on each other: Body Functions, Body Structure, Activities and Participation, and Environmental Factors [19]. A hierarchical structure is present, where each category has a name, a text description, and inclusion and exclusion relationships [19]. The first level of hierarchy is constituted of chapters. Each category at each level has a hierarchical alphanumeric code (an example is provided in Section 1.4.1)[19]. Moreover, in its practical use, each category is qualified by a numerical value, the interpretation of which is defined within a range specific for every chapter [19]. WHO members update the health care terminologies including ICF, and have embarked on an open web-based cooperation to revise International Classification of Disease (ICD 11) using ontology-driven tools [98].

The same process has been envisaged for the ICF concentrated on the Body Functions [99] and Activity and Participation [100] components of ICF.

The ICF ontology has been developed, but it has not been tested yet. The ICF can play a pivotal role for meaningful and automated compilation and exchange of health information across sectors and levels. In order to fulfill this role, the ICF ontology needs to be tested and used in different professions in rehabilitation fields. The ICF ontology highlights the potential that ontologies can hold the potential to move rehabilitation science forward from one where domain is siloed and its data is incompatible with others, to one in which existing rich evidence is integrated, searchable, and can be further analysed to discover new relationships, develop novel hypotheses, and expose gaps in the evidence.

Computation of knowledge using ontologies is important to facilitate evidence synthesis, allowing systematic searches to be automatically and continually updated [101]. Ontology development requires considerable expertise and to that end, the Open Biological and Biomedical Ontology (OBO) Foundry [102] established to provide a resource for ontology developers and a set of guiding principles from which to work. In addition, the NCBO's BioPortal enables the biomedical community to find, comment on, and contribute to biomedical ontologies, thereby facilitating interactions among ontology users and developers to increase the value of the ontologies [103]. Stanford has developed Collaborative Protégé to allow collaborative ontology development in real-time by users in different locations [104].

Developing and testing ontologies for rehabilitation science is crucial for many reasons: (1) to share a common understanding of the structure of information (in this case mobility) among different populations including clinicians, patients, and researchers; (2) to enable reuse of domain knowledge, meaning that by developing a detailed mobility ontology in rehabilitation science, other investigators and digital health developers can reuse it; (3) to integrate many existing ontologies describing portions of the large domain; (4) to make accurate domain assumptions needed to guide an implementation, making it possible to change these assumptions easily if our knowledge about the domain changes; and (5) to analyze domain knowledge when specific terms are available. Formal analysis of terms is extremely beneficial when both are attempting to reuse existing ontologies and extending them [87, 90].

1.6.2 The importance of ontologies for predictive modeling and comparative effectiveness of mobility interventions

Developing an ontology for mobility in rehabilitation science is important to provide standardized terminology for mobility outcome measures [87, 90]. Also, this development is akin to defining a set of data and their structure for other programs to use. For example, evolving the ontology for mobility for rehabilitation science will help in analyzing an inventory list of mobility domains and suggest which domain can expand to choose the best source of information to evaluate mobility. Another application from the mobility ontology will be in influencing the decision making in choosing the proper intervention among individuals with ABI.

Given the large amounts of information that needs to be captured and integrated to gain a good understanding of mobility, information technology will play a big role in storing data and creating decision algorithms to assist clinicians in interpreting outcome measure scores and matching scores to the best interventions for a given patient [105]. The large amount of datasets across large samples, settings, and different sub-groups of individuals with different mobility profiles can be used in predictive modeling using machine learning and reasoning algorithms [81, 105-108] to identify the right intervention at the right time for the right person. Predictive models can predict effect sizes for given interventions and mechanisms of action, as moderated by outcome measures, populations, and settings. Also, it can enable the researcher and clinicians to distinguish between individuals who will benefit from a specific intervention from those that will not. Thus, predictive modeling will facilitate systematic regulations of the rehabilitation field, leading to greater standardization and increased knowledge sharing.

Machine Learning (ML) is a subset of Artificial Intelligence (AI) that enables computers to learn without being explicitly programmed with predefined rules [90]. These programs have been developed to generate and interrogate large, accumulating knowledge databases using ontological approaches [109]. It focuses on developing computer programs that can teach themselves to grow and change when exposed to new data [90]. This predictive ability enables ML to handle massive dataset with efficiency and accuracy. In the rehabilitation sciences, building computer programs that can extract and process knowledge from text documents at a level that can be used by experts in the domain requires many elements that can generally be associated with intelligence [90, 91]. Thus, a computer program performing this kind of tasks can be thought of as artificially intelligent.

In the last two decades, there has been a significant growth in algorithmic modeling applications using ML, which is more efficient and accurate than traditional statistics [110]. ML can produce more reliable information, and

27

ML algorithms do not depend on rules defined by human experts. These algorithms process data in raw form, for example text, emails, documents, social media content, images, voice, and video. ML is more prediction-oriented as compared to statistical modeling, which is generally interpretation-oriented. Statistical modeling is moving towards statistical learning to recognize patterns in text. ML is a computer program that uses examples from a training set to construct a statistical model of how a task should be performed. This model can then be generalized to process new, unseen data, thereby performing the desired task with high confidence. The computer program uses weightings learned from statistical properties, for example, frequencies with which important words appear in the text [110]. Thus, this technique is statistical.

1.7   The role of Natural Language Processing in developing the ontology

ML algorithms are categorized into (1) supervised learning that defined as the task of learning a function that maps an input to an output based on example input-output pairs. A wide range of supervised learning algorithms are available, but the most popular ones include linear/non-linear regression, classification, forecasting and attribute importance; (2) unsupervised learning is used to draw inferences from datasets consisting of input data without labelled responses. The most common unsupervised learning includes clustering, dimensionality reduction, association models; and (3) Reinforcement learning is a technique that enables an agent to learn in an interactive environment by trial and error using feedback from its own actions and experiences. Common reinforcement learning algorithms include Q-learning state-action-reward-state-action (SARSA) and Deep Q Network (DQN) [111]. The focus on this thesis is related to the Natural Language Processing (NLP), unsupervised ML.

NLP is an automatic methodology that deals with the interaction between computers and humans using natural language. The ultimate objective of NLP is to read, decipher, understand, and make sense of human languages in a manner that is valuable [112]. When aiming at grouping words and/or sentences, many approaches can be considered, including the manual one where a human simply reads out all the said words or sentences and groups them according to their own interpretation of what good groupings might be. Beyond its automatic nature and quickness, the NLP method also has the advantage of being able to classify future words (i.e. domains) or sentences (i.e. items) to the best-computed grouping on previous words or sentences.

Since the ontology for mobility that will be developed is greatly concerned with learning patterns from the text, unsupervised learning using NLP was used as a first appropriate step. NLP aimed at exploiting rich knowledge resources with the goal of understanding, extracting, and retrieving from unstructured text. Knowledge resources

that have been used for these purposes include the entire range of terminologies, including lexicons, controlled vocabularies, thesauri, and ontologies (in our case the ICF ontology: https://bioportal.bioontology.org/ontologies/ICF [112]. As discussed above (Section 1.6.1 What is an ontology?) that an ontology is a representation of entities/classes and their relationships in a particular construct, a key requirement is that each entity/class has one unique reference in the ontology, typically a meaningless identifier to avoid confusion among natural language terms. Each identifier is linked to at least one and often more than one natural language term to capture the synonymy inherent in human language [113]. A standard ontology facilitates aggregation of data from multiple sources if each source uses the identifiers from the ontology [113].

An important consideration for NLP is that an ontology be complete with respect to the construct represented as well as their relationships and natural-language synonyms. It follows that when an ontology lacks a representation of the construct, a particular term for it, or some of its particular relationships, the quality of NLP based solely on that ontology will suffer. Lack of any representation of the construct inhibits detection of that construct. Lack of a synonym prevents recognition of the construct when a document uses the synonym to refer to it. Lack of a relationship might prevent finding answers to such questions as "what role does rehabilitation play in the long-term care system among individuals with ABI?" One approach to facilitating this manual process is to use informatics tools to accelerate the interactions among domain experts and ontologists necessary to the ontology development process.

While literature and text documents are major mechanisms for reporting new knowledge about a concept, ontological knowledge is often stated explicitly or implicitly within the text, and these reference documents serve as important knowledge-rich resources for ontology learning. There is a large body of research on automating the development and maintenance of ontologies using NLP [112]. NLP can help enrich and enhance the linguistic realization of ontology as well as, it uses ontological knowledge to interpret the texts. Thus, many researchers have been utilizing methods from fields of NLP and AI to partially or fully automate semantic knowledge extraction.

Clustering is an important concept when it comes to unsupervised learning. It mainly deals with finding a pattern in a collection of uncategorized data. The clustering is useful for two reasons: First, the similarity measurements can provide information about the hierarchical relationships of concepts; second, the identification of distinct clusters of similar terms can help in identifying concepts and their synonyms. The output is often

represented by words or word clusters with associated probabilities. The conceptual explanation of the results is not provided, as full automation seems unachievable. Therefore, a human analyst must make sense of this data [114].

1.8　References

1.　Maas, A.I., N. Stocchetti, and R. Bullock, Moderate and severe traumatic brain injury in adults. *The Lancet Neurology*.2008;7(8):728-741.

2.　Patil, M., et al., Cognitive and functional outcomes following inpatient rehabilitation in patients with acquired brain injury: a prospective follow-up study. *Journal of neurosciences in rural practice*.2017;8(3): 357.

3.　Prabhakaran, V., Non-communicable diseases in India: Transitions, burden of disease and risk factors-A short story. *India health beat*.2012;6(1).

4.　Dewan, M.C., et al., Estimating the global incidence of traumatic brain injury. *Journal of neurosurgery*. 2018;130(4):1080-1097.

5.　Chambers-Richards, T.L.-T.A. Risk factors, trends, health care and general life satisfaction for select neurological conditions among aging population in Canada. 2020.

6.　Thrift, A.G., et al., Global stroke statistics. *International Journal of Stroke*.2017;12(1):13-32.

7.　Parachute, The Cost of Injury in Canada [Internet]. Toronto, ON: Parachute. 2015.

8.　Eng, J.J., S.J. Rowe, and L.M. McLaren, Mobility status during inpatient rehabilitation: a comparison of patients with stroke and traumatic brain injury. *Archives of physical medicine and rehabilitation*. 2002;83(4):483-490.

9.　Hyder, A.A., et al., The impact of traumatic brain injuries: a global perspective. *NeuroRehabilitation*. 2007; 22(5):341-353.

10.　Giustini, A., C. Pistarini, and C. Pisoni, Traumatic and nontraumatic brain injury, in Handbook of clinical neurology. *Elsevier*. 2013;401-409.

11.　Pistarini, C., et al., Functioning and disability in traumatic brain injury: the Italian patient perspective in developing ICF Core Sets. *Disability and rehabilitation*. 2011;33(22-23):2333-2345.

12.　Sveen, U., et al., Problems in functioning after a mild traumatic brain injury within the ICF framework: the patient perspective using focus groups. *Disability and Rehabilitation*. 2013;35(9):749-757.

13.　Patla, A.E. and A. Shumway-Cook, Dimensions of mobility: defining the complexity and difficulty associated with community mobility. *Journal of Aging and Physical Activity*. 1999;7(1):7-19.

14.   van Bennekom, C.A., F. Jelles, and G. Lankhorst, Rehabilitation Activities Profile: the ICIDH as a framework for a problem-oriented assessment method in rehabilitation medicine. *Disability and rehabilitation*. 1995;17(3-4):169-175.

15.   Tyson, S. and L. Connell, The psychometric properties and clinical utility of measures of walking and mobility in neurological conditions: a systematic review. *Clinical rehabilitation.* 2009;23(11):1018-1033.

16.   Ouellet, L.L. and K.L. Rush, A synthesis of selected literature on mobility: A basis for studying impaired mobility. *International Journal of Nursing Terminologies and Classifications*. 1992;3(2):72-80.

17.   Myers, A., E. Cyarto, and R. Blanchard, Challenges in quantifying mobility in frail older adults. *European Review of Aging and Physical Activity*. 2005;2:13-21.

18.   Stalvey, B.T., et al., The Life Space Questionnaire: A measure of the extent of mobility of older adults. *Journal of Applied Gerontology*. 1999;18(4):460-478.

19.   World Health Organization. International Classification of Functioning, Fisability and Health: ICF. Geneva; 2001.

20.   Webber, S.C., M.M. Porter, and V.H. Menec, Mobility in older adults: a comprehensive framework. *The Gerontologist*. 2010;50(4):443-450.

21.   May, D., U. Nayak, and B. Isaacs, The life-space diary: a measure of mobility in old people at home. *International rehabilitation medicine*. 1985;7(4):182-186.

22.   Peel, C., et al., Assessing mobility in older adults: the UAB Study of Aging Life-Space Assessment. *Physical therapy.* 2005;85(10):1008-1019.

23.   Baker, P.S., E.V. Bodner, and R.M. Allman, Measuring life-space mobility in community-dwelling older adults. *Journal of the American Geriatrics Society*. 2003;51(11):1610-1614.

24.   Shumway-Cook, A., et al., Environmental demands associated with community mobility in older adults with and without mobility disabilities. *Physical therapy.* 2002;82(7):670-681.

25.   Clarke, P., et al., Mobility disability and the urban built environment. *American journal of epidemiology*. 2008;168(5):506-513.

26.   Nagel, C.L., et al., The relation between neighborhood built environment and walking activity among older adults. *American journal of epidemiology*. 2008;168(4):461-468.

27.   Oxley, J. and M. Whelan, It cannot be all about safety: the benefits of prolonged mobility. Traffic injury prevention. 2008;9(4):367-378.

28.   Carp, F.M., Significance of mobility for the well-being of the elderly. Transportation in an aging society: Improving mobility and safety of older persons.1988;2:1-20.

29.   Rose, D., Balance, posture, and locomotion. Physical Dimensions of Aging (2nd ed.). Champaign, IL: Human Kinetics. 2005;131-151.

30.   Fuller, R., Towards a general theory of driver behaviour. *Accident analysis & prevention.* 2005;37(3):461-472.

31.   Tsai, L.-T., Walking, physical activity and life-space mobility among older people. *Studies in sport, physical education and health.* 2017(254).

32.   Commission on Social Determinants of Health. Closing the gap in a generation: health equity through action on the social determinants of health: final report of commission on social determinants of health. World Health Organization. 2008.

33.   Guralnik, J.M., et al., Physical performance measures in aging research. *Journal of gerontology.* 1989; 44(5):41-46.

34.   Butte, N.F., U. Ekelund, and K.R. Westerterp, Assessing physical activity using wearable monitors: measures of physical activity. *Medicine & Science in Sports & Exercise.* 2012;44(1S):S5-S12.

35.   Mallik, S., et al., Imaging outcomes for trials of remyelination in multiple sclerosis. *J Neurol Neurosurg Psychiatry.* 2014:307-650.

36.   Webber, S.C. and M.M. Porter, Monitoring mobility in older adults using global positioning system (GPS) watches and accelerometers: a feasibility study. *Journal of Aging and Physical Activity.* 2009;17(4):455-467.

37.   US Food and Drug Administration. Clinical outcome assessment (COA): Glossary of terms. Drug Development Tools Qualification Programs. *Silver Spring.* 2015.

38.   Ahmed, S. and D. Andrich. International Society for Quality of Life Research (ISOQOL) dictionary of quality of life and health outcomes measurement; 2015.

39.   Murphy, M.A., et al., An overview of systematic reviews on upper extremity outcome measures after stroke. *BMC neurology.* 2015;15(1):29.

40.   Miller, E.L., et al., Comprehensive overview of nursing and interdisciplinary rehabilitation care of the stroke patient: a scientific statement from the American Heart Association. *Stroke*. 2010;41(10):2402-2448.

41.   Party, I.S.W. National clinical guideline for stroke. London: Royal College of Physicians. 2012.

42.   Salter, K., et al., Issues for selection of outcome measures in stroke rehabilitation: ICF Body Functions. Disability and Rehabilitation, 2005. 27(4): p. 191-207.

43.   Salter, K., et al., Issues for selection of outcome measures in stroke rehabilitation: ICF Participation. *Disability and rehabilitation*. 2005;27(9):507-528.

44.   Salter, K., et al., Issues for selection of outcome measures in stroke rehabilitation: ICF activity. *Disability and rehabilitation*. 2005;27(6):315-340.

45.   Zumbo, B. and E. Chan, Validity and validation in social, behavioral, and health sciences (Social Indicators Research Series). *Springer International Publishing*. 2014(45).

46.   American Psychological Association & National Council of Measurement in Education. Standards for educational and psychological testing. 2014.

47.   Kane, M., The argument-based approach to validation. *School Psychology Review*. 2013;42(4):448-457.

48.   Hawkins, M., G.R. Elsworth, and R.H. Osborne, Application of validity theory and methodology to patient-reported outcome measures (PROMs): building an argument for validity. *Quality of Life Research*. 2018;27(7):1695-1710.

49.   Castillo-Díaz, M. and J.-L. Padilla, How cognitive interviewing can provide validity evidence of the response processes to scale items. *Social indicators research*. 2013;114(3):963-975.

50.   Gadermann, A.M., M. Guhn, and B.D. Zumbo, Investigating the substantive aspect of construct validity for the satisfaction with life scale adapted for children: A focus on cognitive processes. *Social Indicators Research*. 2011;100(1):37-60.

51.   Cronbach, L.J. and P.E. Meehl, Construct validity in psychological tests. *Psychological bulletin*. 1955;52(4):281.

52.   Messick, S., Test validity and the ethics of assessment. *American psychologist*. 1980;35(11):1012.

53.   Sireci, S.G., On validity theory and test validation. *Educational Researcher*. 2007;36(8):477-481.

54.   Shepard, L.A., The centrality of test use and consequences for test validity. *Educational Measurement: Issues and Practice*. 1997;16(2):5-24.

55.   Kane, M.T., An argument-based approach to validity. *Psychological bulletin.* 1992;112(3):527.

56.   Hubley, A.M. and B.D. Zumbo, Validity and the consequences of test interpretation and use. *Social Indicators Research.* 2011;103(2):219.

57.   Cook, D.A., et al., A contemporary approach to validity arguments: a practical guide to K ane's framework. *Medical education.* 2015;49(6):560-575.

58.   Moss, P.A., The role of consequences in validity theory. *Educational measurement: Issues and practice.* 1998;17(2):6-12.

59.   Prinsen, C.A., et al., How to select outcome measurement instruments for outcomes included in a "Core Outcome Set"–a practical guideline. *Trials.* 2016;17(1):449.

60.   Geyh, S., et al., ICF Core Sets for stroke. *Journal of rehabilitation medicine.* 2004;36(0):135-141.

61.   Geyh, S., et al., Identifying the concepts contained in outcome measures of clinical trials on stroke using the International Classification of Functioning, Disability and Health as a reference. *Journal of Rehabilitation Medicine.* 2004;36(0):56-62.

62.   Laxe, S., et al., What domains of the International Classification of Functioning, Disability and Health are covered by the most commonly used measurement instruments in traumatic brain injury research? *Clinical neurology and neurosurgery.* 2012;114(6):645-650.

63.   Laxe, S., et al., Development of the International Classification of Functioning, Disability and Health core sets for traumatic brain injury: an international consensus process. *Brain injury.* 2013;27(4):379-387.

64.   Laxe, S., et al., ICF use to identify common problems on a TBI neurorehabilitation unit in Spain. *NeuroRehabilitation.* 2011;29(1):99-110.

65.   Cieza, A., et al., Refinements of the ICF Linking Rules to strengthen their potential for establishing comparability of health information. *Disability and rehabilitation.* 2019;41(5):574-583.

66.   Daluiso-King, G. and C. Hebron, Is the biopsychosocial model in musculoskeletal physiotherapy adequate? An evolutionary concept analysis. *Physiotherapy theory and practice.* 2020:1-17.

67.   Stineman, M.G. and J.E. Streim, The biopsycho-ecological paradigm: a foundational theory for medicine. *PM&R.* 2010;2(11):1035-1045.

68.   Barry, M.J. and S. Edgman-Levitan, Shared decision making—The pinnacle patient-centered care. 2012.

69. Evans, D.W., N. Lucas, and R. Kerry, The form of causation in health, disease and intervention: biopsychosocial dispositionalism, conserved quantity transfers and dualist mechanistic chains. *Medicine, Health Care and Philosophy.* 2017;20(3):353-363.

70. Holopainen, R., et al., From "Non-encounters" to autonomic agency. Conceptions of patients with low back pain about their encounters in the health care system. *Musculoskeletal Care.* 2018;16(2):269-277.

71. Low, M., A novel clinical framework: the use of dispositions in clinical practice. A person centred approach. *Journal of evaluation in clinical practice.* 2017;23(5):1062-1070.

72. McMillan, S.S., et al., Patient-centered approaches to health care: a systematic review of randomized controlled trials. *Medical Care Research and Review.* 2013;70(6):567-596.

73. Epstein, R.M. and R.L. Street, The values and value of patient-centered care. *Annals Family Med.* 2011.

74. Cieza, A. and G. Stucki, The International Classification of Functioning Disability and Health: its development process and content validity. *Eur J Phys Rehabil Med.* 2008;44(3):303-313.

75. Mayo, N.E., et al., Montreal Accord on Patient-Reported Outcomes (PROs) use series–Paper 2: terminology proposed to measure what matters in health. *Journal of clinical epidemiology.* 2017;89:119-124.

76. Agarwal, R. and J. Prasad, The role of innovation characteristics and perceived voluntariness in the acceptance of information technologies. *Decision sciences.* 1997;28(3):557-582.

77. Duncan, P.W., et al., Evaluation of proxy responses to the Stroke Impact Scale. *Stroke.* 2002;33(11):2593-2599.

78. Hastings, J., et al., Representing mental functioning: Ontologies for mental health and disease. 2012.

79. Dorman, P.J., et al., A randomised comparison of the EuroQol and Short Form-36 after stroke. *Bmj.* 1997; 315(7106):461.

80. Alter, J.S., Heaps of health, metaphysical fitness: Ayurveda and the ontology of good health in medical anthropology. *Current Anthropology.* 1999;40(S1):S43-S66.

81. Arp, R., B. Smith, and A.D. Spear, Building ontologies with basic formal ontology. *Mit Press.* 2015.

82. U.S., National Library of Medicine. Fact sheet: Medical subject headings (MeSH®). 1999. Retrived March 30, 2021, from https://www.nlm.nih.gov/mesh/meshhome.html.

83.   Norris, E., et al., Identifying and evaluating ontologies related to human behaviour change interventions: a scoping review. 2018.

84.   McMurry, J.A., et al., Identifiers for the 21st century: How to design, provision, and reuse persistent identifiers to maximize utility and impact of life science data. *PLoS biology.* 2017;15(6).

85.   McGuinness, D.L. and F. Van Harmelen, OWL web ontology language overview. *W3C recommendation.* 2004;10(10):2004.

86.   Gennari, J.H., et al., The evolution of Protégé: an environment for knowledge-based systems development. *International Journal of Human-computer studies.* 2003;58(1):89-123.

87.   Noy, N.F. and D.L. McGuinness. Ontology development 101: A guide to creating your first ontology. 2001.

88.   Larsen, K., et al. Developing an interdisciplinary taxonomy of behavior. WT Riley (Chair). 2015; 37.

89.   Ashburner, M., et al., Gene ontology: tool for the unification of biology. *Nature genetics.* 2000;25(1):25-29.

90.   Larsen, K.R., et al., Behavior change interventions: the potential of ontologies for advancing science and practice. Journal of behavioral medicine, 2017. 40(1): p. 6-22.

91.   Okhmatovskaia, A., et al. Addressing the challenge of encoding causal epidemiological knowledge in formal ontologies: a practical perspective. *MIE*. 2014;1125-1129.

92.   Hastings, J., et al. In: International and Interdisciplinary Conference on Modeling and Using Context. *The Emotion Ontology: Enabling Interdisciplinary Research in the Affective Sciences*. Springer. 2011.

93.   Rector, A., J. Rogers, and P. Pole, The GALEN high level ontology. 1996.

94.   Donnelly, K., SNOMED-CT: The advanced terminology and coding system for eHealth. *Studies in health technology and informatics.* 2006;121:279.

95.   Bodenreider, O., The unified medical language system (UMLS): integrating biomedical terminology. *Nucleic Acids Research*. 2004;32(1):267-270.

96.   Karlsson, D., A Design and Prototype for a Decision-Support System in the Field of Urinary Tract Infections-Application of OpenGALEN Techniques for Indexing Medical Information. *Studies in Health Technology and Informatics.* 2001(1):479-483.

97.   Jannin, P. and X. Morandi. Erratum to "Surgical models for computer-assisted neurosurgery". *NeuroImage*. 2008; 2(39):914.

98.   WHO, F. Using the CEN/ISO standard for categorial structure to harmonise the development of WHO international terminologies. in Medical Informatics in a United and Healthy Europe: Proceedings of MIE 2009, the XXII International Congress of the European Federation for Medical Informatics. *IOS Press*. 2009.

99.   Kumar, A. and B. Smith. The ontology of processes and functions: a study of the international classification of functioning, disability and health. in Proceedings of the AIME 2005 Workshop on Biomedical Ontology Engineering, Aberdeen, Scotland. 2005.

100.   Della Mea, V. and A. Simoncello, An ontology-based exploration of the concepts and relationships in the activities and participation component of the international classification of functioning, disability and health. *Journal of biomedical semantics*. 2012;3(1):1-9.

101.   Hood, L. and M. Flores, A personal view on systems medicine and the emergence of proactive P4 medicine: predictive, preventive, personalized and participatory. *New biotechnology*. 2012;29(6):613-624.

102.   Smith, B., et al., The OBO Foundry: coordinated evolution of ontologies to support biomedical data integration. *Nature biotechnology*. 2007;25(11):1251-1255.

103.   Noy, N.F., et al. BioPortal: ontologies and integrated data resources at the click of a mouse. *Nucleic Acids Research*. 2009;37(2):W170-W173.

104.   Tudorache, T., et al. Supporting collaborative ontology development in Protégé. in International Semantic Web Conference. *Springer*. 2008.

105.   Simperl, E. and C. Tempich. In: Exploring the economical aspects of ontology engineering. *Handbook on Ontologies*. Springer; 2009;337-358.

106.   Cheng, C.K., X. Pan, and F. Kurfess. Ontology-based semantic classification of unstructured documents. in International Workshop on Adaptive Multimedia Retrieval. *Springer*. 2003.

107.   Holsapple, C.W. and K.D. Joshi. A collaborative approach to ontology design. *Communications of the ACM*. 2002;45(2):42-47.

108.   Liu, B., L. Yao, and D. Han, Harnessing ontology and machine learning for RSO classification. *SpringerPlus*. 2016;5(1):1655.

109. Huang, G.-B., Q.-Y. Zhu, and C.-K. Siew. Extreme learning machine: a new learning scheme of feedforward neural networks. IEEE international joint conference on neural networks. 2004.

110. Russell, S.J. and P. Norvig. *Artificial intelligence: A modern Approach*. Pearson Education limited. Malaysia; 2016.

111. Andrich, D. *Rasch Models for Measurement*. Sage; 1988(68).

112. Liu, K., W.R. Hogan, and R.S. Crowley, Natural language processing methods and systems for biomedical ontology learning. *Journal of biomedical informatics.* 2011;44(1):163-179.

113. Smith, B., W. Kusnierczyk, and W. Ceusters. Towards a reference terminology for ontology research and development in the biomedical domain. 2006.

114. Renganathan, V., Text mining in biomedical domain with emphasis on document clustering. *Healthcare informatics research.* 2017;23(3):141-146.

Table 1. The International Classification of Functioning, Disability, and Health linking rules

Number	Rule
1	Acquire good knowledge of the conceptual and taxonomical fundamentals of the ICF, as well as of the chapters, domains and categories of the detailed classification, including definitions before starting to link meaningful concepts to the ICF categories.
2	Identify the purpose of the information to be linked by answering the question What is this piece of information about? Or What is this item about? The answer to these questions will help to identify the main concept(s) most relevant to be linked to the ICF.
3	Identify any additional concepts contained in the piece of information in addition to the main concept(s) already identified in the previous step.
4	Identify and document the perspective taken on within a certain piece of information when linking it to the ICF.
5	Identify and document the categorization of the response options.
6	Link all meaningful concepts, the most relevant and additional ones, to the most precise ICF category.
7	Use "other specified" or "unspecified" ICF categories as appropriate.
8	If the information provided by the meaningful concept is not sufficient for making a decision about the most precise ICF category, assign the concept to nd (not definable).
9	If the meaningful concept is not contained in the ICF, but is clearly a personal factor as defined in the ICF, assign the meaningful concept to pf (personal factors).
10	If the meaningful concept is not contained in the ICF, assign this meaningful concept to nc (not covered).

Source: Cieza et al. [51]

Table 2. Glossary of terms

Terminology	Description
Ontology	In Information Science, ontologies are data structures that define classes and the relations between those classes. It is the basic form specified through taxonomy and controlled vocabulary [67].
Domain	The highest taxonomic category [67].
Taxonomy	Hierarchical tree structure illustrating relationships between classes [89].
Class	A set or category that has some property or attribute in common and differentiated from others by kind, type, or quality [89].
Attributes	The properties that characterize a class [89].
Construct	Complex ideas and concepts that occur on an empiric-abstract continuum derived from direct and indirect evidence. Abstract concepts are less empirically based and therefore dependent on the theoretical meaning used to define it [89].
Operational definition	Statement of meaning that indicates how a term or concept can be assessed empirically [89].
Knowledge base	A repository of information from the domain of interest linking classes in the ontology to instances. For example, annotating a class in the literature, or describing a specific relationship from experimental data [89].
Controlled vocabulary	A controlled vocabulary is a collection of the preferred terms in a target scientific domain, with precise, agreed upon and understandable definitions, and a listing of synonyms and antonyms for each term [67].
Mechanism of Action	Process that mediate the effect of the intervention on the outcome. These can be specified in terms of changes to capability, opportunity, motivation or others [67].
Web Ontology Language (OWL)	A formal language for describing ontologies. It provides methods to model classes of "things", how they relate to each other and the properties they are OWL is designed to be interpreted by computer programs and is extensively used in the Semantic Web where rich knowledge about web documents and the relationships between them are represented using OWL syntax [89].
Reasoning algorithms	Computer programs that can generate conclusions from available knowledge. Reasoning algorithms may derive conclusions through combinations of logic based-reasoning (where basic axioms about the physical environment are provided as a basis for reasoning) and statistical learning (where patterns are used to construct new facts) [67].

Source: Larsen et al. [74]

Figure 1. A conceptual framework for mobility
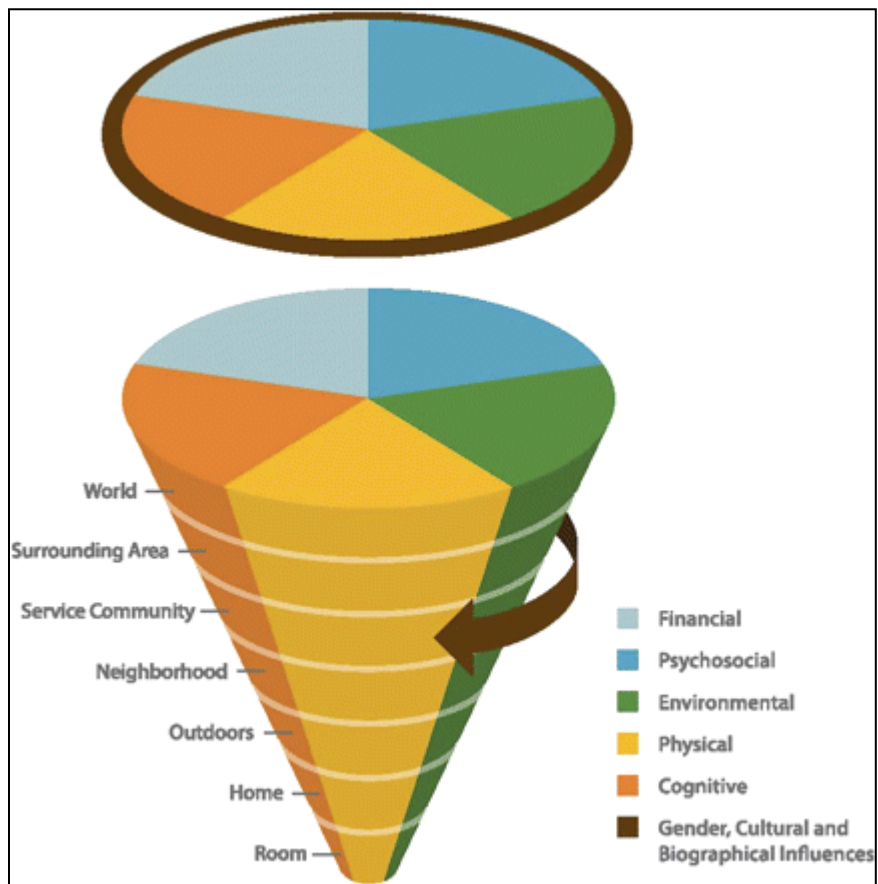
Source: Webber et al. [20]

Figure 2. The World Health Organization's International Classification, Functioning, Disability, and Health

Framework for classifying mobility
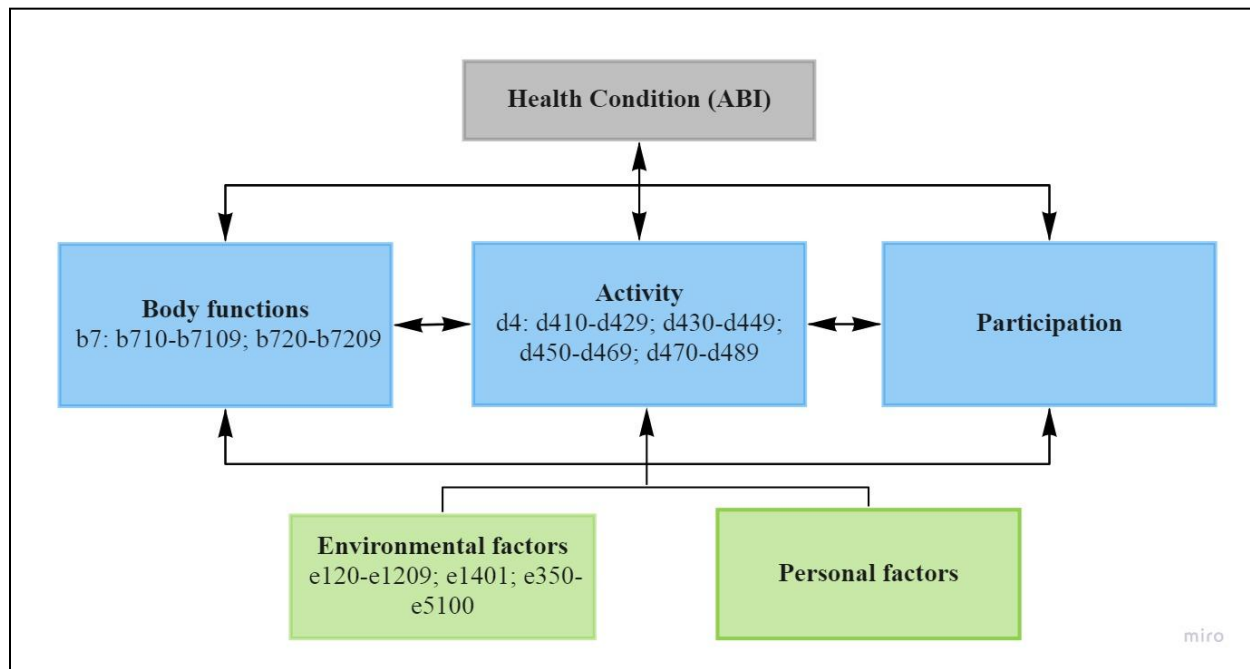
Figure 3. The International Classification of Functioning, Disability and Health Framework
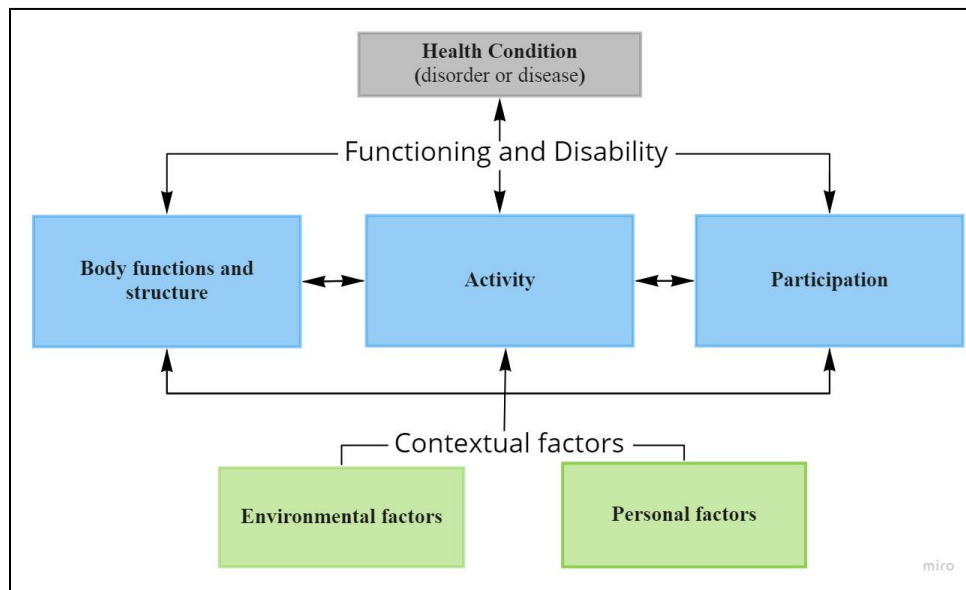
Source: WHO ICF [19]

Figure 4. The International Classification of Functioning, Disability and Health Framework
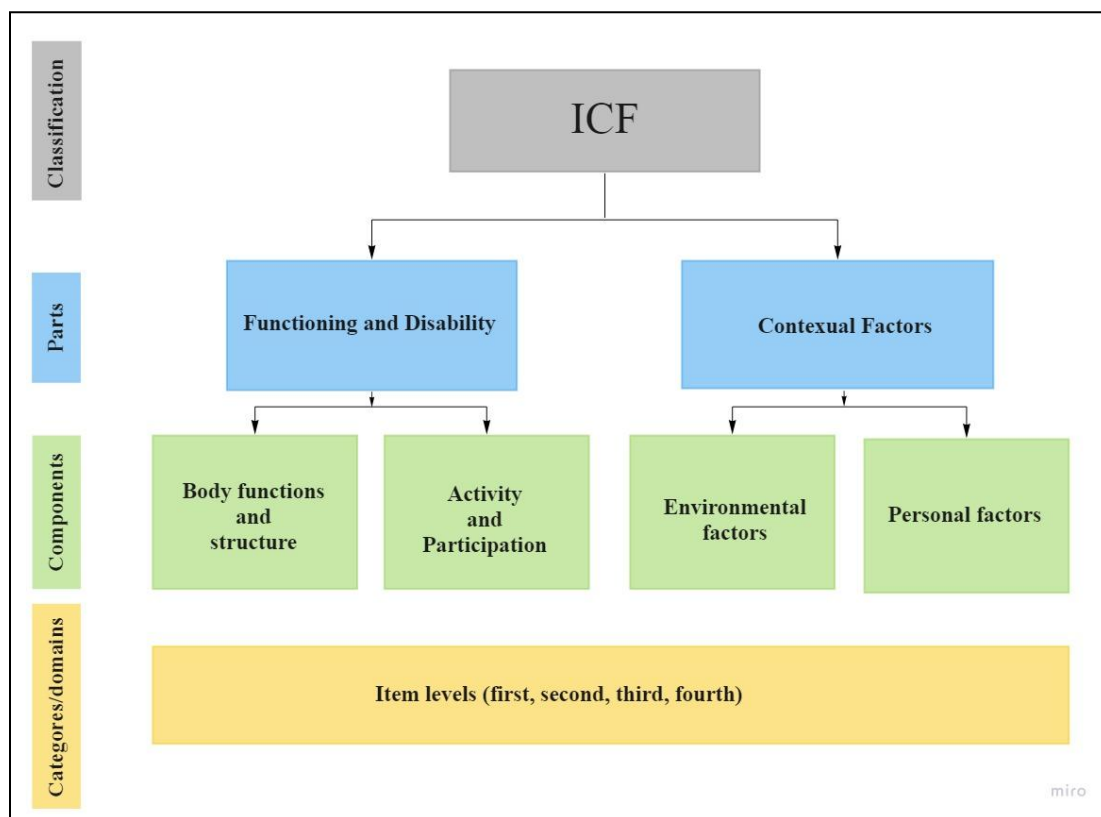
Source: WHO ICF [19]

Figure 5. The International Classification of Functioning, Disability and Health linking decision tree
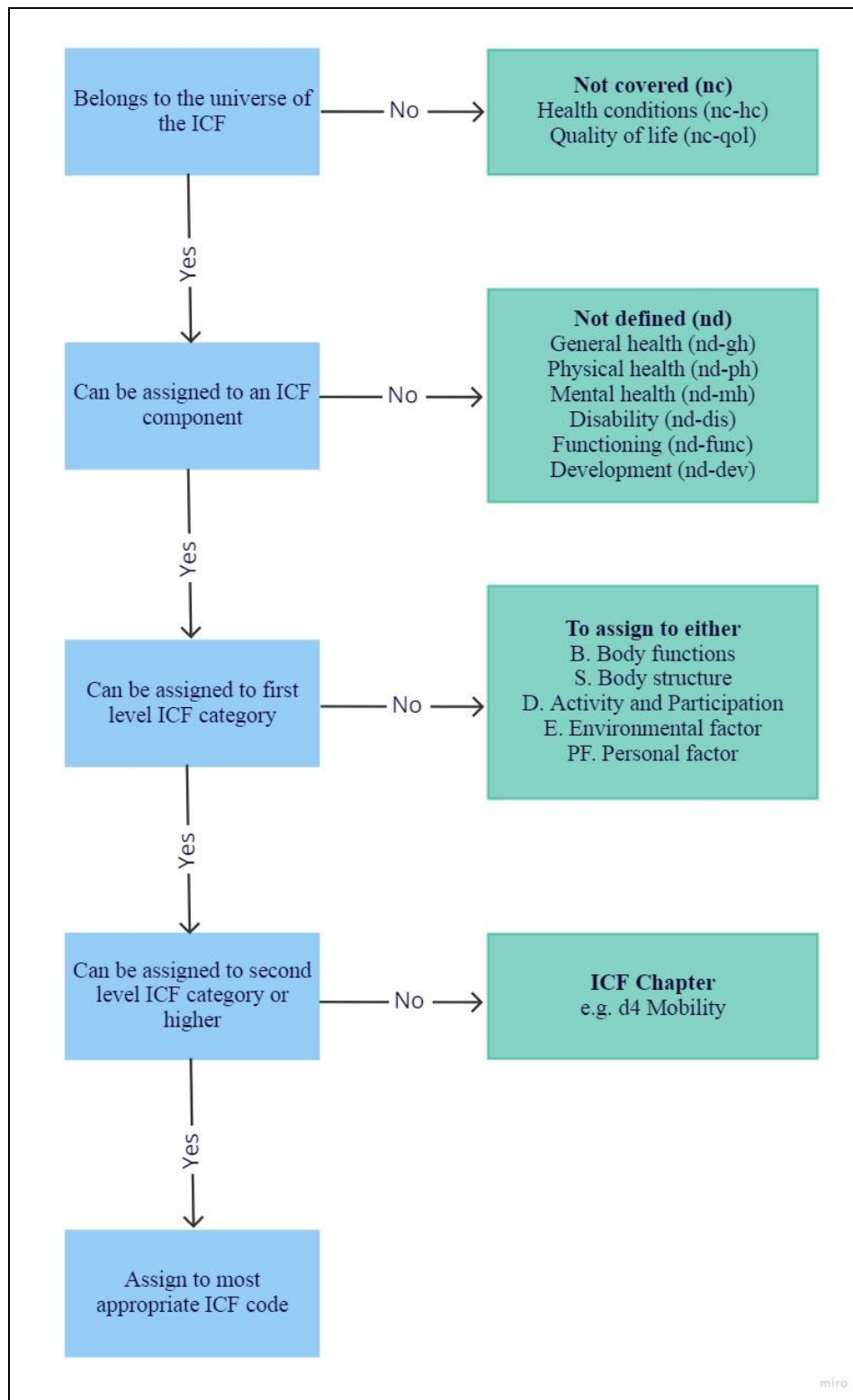
Source: Cieza et al. [51]

Figure 6. Definition of an ontology
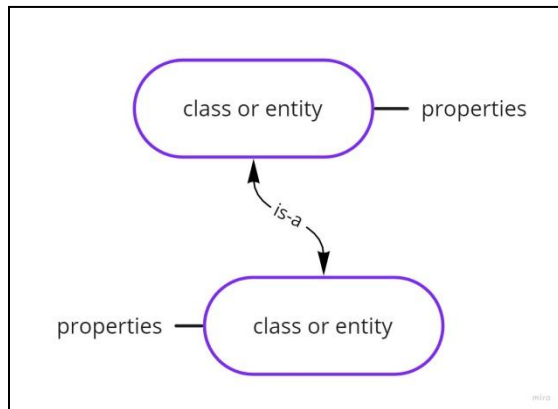
CHAPTER 2 RATIONALE AND OBJECTIVES OF THE THESIS PROJECTS

2.1   Overall objective

To provide a common language and taxonomy of mobility to help compare and select mobility measures for clinical care and research among individuals with ABI (Stroke and TBI).

2.2   Rationale

The number of individuals with ABI (Stroke and TBI) is rapidly increasing; in turn, the number of individuals with a mobility limitation and participation restrictions is on the rise [1-3]. These limitations negatively impact the individual, society, and demand on scarce health care resources. There is no reliable and comprehensive measure to evaluate mobility and the myriad of individual and environmental factors that influence mobility for individuals with ABI (Stroke and TBI). Further, to measure mobility in research, we rely on expensive laboratory technologies and performance-based tools that are burdensome in terms of set up, staff time for administration, and analysis. These tools may not be readily applied in community settings. Further, in rehabilitation, electronic platforms that can collect real-time patient and clinician-reported data are in their early stages. A common language is needed to standardize data capture in electronic platforms so that clinicians and researchers can make meaningful comparisons in outcomes within and between patients.

Despite available evidence from systematic reviews on mobility outcome measures for individuals with ABI (Stroke and TBI) [4-10], the aims of these systematic reviews of mobility outcome measures are varied and challenging to compare. These reviews are often not comprehensive in examining the range of factors that influence mobility and information sources that may be used to evaluate mobility. For example, a review may only include outcome measure to assess walking tasks [9] or only identify outcome measures reflecting "real life" functioning [4]. Also, differences can exist between reviews regarding study inclusion, and appraisal process and methodology. The heterogeneity in the methods used to synthesize mobility measures and terminology makes it difficult for clinicians, researchers, and decision-makers to determine which measures should be selected. Selecting the right mobility measure for a specific purpose such as evaluating outcomes, facilitating clinical decision-making, making an accurate long-term prognosis, or using in research to assess intervention effectiveness is even more challenging.

Generating evidence to support improvements in patients' mobility in clinical care and the effectiveness of interventions is dependent on selecting appropriate outcome measures. A synthesis of the literature on mobility establishing evidence to support improvements in patients' mobility in clinical care and the effectiveness of

interventions is dependent on the type and relevance of outcome measures used. A synthesis of mobility and determinants of mobility outcome measures is needed to provide clinicians and researchers with guidance on selecting the most appropriate measure given the patient population and clinical context and purpose of measurement. Of relevance is information on mobility measures' psychometric properties and the sources (patient, clinician, and technology) used to evaluate mobility.

Generally, any rehabilitation intervention plan begins with a comprehensive assessment of impairments, activity limitations, and participation restrictions. Choosing the most suitable intervention for individuals with ABI with mobility limitations requires a comprehensive evaluation of mobility. The intervention plan varies depending on the patients' personal context goals and the complex interplay of the factors that influence mobility. Thus, optimal measures will result in an individualized treatment plan that targets patients' needs.

There is a challenge in achieving a consensus concerning definitions of mobility because it is a latent construct reflected by many terms. This lack of common terms is evident when examining the proliferation of the theoretical frameworks related to mobility in the literature [11, 12]. Another difficulty is related to the mixing of terms and labels [13]. This lack of common terms and shared definitions for mechanisms of action, outcome measures, target individuals, and context renders the aggregation of knowledge across rehabilitation science difficult. These inconsistencies limit the precise specification of theoretical constructs of mobility, how they are measured, and the relationships between different mobility domains, which limits our capacity to integrate and summarize available evidence linked to theories efficiently and to apply those theories to decide which measure is optimal to evaluate mobility among individuals with ABI.

Given the "black box" on sharing common language and taxonomy of mobility, and inconsistency and incompleteness in reporting of study methods and findings in the rehabilitation literature, one strategy named "ontology" can be used to support an efficient knowledge representation with considerable potential. The term 'ontology' defined in information science as a data structure consisting of a set of unique identifiers representing types of "entity or class", labels and definitions corresponding to these identifiers and specified relationships between the entities/classes [14]. Therefore, having a mutually agreed upon terminology may enable better knowledge sharing and diffusion of information about mobility and will pave the way for a standardized and comprehensive evaluation process [15].

Developing an ontology for mobility in rehabilitation science is essential in order to provide a standardized terminology for mobility outcome measures [16, 17]. Also, this development is akin to defining a set of data and their structure for other programs to use. For example, evolving the ontology for mobility for rehabilitation science will help in analyzing a Core Outcome Set of mobility domains and suggest which source of information is ideal to evaluate a specific domain of mobility; for example, walking can be evaluated using both SRO and PerfO. Another application of the mobility ontology will be in influencing the decision making in choosing the proper intervention among individuals with ABI, for example, intervention aiming to improve balance impairments.

Given the massive amounts of information that needs to be captured and integrated to gain a good understanding of mobility, information technology will play a significant role in storing data and creating decision algorithms to assist clinicians in interpreting outcome measure scores and matching scores to the best interventions for a given patient [18]. The large number of datasets across large samples, settings, and different sub-groups of individuals with different mobility profiles can be used in predictive modeling using machine learning and reasoning algorithms [14, 18-21]. Predictive models will facilitate systematic regulations of the rehabilitation field, leading to greater standardization and increased knowledge sharing.

Therefore, the global aim of this PhD thesis is to provide a common language and taxonomy of mobility to help compare and select mobility measures for clinical care and research among individuals with ABI (Stroke and TBI). All manuscripts included in this PhD thesis will generate scientific evidence to advance mobility evaluation that will allow clinicians and researchers to tailor interventions to individuals' specific mobility limitations and to monitor changes. The evidence in the series of studies in this thesis includes reviewing the quality of existing outcome measures. Further evidence was generated on the mobility domains relevant to evaluate among individuals with ABI based on discussions with clinicians, persons with ABI, and their caregivers. Theoretical frameworks and expert input guided the creation of a standardized classification of mobility domains. The classification system provided a common language that will inform the development of the ontology (knowledge representation) to enable knowledge reasoning that can explain variability in mobility among individuals with ABI. Formally encoding mobility terminology within the ontology will help to reach a common language to define mobility.

There is a direct application of all manuscripts to the BRILLIANT (Biomedical Research and Informatics Living Laboratory for Innovative Advances of New Technologies in Community Mobility Rehabilitation) research program. The first objective of BRILLIANT is to identify factors limiting or enhancing mobility in real-world

community environments (public spaces including the RehabMaLL, home, outdoors), and to understand their complex interplay in individuals of all ages with ABI. The second objective of BRILLIANT is to customize community environment mobility training by continuously identifying the specific rehabilitation strategies and interventions that patient subgroups benefit from most. The thesis work will inform the optimal mobility outcome measures to include in the BRILLIANT health informatics solutions to collect relevant mobility outcome measures, using various sources of information (patient, clinicians and technology), in both clinical practice and research. The mobility ontology will be included as a coding system when programming the digital health solutions. In this way, fields (e.g. item on a measure or intervention target) can be classified appropriately in the BRILLIANT research database to facilitate use of the data for predictive analyses and development of decision support for clinical decision-making.

Moreover, these measures will be used to develop predictive algorithms that will inform which interventions work best for different individuals across various environments. Eventually, these predictive algorithms will be used within a mobility clinical decision support system that will provide patients and health professionals with evidence-based recommendations for mobility retraining. This work will contribute to the literature and scientific community a common vocabulary of mobility concepts and their interrelationships (i.e. sharing a common understanding of mobility). The mobility Core Outcome Set will facilitate predicting particular combinations of intervention content and mechanisms of action, as moderated by contextual factors, populations, and settings among clinicians, patients, caregivers, and researchers [11, 22].

2.3 Objectives

To achieve the overall objective "to provide a common language and taxonomy of mobility to help compare and select mobility measures for clinical care and research among individuals with ABI (Stroke and TBI)", all studies in this thesis were guided by the International Classification of Functioning, Health, and Disability (ICF) framework; and define the mobility ontology's scope. Webber's framework for mobility was used among all studies to identify the determinants (i.e. cognitive, physical, psychosocial, environmental, and financial) that influence mobility.

The *First Manuscript* aimed to synthesize the measurement properties, the interpretability, and the feasibility of mobility measures, from various sources of information (patients, clinicians, technology), through an umbrella review of published systematic reviews among individuals with ABI (stroke, TBI). This study contributed to synthesizing mobility measures by mapping mobility domains from these measures to the ICF to inform the Core Outcome Set of mobility.

The *Second Manuscript* aimed to identify factors influencing mobility which need to be considered while evaluating mobility, and incorporating patients' needs and preferences into individualized care management plans among individuals with ABI (stroke, TBI), as perceived by clinicians, individuals with ABI, and their caregivers. This study contributed to identifying mobility measures used in the clinics, and the determinants of mobility. The factors influencing mobility were also mapped to the ICF, further contributing to inform a future Core Outcome Set of mobility.

The *Third Manuscript* aimed to explore the care experiences and service design related to rehabilitation for mobility and participation in the community among individuals with ABI (stroke, TBI), as perceived by clinicians, individuals with ABI, and their caregivers. This study explored rehabilitation service provision for mobility and identified the societal environmental determinants that influence mobility. The environmental factors influencing mobility were also mapped to the ICF, further contributing to inform a future Core Outcome Set of mobility.

The *Fourth Manuscript* aimed to identify a comprehensive outcome set of mobility, and develop preliminary banks of items of mobility among individuals with ABI (stroke, TBI) using Natural Language Processing. This study contributed a comprehensive set ups of domains and items that will be used in creating a Core Outcome Set of mobility.

2.4   References

1.   Giustini, A., C. Pistarini, and C. Pisoni. In: Traumatic and Nontraumatic Brain Injury. *Handbook of Clinical Neurology*. Elsevier; 2013;401-409.

2.   Hyder, A.A., et al. The impact of traumatic brain injuries: a global perspective. *NeuroRehabilitation*. 2007;22(5):341-353.

3.   Statistics Canada. Retrieved December 4, 2018, from https://www.canada.ca/en/public-health/services/reports-publications/mapping-connections-understanding-neurological-conditions.html#tables.

4.   Ashford, S., S. Brown, and L. Turner-Stokes. Systematic review of patient-reported outcome measures for functional performance in the lower limb. *Journal of Rehabilitation Medicine*. 2015;47(1):9-17.

5.   Fini, N.A., et al. How is physical activity monitored in people following stroke? *Disability and Rehabilitation*. 2015;37(19):1717-1731.

6.   Hong, I. and H.S. Bonilha. Psychometric properties of upper extremity outcome measures validated by Rasch analysis: a systematic review. *International Journal of Rehabilitation Research*. 2017;40(1):1-10.

7.   Rowland, T.J. and L. Gustafsson. Assessments of upper limb ability following stroke: a review. British *Journal of Occupational Therapy*. 2008;71(10):427-437.

8.   Tyson, S. and L. Connell. The psychometric properties and clinical utility of measures of walking and mobility in neurological conditions: a systematic review. *Clinical Rehabilitation.* 2009;23(11):1018-1033.

9.   van Bloemendaal, M., A.T. van de Water, and I.G. van de Port. Walking tests for stroke survivors: a systematic review of their measurement properties. *Disability and Rehabilitation*. 2012;34(26):2207-2221.

10.   Velstra, I.-M., C.S. Ballert, and A. Cieza. A systematic literature review of outcome measures for upper extremity function using the international classification of functioning, disability, and health as reference. *PM&R*. 2011;3(9):846-860.

11.   World Health Organization. *International Classification of Functioning, Fisability and Health: ICF*. Geneva; 2001.

12.   Webber, S.C., M.M. Porter, and V.H. Menec. Mobility in older adults: a comprehensive framework. *The Gerontologist*. 2010;50(4):443-450.

13.   Mayo, N.E., et al. Montreal Accord on Patient-Reported Outcomes (PROs) use series–Paper 2: terminology proposed to measure what matters in health. *Journal of Clinical Epidemiology.* 2017;89:119-124.

14.   Arp, R., B. Smith, and A.D. Spear. *Building Ontologies with Basic Formal Ontology*. Mit Press; 2015.

15.   Norris, E., et al. Identifying and evaluating ontologies related to human behaviour change interventions: a scoping review. 2018. https://doi.org/10.31234/osf.io/y7dus.

16.   Larsen, K.R., et al. Behavior change interventions: the potential of ontologies for advancing science and practice. *Journal of Behavioral Medicine*. 2017;40(1):6-22.

17.   Noy, N.F. and D.L. McGuinness. Ontology development 101: A guide to creating your first ontology. 2001.

18.   Simperl, E. and C. Tempich. In: Exploring the Economical Aspects of Ontology Engineering. *Handbook on Ontologies*. Springer; 2009;337-358.

19.   Cheng, C.K., X. Pan, and F. Kurfess. In: Ontology-based Semantic Classification of Unstructured Documents. *International Workshop on Adaptive Multimedia Retrieval*. Springer; 2003.

20.   Holsapple, C.W. and K.D. Joshi. A collaborative approach to ontology design. *Communications of the ACM*. 2002;45(2):42-47.

21.   Liu, B., L. Yao, and D. Han. Harnessing ontology and machine learning for RSO classification. *SpringerPlus*.2016;5(1):1655.

22.   World Health Organization. *Active Ageing: A policy Framework*. Geneva; 2002.

CHAPTER 3 MANUSCRIPT 1

Title: Quality of Mobility Measures among Individuals with Acquired Brain Injury: An Umbrella Review

Rehab Alhasani, MSc,[1,2,6] Claudine Auger, PhD,[2,4,5] Matheus de Paiva Azevedo, BSc,[1] Sara Ahmed, PhD [1-3]

* This manuscript has been accepted for publication in the Quality of Life Research Journal

Author affiliations:

1. School of Physical and Occupation Therapy, Faculty of Medicine, McGill University, Montréal, Canada

2. Centre de Recherche Interdisciplinaire en Réadaptation (CRIR), Montréal, Canada

3. Constance Lethbridge Rehabilitation Center, CIUSSS Centre Ouest de l'Île de Montréal, Montréal, Canada

4. School of Rehabilitation, Faculty of Medicine, University de Montréal, Montréal, Canada

5. Site Institut Universitaire sur la Réadaptation en Déficience Physique de Montréal (IURDPM), CIUSSS Centre-Sud-de- l'Île -de-Montréal, Montréal, Canada

6. Department of Rehabilitation Sciences, College of Health and Rehabilitation Sciences, Princess Nourah bint Abdulrahman University, Riyadh, Saudi Arabia

Corresponding author:

Sara Ahmed, PhD.
School of Physical and Occupation Therapy, Faculty of Medicine, McGill University
3655 Sir William-Osler
Montreal, QC, Canada, H3G 1Y6
E-mail: sara.ahmed@mcgill.ca
Tel.: 514-398-4400 ext. 00531.

3.1 Abstract

Objective: To synthesize the measurement properties, the interpretability and the feasibility of mobility measures, from various sources of information (patients, clinicians, technology), through an umbrella review of published systematic reviews among individuals with acquired brain injury.

Methods: Ovid MEDLINE, CINHAL, Cochrane Library and EMBASE electronic databases were searched from 2000 to March 2020. Two independent reviewers appraised the methodological quality of the systematic reviews using the Joanna Briggs Institute critical appraisal checklist. Measurement properties and quality of evidence were applied according to COnsensus-based Standards for the Selection of Health Measurement Instrument (COSMIN) guidelines. Mobility measures were categorized using international standards with the International Classification of Functioning, Disability and Health (ICF).

Results: Thirty-five systematic reviews were included covering 147 mobility measures (stroke/acute: n=24%; stroke/sub-acute=9%; stroke/chronic: n=83%; and traumatic brain injury: n=11%), of which 85% were mapped to the ICF Activity and Participation component. Results showed an acceptable overall "sufficient" rating for reliability in 133 (90%) of measures, construct validity in 128 (87%), and responsiveness in 76 (52%); however, results indicated a limited "High" quality of evidence among the systematic reviews. Also, there was limited information that supports measure feasibility and scoring interpretability.

Conclusions: Future systematic reviews should report measures' content validity to support the use of the measure in clinical care and research. More evaluations of the minimal important difference and floor and ceiling effects are needed to help guide clinical interpretation.

Registration information: International Prospective Register of Systematic Reviews (PROSPERO); ID: CRD42018100068

Key Words: Umbrella review, Acquired Brain Injury, Mobility, Measures, Psychometrics.

3.2   Introduction

Acquired Brain Injury (ABI), including traumatic brain injury (TBI) and stroke, are the leading causes of disability worldwide [1-3]. According to the World Health Organization, the global incidence of all-severity TBI is estimated at 69 million people, while 15 million people suffer a stroke worldwide each year [4-6]. Statistics Canada indicates that 100,000 Canadians will experience a stroke (59%) or a TBI (71%) each year [5]. Among the 1.5 million Canadians with ABI that go through the care continuum annually; over 60% report ongoing restrictions in mobility and participation in societal roles [5]. Webber et al. [7] defined mobility broadly as the ability to move oneself within environments that expand from one's home to the neighbourhood and regions beyond. It identifies five "key" interrelated determinants of mobility: cognitive, psychosocial, physical, environmental, and financial influences. The multidimensionality and complexity of all domains that encompass mobility are also reflected in the International Classification, Functioning, Disability, and Health Framework (ICF) mobility core set [8]. The ICF classifies mobility under body function, including motion of all body bones and joints. In the activities and participation section, mobility is given an entire chapter, and it is about moving by changing body position or location; or by transferring from one place to another, by using the upper extremity in carrying, moving or manipulating objects, by walking, running or climbing, and by using various forms of transportation. In the environmental factors section, mobility is classified as products, devices, domesticated animals, and services used for transportation [8].

Appropriate outcome measures are critical to accurately characterize and monitor changes in mobility during rehabilitation interventions for individuals with ABI [9]. However, selection of the best measure is difficult given the vast number of measures available, and the often-unclear distinctions between them. While published guidelines recommend the use of valid, reliable, and responsive assessment tools [10-13], guidance does not extend to which outcome measures are optimal for particular evaluative needs [14-18]. Researchers and clinicians also need to consider the content of measures and whether the domains evaluated match research and clinical objectives. A comparative examination of mobility measures will provide researchers and clinicians with the information needed to select the best outcome measure(s) to address the impairments, activity limitations, and participation restrictions experienced by individuals with ABI. The ICF framework can be used to systematically classify the different domains of available outcome measures and, therefore, provide an additional basis for selection of a measure, based on comparison of content [8].

There are also different sources of information (SOI) of mobility measures. Outcomes that can only be assessed by asking the person directly are termed patient-reported outcomes (PROs) while clinician-reported outcomes (ClinROs) involve clinical judgment. Performance-reported outcomes (PerfOs) require patient cooperation and motivation [19]. Technology-based outcomes (TechOs) include sensors or assistive technologies to capture community mobility [20]. Self-reported outcomes (SROs) are not the same as PROs because SROs are outcomes that can be reported by the person with ABI but also observed and scored by someone else [24,25,22]. Most existing reviews on measuring mobility among individuals with ABI are limited to physical aspects and do not account for an expanded definition of mobility that encompasses mobility determinants [21-27]. Many walking measures are available and provide an index of what an individual can do or believes they can do, but the extent to which they indicate actual performance in the home environment is limited [28]. Life-space measures attempt to capture broader mobility, including mobility inside and outside the home, within the neighbourhood, and beyond [29]. However, life-space measures do not capture transportation patterns or community engagement directly. To date, reviews have indicated that no measure evaluates mobility holistically among individuals with ABI.

Without considering the multidimensional nature of mobility, evaluations will inadequately prepare individuals to return to the community post-rehabilitation, and limits our ability to correctly identify interventions which target factors that influence mobility in a given context. Clinicians require information on the content of measures to select comprehensive measures of mobility, as well as on measurement properties to ensure the minimum decision criteria to personalize care and deliver high-quality rehabilitation.

Moreover, Clinicians and clinical researchers may be unfamiliar with how to interpret a measure score. They may not understand or have reference to the usual distribution of scores of a particular measure in a clinical or general population. Without knowledge of normal ranges, clinicians may not know what cut-points of scoring indicate that action is warranted. Without reference values from a comparable population, researchers will not know whether an observed difference between two groups is meaningful, and whether a given change within or between groups is important [30]. In addition, the feasibility of using a measure (i.e., the time, cost required, length of the instrument, type and ease of administration, etc.) is another important aspect for a well-considered selection of the most appropriate measure [30, 31]. Thus, this study aimed to address these gaps by conducting a comprehensive synthesis of existing evidence on measurement properties, the interpretability, and the feasibility of mobility measures using an umbrella review [32] of published systematic reviews among individuals with ABI.

3.3. Objective

To conduct a comprehensive synthesis of existing evidence on measurement properties, the interpretability, and the feasibility of mobility measures from various SOI (patients, clinicians, technology) using an umbrella review of published systematic reviews among individuals with ABI.

3.4 Methods

This umbrella review was reported according to both the Joanna Briggs Institute (JBI) guidelines for conducting an umbrella review [33], and the COnsensus-based Standards for the Selection of Health Measurement Instrument (COSMIN) guidelines for systematic reviews of outcome measures [31] (Figure 1). The reasons for conducting a JBI umbrella review was to summarize evidence from more than one existing research syntheses evidence related to a given topic or question [33]. Given that the JBI umbrella review guidelines did not focus on providing a rigorous methodology to assess the measurement properties and describe the interpretability and the feasibility of an instrument, COSMIN guidelines were used [31].

3.4.1 Eligibility criteria

The inclusion criteria were systematic reviews published in peer-reviewed journals, including individuals with ABI (Stroke, TBI); ≥18 years, which: report a clear objective to identify measures of mobility; include either multiple or single measures(s) of mobility; report on and/or evaluate the measurement properties of the measures. The exclusion criteria were: reviews investigating the effectiveness of interventions, monitoring recovery, focusing on diagnostic screening, clinical commentaries, case reports, non-structured reviews, qualitative reviews, non-human studies, and grey literature.

3.4.2 Search strategy

A search of the literature was performed using electronic databases of Ovid MEDLINE, CINHAL, Cochrane Library and EMBASE from 2000 to March 2020. The search was conducted in collaboration with a health sciences librarian to ensure that the review included the appropriate and necessary keywords. The initial search strategy was constructed for Ovid MEDLINE (Appendix 1) and adapted to other databases. A combination of Medical Subject Headings (MeSH) terms, subject headings and/or key words was used. Three groups of terms were generated describing: (1) the population "acquired brain injury" AND; (2) The outcome measure "mobility"; AND (3) psychometric properties using a sensitive validated search filter [34]. Terms within each group were combined with the Boolean operator 'OR'. Because the search included different types of studies, the search was narrowed by

filtering the search specifying the type of studies including systematic review, review, and meta-analyses. This filter has been used to avoid missing important information related to mobility measures. Searches were run in July 2019 (n=32) with an updated search in March 2020 (n=35).

3.4.3 Study selection

All identified systematic reviews were uploaded into ENDNote X9.1 (Clarivate Analytics, PA, USA) and duplicates removed. Two independent reviewers screened titles and abstracts of each systematic review against the eligibility criteria. Then, full-text of the included systematic reviews were retrieved and evaluated for eligibility. Disagreements were resolved by discussion and consensus. The reference list of the articles included for the full-text screening was also hand-searched for additional identification of relevant systematic reviews. The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) flow diagram [35] was used to guide the selection process.

3.4.4 Linking to the ICF

Each extracted mobility measure was linked to the ICF according to a set of linking rules [8, 36]. A measure can be linked to one or more ICF components (Body Functions and Structure, Activity and Participation, and Contextual Factors), depending on the number of constructs contained in each measure.

3.4.5 Data extraction

Two reviewers independently extracted descriptive data from the included systematic reviews based on both JBI data extraction tool for Systematic Reviews and Research Syntheses [33] and COSMIN guidelines [31]. We extracted the characteristics of each systematic review; characteristics of mobility measures; healthcare settings or recovery phase where the mobility measure was used (if possible); results on the measurement properties; the interpretability of the scores of the measure; and the feasibility of the measure. Extracted outcome measures were categorized according to the study population, SOI, and settings.

3.4.6 Appraising methodological quality

The JBI critical appraisal checklist for systematic reviews and research syntheses quality assessment tool that includes 11 items was used to evaluate the quality of the systematic reviews [33]. In addition, the 4-point COSMIN rating scale was used to evaluate the methodological quality of studies on a measurement property in each included systematic review, this evaluation is important as low-quality studies are considered to have a high risk of

biased results. Each study was rated as very good, adequate, doubtful, or inadequate quality. Two independent reviewers evaluated the methodological quality followed by discussions and consensus [31, 37].

3.4.7 Levels of evidence appraisal

Based on COSMIN guidelines [31], results of each single study on a measurement property were rated against the updated criteria for good measurement properties [38]. Each result was rated as sufficient (+), insufficient (-), or indeterminate (?). A levels-of-evidence appraisal was undertaken to determine the overall quality of each measurement property, established in the different studies. The appraisal produced a final rating for each measure for each of the measurement properties. All available information was synthesised, combining the results qualitatively into one overall category of the different studies for each measure. The overall rating for the summarized results was then rated as sufficient (+), insufficient (-), inconsistent (±), or indeterminate (?) [31, 39]. The quality of the evidence was graded by using the modified-Grading of Recommendations Assessment, Development, and Evaluation (modified-GRADE) approach, the quality of the evidence was graded as High, Moderate, Low, or Very Low [31]. Two independent reviewers completed the evaluation before consensus discussions.

3.4.8 Overview of measurement properties

The psychometric results reported in the systematic reviews were described and categorised into the following COSMIN measurement properties including content/structural validity, internal structure, reliability, measurement error, construct validity and responsiveness. Table 1 presents the updated criteria for good measurement properties based on COSMIN guidelines [31].

Evaluate content validity

Content validity is defined as "the degree to which the content of the outcome measure is an adequate reflection of the construct to be measured", and is considered the most important measurement property [40]. In the COSMIN guidelines, Terwee et al. [41] describe three aspects of content validity, including relevance, comprehensiveness, and comprehensibility.

Evaluate internal structure

Internal structure refers to the relation among different items in the outcome measure. The evaluation of the internal structure includes an evaluation of:

Structural validity is defined as "the degree to which the scores of the outcome measures are an adequate reflection of the dimensionality of the construct to be measured" [31].

Internal consistency is defined as "the degree of interrelatedness among the items. [31].

Cross-cultural validity is defined as "the degree to which the performance of the items on a translated or culturally adapted outcome measure is comparable with the original version of the outcome measure. [31].

Evaluate the remaining measurement properties

Reliability is defined as "the degree to which the measurement is free from measurement error" [31].

Measurement error is defined as "the systematic and random error of a patient's score that is not attributed to true changes in the construct to be measured" [31].

Construct validity is defined as "the degree to which the scores of an instrument are consistent with hypotheses (for instance concerning internal relationships, relationships to scores of other instruments, or differences between relevant groups) based on the assumption that the instrument validly measures the construct to be measured" [31].

Responsiveness is defined as "the ability of an instrument to detect change over time in the construct to be measured" [31].

3.4.9   Describe interpretability and feasibility

Interpretability and feasibility are not measurement properties, because they do not refer to the quality of the outcome measure. However, they are considered important aspects for a well-considered selection of the outcome measure.

Interpretability is defined as "the degree to which one can assign qualitative meaning, that is, clinical or commonly understood connotations to an instrument's quantitative scores or change in scores". It includes distribution of the scores in the study population, floor and ceiling effect, minimal important change, and minimal important difference [31].

Feasibility is defined as "the ease of application of the measure in its intended setting; given constraints such as time or money". It includes type and ease of administration, length of the instrument, completion time, ease of score calculation, cost of the instruments, required equipment available in different settings [31].

3.5   Results

3.5.1   Search results

The search strategy yielded a total of 35 systematic reviews. Figure 2 presents the PRISMA flow diagram including the selection process and reasons for exclusion.

3.5.2 Characteristics of the systematic reviews

The 35 systematic reviews were published between 2004 and 2019 in peer-reviewed journals. Nine reviews focused mainly on ClinRO/PerfO; 7 on PRO/SRO; 2 on TechO; and 17 reports mixed SOI. Twenty-six reviews targeted individuals with stroke [16-18, 22, 24, 26, 42-61], three targeted both stroke and TBI [21, 62, 63]; one targeted TBI [64], and five incorporated stroke and TBI as part of a wider population search [23, 25, 27, 28, 65]. 320 mobility measures were extracted from the systematic review. After removing the duplicates, 147 measures were identified; some measures were used in multiple healthcare settings. The included systematic reviews did not specify the recovery phase for individuals with TBI (Appendix 2).

3.5.3 Linking to ICF

The 147 mobility measures covered the component of Activities and Participation (85%), followed by Body functions (30%) (Table 2)

3.5.4 Methodological quality

Based on the JBI guidelines checklist, nine (26%) reviews used a standardized methodology, either PRISMA guidelines [21, 49, 52-54, 57] or standardized accepted guidelines from previously published work [25, 46, 63]. Although the literature search and evaluation of measurement properties of the review was generally acceptable, a minority of systematic reviews (17%) [21, 26, 49, 52-54] used the COSMIN Risk of Bias checklist, which resulted in low quality of evidence (Appendix 3). We have applied the 4-point COSMIN rating scale to evaluate the quality of studies in each included systematic review. Among the 147 mobility measures, we found that the quality for content validity was rated as adequate or higher in 16 (11%) of measures; for internal consistency in 45 (30%); for reliability in 54 (36%); for construct validity in 101 (68%); and for responsiveness in 46 (67%) (Appendix 4). Many measurement properties were not reported, and there was inconsistent reporting between studies. None of the included systematic reviews reported cross-cultural validity or criterion validity.

3.5.5 Levels of evidence

Table 3 presents the level of evidence for the 147 mobility measures. The overall rating of summarized results were rated as "sufficient" for content validity in 56 (38%) of measures, internal consistency in 49 (33%), reliability in 133 (90%), measurement error in 12 (8%), construct validity in 128 (87%), and responsiveness in 76

(52%). After applying the modified-GRADE criteria, the quality of evidence were graded as "High" for content validity in 21(14%) of measures, internal consistency in 14 (9%), reliability in 37 (25%), measurement error in 3 (2%), construct validity in 33 (22%), and responsiveness in 19 (13%). All reported outcome measures below had "sufficient" measurement properties and "High" quality of evidence. The results were presented by population, SOI, and settings (For more information about the process of evaluating the level of evidence, please see Appendix 5, 6 & 7).

3.5.6   Overview of measurement properties

Content validity was reported among individuals with stroke in (1) acute setting, for a PRO and a PerfO of measures; (2) sub-acute setting, for a PerfO of measures; (3) chronic setting, for 6 ClinROs, 7 PerfOs and 3 PROs. Among individuals with TBI, content validity was reported for a ClinRO and a PRO.

Internal consistency was reported among individuals with stroke in (1) sub-acute setting, for a SRO of measures; (2) chronic setting, for 4 ClinROs, 4 PerfOs, 2 PROs and a SRO of measures. Among individuals with TBI, internal consistency was reported for 2 PROs of measures. None of the systematic reviews reported internal consistency with "sufficient" and "High" quality of evidence among individuals with stroke in acute setting.

Reliability was reported among individuals with stroke in (1) acute setting, test-retest reliability was reported for a ClinRO and 3 PROs of measures, inter-rater reliability for a PerfO of measures; (2) sub-acute setting, test-retest reliability for a PerfO of measures; (3) chronic Setting, test-retest reliability for 10 ClinROs, 11 PerfOs, 3 PROs and a SRO of measures; inter-rater reliability for 3 ClinROs and 4 PerfOs of measures; intra-rater reliability for 2 ClinROs and 3 PerfOs of measures. Among individuals with TBI, test-retest reliability was reported for a ClinRO, a PerfO and a PRO of measures; inter-rater reliability for 2 PerfOs and 2 PROs of measures and intra-rater for a PerfO of measures.

Measurement error was reported among individuals with stroke in (1) sub-acute setting for a PerfO of measures (6MWT: SEM=12.4-23.2 meter); (3) chronic setting for 2 PerfOs of measures (2MWT: SEM= 4.7-5.1 meter; 6MWT: SEM=12.4-18.6 meter). None of the systematic reviews reported measurement error with "sufficient" rating and "High" quality of evidence among individuals with stroke in acute setting or for individuals with TBI.

Construct validity was reported among individuals with stroke in (1) acute setting, for 2 PROs of measures, (2) sub-acute setting, for a PerfO of measures; (3) chronic Setting, for 10 ClinROs, 7 PerfOs, 5 PROs, 4 SROs and a

TechO of measures. Among individuals with TBI, construct validity was reported for a PerfO and 2 PROs of measures.

Responsiveness was reported among individuals with stroke in (1) acute setting, for 7 PerfOs and 2 ClinROs of measures, (2) chronic Setting, for 4 ClinROs, 4 PerfOs and 2 PROs of measures. None of the systematic reviews reported responsiveness with "sufficient" and "High" quality of evidence among individuals with stroke in sub-acute setting or for individuals with TBI.

3.5.7   Description of interpretability and feasibility

Forty-Four measures met the standards and criteria for interpretability and feasibility, and were evaluated among individuals with stroke in (1) acute setting, for 2 SROs, 3 PerfOs, and 2 ClinROs of measures; (2) sub-acute setting, for 3 PROs, 3 SROs, 3 ClinROs, 12 PerfOs of measures; (3) chronic setting, for 2 PROs, a SRO, 4 ClinROs, 4 PerfOs, and a TechO of measures; and among individuals with TBI, for 5 PROs, 2 SROs, and 10 PerfOs of measures. Information about floor and ceiling effects was limited and only reported in 7 (5%) of measures (Table 4).

3.6   Discussion

This umbrella review aimed to synthesize the measurement properties, the interpretability, and the feasibility of mobility measures evaluated using clinician, patient, and technology derived information among individuals with ABI. Additionally, unified results from several reviews can provide a larger body of evidence and strengthen the recommendations based on these findings. In this review, 85% of 147 mobility measures among 35 systematic reviews were mapped mainly to the ICF component of Activity and Participation. This finding is consistent with previous studies that mapped the construct of mobility measures into the components of Activity and Participation [23, 26, 27, 46, 48, 56, 66, 67]. Also, our results showed that current mobility measures lack information on Environmental Factors. Therefore, we recommend increasing the coverage of Environmental Factors when evaluating mobility, especially as evidence accumulates about how to tailor interventions to specific individual profiles [67].

Without published guidelines for umbrella reviews for measurement properties, we applied the COSMIN guidelines for systematic reviews of outcome measures to guide the methodology of this review [31]. This facilitated comparing the evidence supporting the measures' measurement properties across systematic reviews; identifying strengths and limitations of mobility measures; and supporting the selection of outcome measures for a specific

purpose. Our findings showed that the systematic reviews' methodological quality using the JBI critical appraisal tool was relatively low as 83% of systematic reviews did not apply COSMIN Risk of Bias checklist. The use of clear, unified criteria for evaluation of measurement properties enables a reasonable comparison between the findings and is recommended for future systematic reviews.

Although content validity is considered the most important measurement property [31], only 11% of measures were evaluated as "adequate". High-quality content validity systematic reviews include studies with representative samples of target users who could attest to the relevance, comprehensiveness, and comprehensibility of the measurement tool [31]. Future systematic reviews should report measures' content validity, as the appropriate content as perceived by target users imperative to support the use of the measure in clinical care and research. None of the included systematic reviews reported cross-cultural validity, meaning it is unknown if the tool's content validity is maintained at a conceptual level across cultures and languages. Also, criterion validity was not reported in any study due to lack of a 'gold standard', according to the COSMIN definition [31]. Therefore, future systematic reviews should include cross-cultural validity and criterion validity when evidence is available according to COSMIN guidelines [31].

Results showed an acceptable overall "sufficient" rating for reliability in 133 (90%) of measures, construct validity in 128 (87%), and responsiveness in 76 (52%); however, results indicated a limited "High" quality of evidence among the systematic reviews. One reason was related to the sample size, as the majority of systematic reviews included studies with sample size either <50 or unreported. Recruiting an adequate sample size to detect modest but important effect sizes is a challenge in the current state of training and funding in rehabilitation research [68]. The synthesis of the sample size used to evaluate the measurement properties of each measure in this review can be used to inform the sample size that is ideal for future evaluation of mobility measures.

Only 30% of mobility measures contained information on interpretability and feasibility. For every SOI, there are different reasons for lack of feasibility which should be reported in future studies. For ClinRO/PerfO, feasibility is primarily expressed as the proportion of missing data for participants that cannot be assessed [66]. For PRO/SRO, whether participants required assistance is considered while evaluating feasibility [69]; and for TechO, the complexity of tracking motion while carrying out daily activities may influence feasibility [70]. Less information was provided in terms of scoring interpretability. Future studies should evaluate the minimal important difference or minimal important change, and floor and ceiling effects to help guide clinical interpretation.

Results identified mobility measures that were rated as "sufficient" for most measurement properties as well as interpretability and feasibility, including Rivermead Mobility Index (RMI), Six-minute Walking test (6MWT), Ten-meter Walking test (10MWT), Barthel Index (BI), Berg Balance Scale (BBS), Frenchay Activity Index (FAI) and Stroke Impact Scale (SIS) among individuals with stroke, and RMI and 6MWT among individuals with TBI. RMI and 6MWT have been used across the continuum of care, SIS and 10MWT were used in both sub-acute and chronic settings, and FAI, BI and BBS were used at both acute and chronic settings. These widely used measures, however, have limitations in that they cannot be used in certain contexts; for example, a patient with cognitive impairment or unable to change body position. Decisions about the inclusion or exclusion of a mobility measure need to consider applicability to all patients and clinical contexts [71].

Few reviews of mobility measures focused on TBI as compared to stroke. Many of the outcome measures that were developed for individuals with TBI are either related to injury severity (e.g. Glasgow Coma Scale), or reflect global outcome (e.g. Disability Rating Scale). Multidimensional tools reflecting complex ranges of factors affecting TBI outcomes may be required for assessment across the continuum of care depending on level of recovery and context of practice, and the need to evaluate community activities.

Evidence of intervention effectiveness depends on the common use of valid and reliable measures, which reflect clinically important outcomes and are responsive to change. Despite the increased use of validated outcomes, different outcome measures are being used in clinical sites, impacting the identification and implementation of best practices. This review provided a comprehensive classification of mobility measures, from all possible sources, and mapped the constructs measured in each measure to the ICF. These results will be used as part of a consensus process to select a Core Outcome Set for mobility to unify the language of measuring mobility among individuals with ABI, and standardize measures used across clinical sites and studies.

Terminologies for SOI were used interchangeably with no distinctions if patients or clinicians reported on a domain in a measure. For example, in a systematic review of PRO measures for functional performance [21] in the lower limb, they did not distinguish between SROs and PROs. Distinction between different SOI is important as, in addition to the items and scale, the respondent influences the interpretation of the scores. Thus, a common language for the SOI needs to be standardized to facilitate the selection of measures ensuring that evaluations of change within and between patients can be compared. In this review, we used SOI definitions published by Mayo et al. [19].

Moreover, to capture the quality of movement, technological measures are required. For example, accelerometry provides kinematic data that can provide an opportunity to extend the quality and accuracy of measurement, filling the gaps not covered by the ClinRO, PRO, and SRO scales. However, we found variations in evaluation of measurement properties between the different technologies. Two systematic reviews [22, 45] incorporated technology measures, without a standardized evaluation of the measurement properties. Standardisation of how TechO measurement properties are tested is needed to increase applicability of rapidly emerging technologies in research and clinical care.

3.7   Study limitations

The main strength of this umbrella review is that we have independently applied COSMIN guidelines to synthesise the measurement properties, interpretability and feasibility of ABI mobility measures. The main limitations included: (1) data on measurement properties relied on what was in the reviews and were not retrieved or evaluated from primary studies; (2) articles before the year 2000 were not included. This decision was based on the rationale that the recommendations for appropriate statistical methods and interpretation of the results changed over time; (3) articles with low methodological quality were not excluded, as this review intended to be a comprehensive review of measures of mobility among individuals with ABI; (4) according to the standards at the time of publication, many studies used different terms and statistical methods to examine measurement properties. Applying modern measurement standards often requires "translation" between the author's terminology and COSMIN terms; (5) systematic reviews of measures that only evaluated determinants were not included to limit the scope of this review. However, some measures included determinants of mobility as part of the content, and these are reported in this review; (6) this review is still limited in capturing all mobility measures, as we only included systematic reviews reporting measurement properties and used systematic literature searches to enable an unbiased selection of the outcome measures. It is possible that we have missed tools that are used in clinical practice but have not been applied in research. Therefore, we missed studies that mapped mobility measures to the ICF without considering the measurement properties [12, 72-81]. Some of these domains may become important for a Core Outcome Set for mobility to standardize mobility measures among individuals with ABI.

3.8   Conclusions

A comprehensive systematic synthesis of evidence regarding the measurement properties of mobility measures among individuals with ABI can provide guidance for researchers and clinicians for evidence-based

outcome measure selection. RMI, BI, FAI, BBS, 6MWT, 10MWT and SIS had the strongest measurement properties as well as interpretability and feasibility; however, each of these measures were limited in evaluating mobility comprehensively. Future reviews should consider tools which comprehensively capture the degree of complexity and variety of deficits experienced by individuals surviving TBI. Identifying the most critical domains for mobility based on the ICF is critical to guide the development of the Core Outcome Set among individuals with ABI. Future systematic reviews should report measures' content validity to support the use of the measure in clinical care and research. Also, they are encouraged to evaluate the minimal important difference or minimal important change, and floor and ceiling effects to help guide clinical interpretation.

3.9   References

1. Maas, A.I., N. Stocchetti, and R. Bullock. Moderate and severe traumatic brain injury in adults. *The Lancet Neurology.* 2008;7(8):728-741.

2. Patil, M., et al. Cognitive and functional outcomes following inpatient rehabilitation in patients with acquired brain injury: a prospective follow-up study. *Journal of Neurosciences in Rural Practice*. 2017;8(3):357.

3. Prabhakaran, V. Non-communicable diseases in India: Transitions, burden of disease and risk factors-A short story. *India Health Beat*. 2012;6(1).

4. Dewan, M.C., et al. Estimating the global incidence of traumatic brain injury. *Journal of Neurosurgery*. 2018;130(4):1080-1097.

5. Chambers-Richards, T.L.-T.A. Risk factors, trends, health care and general life satisfaction for select neurological conditions among aging population in Canada. 2020.

6. Thrift, A.G., et al. Global stroke statistics. *International Journal of Stroke*. 2017;12(1):13-32.

7. Webber, S.C., M.M. Porter, and V.H. Menec. Mobility in older adults: a comprehensive framework. *The Gerontologist.* 2010;50(4):443-450.

8. World Health Organization. *International Classification of Functioning, Disability and* Health: ICF. Geneva; 2001.

9. Murphy, M.A., et al. An overview of systematic reviews on upper extremity outcome measures after stroke. *BMC Neurology.* 2015;15(1):29.

10. Otterman, N., et al. Selecting relevant and feasible measurement instruments for the revised Dutch clinical practice guideline for physical therapy in patients after stroke. *Disability and Rehabilitation.*2017;39(14): 1449-1457.

11. Sullivan, J.E., et al. Outcome measures for individuals with stroke: process and recommendations from the American Physical Therapy Association neurology section task force. *Physical Therapy*. 2013;93(10): 1383-1396.

12. McCulloch, K.L., et al. Outcome measures for persons with moderate to severe traumatic brain injury: recommendations from the American Physical Therapy Association Academy of Neurologic Physical Therapy TBI EDGE Task Force. *Journal of Neurologic Physical Therapy*. 2016;40(4):269-280.

13. Russell, S.J. and P. Norvig. *Artificial Intelligence: A Modern Approach*. Pearson Education Limited. Malaysia; 2016.

14. Miller, E.L., et al. Comprehensive overview of nursing and interdisciplinary rehabilitation care of the stroke patient: a scientific statement from the American Heart Association. *Stroke*. 2010;41(10):2402-2448.

15. Party, I.S.W. National clinical guideline for stroke. London: Royal College of Physicians. 2012.

16. Salter, K., et al. Issues for selection of outcome measures in stroke rehabilitation: ICF Body Functions. *Disability and Rehabilitation* 2005;27(4):191-207.

17. Salter, K., et al. Issues for selection of outcome measures in stroke rehabilitation: ICF Participation. *Disability and Rehabilitation*. 2005;27(9):507-528.

18. Salter, K., et al. Issues for selection of outcome measures in stroke rehabilitation: ICF activity. *Disability and Rehabilitation*. 2005;27(6):315-340.

19. Mayo, N.E., et al. Montreal Accord on Patient-Reported Outcomes (PROs) use series–Paper 2: terminology proposed to measure what matters in health. *Journal of Clinical Epidemiology.* 2017; 89:119-124.

20. Webber, S.C. and M.M. Porter., Monitoring mobility in older adults using global positioning system (GPS) watches and accelerometers: a feasibility study. *Journal of Aging and Physical Activity*. 2009;17(4):455-467.

21. Ashford, S., S. Brown, and L. Turner-Stokes. Systematic review of patient-reported outcome measures for functional performance in the lower limb. *Journal of Rehabilitation Medicine*. 2015;47(1):9-17.

22. Fini, N.A., et al. How is physical activity monitored in people following stroke? *Disability and Rehabilitatio.* 2015;37(19):1717-1731.

23. Hong, I. and H.S. Bonilha, Psychometric properties of upper extremity outcome measures validated by Rasch analysis: a systematic review. *International Journal of Rehabilitation Research.* 2017;40(1):1-10.

24. Rowland, T.J. and L. Gustafsson, Assessments of upper limb ability following stroke: a review. *British Journal of Occupational Therapy*. 2008;71(10):427-437.

25. Tyson, S. and L. Connell, The psychometric properties and clinical utility of measures of walking and mobility in neurological conditions: a systematic review. *Clinical Rehabilitation*. 2009;23(11):1018-1033.

26. van Bloemendaal, M., A.T. van de Water, and I.G. van de Port, Walking tests for stroke survivors: a systematic review of their measurement properties. *Disability and Rehabilitation*. 2012;34(26):2207-2221.

27.   Velstra, I.-M., C.S. Ballert, and A. Cieza. A systematic literature review of outcome measures for upper extremity function using the international classification of functioning, disability, and health as reference. *PM&R*. 2011;3(9):846-860.

28.   Pearson, O.R., et al. Quantification of walking mobility in neurological disorders. *QJM*. 2004;97(8):463-475.

29.   Peel, C., et al. Assessing mobility in older adults: the UAB Study of Aging Life-Space Assessment. *Physical Therapy*. 2005;85(10):1008-1019.

30.   Velentgas, P., N.A. Dreyer, and A.W. Wu. Outcome definition and measurement, in Developing a protocol for observational comparative effectiveness research: a user's guide. Agency for Healthcare Research and Quality. USA. 2013.

31.   Prinsen, C., et al., COSMIN guideline for systematic reviews of patient-reported outcome measures. *Quality of Life Research*. 2018;27(5):1147-1157.

32.   Aromataris, E., et al. Summarizing systematic reviews: methodological development, conduct and reporting of an umbrella review approach. *International Journal of Evidence-Based Healthcare*. 2015; 13(3):132-140.

33.   Aromataris, E., et al. Methodology for JBI umbrella reviews. 2014.

34.   Terwee, C.B., et al. Development of a methodological PubMed search filter for finding studies on measurement properties of measurement instruments. *Quality of Life Research*. 2009;18(8):1115-1123.

35.   Moher, D., et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic Reviews*. 2015;4(1):1.

36.   Cieza, A., et al. Refinements of the ICF Linking Rules to strengthen their potential for establishing comparability of health information. *Disability and Rehabilitation*. 2019;41(5):574-583.

37.   Mokkink, L.B., et al. COSMIN risk of bias checklist for systematic reviews of patient-reported outcome measures. *Quality of Life Research*. 2018;27(5):1171-1179.

38.   Terwee, C.B., et al. Quality criteria were proposed for measurement properties of health status questionnaires. *Journal of Clinical Epidemiology*. 2007;60(1):34-42.

39.   Prinsen, C.A., et al. How to select outcome measurement instruments for outcomes included in a "Core Outcome Set" a practical guideline. *Trials*. 2016;17(1):1-10.

40. Mokkink, L.B., et al. The COSMIN study reached international consensus on taxonomy, terminology, and definitions of measurement properties for health-related patient-reported outcomes. Journal of Clinical Epidemiology. 2010;63(7):737-745.

41. Terwee, C.B., et al. COSMIN methodology for evaluating the content validity of patient-reported outcome measures: a Delphi study. *Quality of Life Research*. 2018;27(5):1159-1170.

42. Baker, K., S.J. Cano, and E.D. Playford. Outcome measurement in stroke: a scale selection strategy. *Stroke*. 2011;42(6):1787-1794.

43. Barak, S. and P.W. Duncan. Issues in selecting outcome measures to assess functional recovery after stroke. *NeuroRx*. 2006;3(4):505-524.

44. Croarkin, E., J. Danoff, and C. Barnes, Evidence-based rating of upper-extremity motor function tests used for people following a stroke. *Physical Therapy*. 2004;84(1):62-74.

45. Gebruers, N., et al. Monitoring of physical activity after stroke: a systematic review of accelerometry-based measures. *Archives of Physical Medicine and Rehabilitation*. 2010;91(2):288-297.

46. Geroin, C., et al. Systematic review of outcome measures of walking training using electromechanical and robotic devices in patients with stroke. *Journal of Rehabilitation Medicine*. 2013;45(10):987-996.

47. Gor-García-Fogeda, M.D., et al. Scales to assess gross motor function in stroke patients: a systematic review. *Archives of Physical Medicine and Rehabilitation*. 2014;95(6):1174-1183.

48. Lemmens, R.J., et al. Valid and reliable instruments for arm-hand assessment at ICF activity level in persons with hemiplegia: a systematic review. *BMC Neurology*. 2012;12(1):21.

49. Martins, J.C., et al. Measurement properties of self-report physical activity assessment tools for patients with stroke: a systematic review. *Brazilian Journal of Physical Therapy*. 2019;23(6):476-490.

50. Oczkowski, C. and M. O'Donnell. Reliability of proxy respondents for patients with stroke: a systematic review. *Journal of Stroke and Cerebrovascular Diseases*. 2010;19(5):410-416.

51. Pollock, C., J. Eng, and S. Garland, Clinical measurement of walking balance in people post stroke: a systematic review. *Clinical Rehabilitation*. 2011;25(8):693-708.

52. Salbach, N.M., et al. Considerations for the selection of time-limited walk tests poststroke: a systematic review of test protocols and measurement properties. *Journal of Neurologic Physical Therapy*. 2017;41(1):3-17.

53.   Scrivener, K., C. Sherrington, and K. Schurr. A systematic review of the responsiveness of lower limb physical performance measures in inpatient care after stroke. *BMC Neurology*. 2013;13(1):4.

54.   Silva, P.F., et al. Measurement properties and feasibility of clinical tests to assess sit-to-stand/stand-to-sit tasks in subjects with neurological disease: a systematic review. *Brazilian Journal of Physical Therapy*. 2014;18(2):99-110.

55.   Simpson, L.A. and J.J. Eng. Functional recovery following stroke: capturing changes in upper-extremity function. *Neurorehabilitation and Neural Repair*. 2013;27(3):240-250.

56.   Sivan, M., et al. Systematic review of outcome measures used in the evaluation of robot-assisted upper limb exercise in stroke. *Journal of Rehabilitation Medicine*. 2011;43(3):181-189.

57.   Sorrentino G., S.P., Solaro C., Rabini A., Cerri C., Ferriero G. Clinical measurement tools to assess trunk performance after stroke: a systematic review. *European Journal of Physical and Rehabilitation Medicine*. 2018.

58.   Teale, E.A. and J.B. Young. A review of stroke outcome measures valid and reliable for administration by postal survey. *Reviews in Clinical Gerontology*. 2010;20(4):338-353.

59.   Tse, T., et al. Measuring participation after stroke: a review of frequently used tools. *Archives of Physical Medicine and Rehabilitation*. 2013;94(1):177-192.

60.   Van Peppen, R.P., et al. The development of a clinical practice stroke guideline for physiotherapists in The Netherlands: a systematic review of available evidence. *Disability and Rehabilitation*. 2007;29(10):767-783.

61.   Verheyden, G., et al. Clinical tools to measure trunk performance after stroke: a systematic review of the literature. *Clinical Rehabilitation*. 2007;21(5):387-394.

62.   Ashford, S., et al. Evaluation of functional outcome measures for the hemiparetic upper limb: a systematic review. *Journal of Rehabilitation Medicine*. 2008;40(10):787-795.

63.   Connell, L.A. and S.F. Tyson. Clinical reality of measuring upper-limb ability in neurologic conditions: a systematic review. *Archives of Physical Medicine and Rehabilitation*. 2012;93(2):221-228.

64.   Wilde, E.A., et al. Recommendations for the use of common outcome measures in traumatic brain injury research. *Archives of Physical Medicine and Rehabilitation*. 2010;91(11):1650-1660.

65. Stevens, P.M. Clinimetric properties of timed walking events among patient populations commonly encountered in orthotic and prosthetic rehabilitation. *Journal of Prosthetics and Orthotics*. 2010;22(1):62-74.

66. Mortenson, W.B., W.C. Miller, and C. Auger. Issues for the selection of wheelchair-specific activity and participation outcome measures: a review. *Archives of Physical Medicine and Rehabilitation*. 2008;89(6):1177-1186.

67. Menezes, K.V.R.S., et al. Instruments to evaluate mobility capacity of older adults during hospitalization: a systematic review. *Archives of Gerontology and Geriatrics*. 2017;72:67-79.

68. Asano, M., et al. What does a structured review of the effectiveness of exercise interventions for persons with multiple sclerosis tell us about the challenges of designing trials? *Multiple Sclerosis Journal.* 2009;. 15(4):412-421.

69. Auger, C., L. Demers, and B. Swaine. Making sense of pragmatic criteria for the selection of geriatric rehabilitation measurement tools. *Archives of Gerontology and Geriatrics*. 2006;43(1):65-83.

70. Maceira-Elvira, P., et al. Wearable technology in stroke rehabilitation: towards improved diagnosis and treatment of upper-limb motor impairment. *Journal of Neuroengineering and Rehabilitation*. 2019;16(1): 142.

71. Auger, C., et al. Applicability of a toolkit for geriatric rehabilitation outcomes. *Disability and Rehabilitation*. 2007;29(2):97-109.

72. Geyh, S., et al. Identifying the concepts contained in outcome measures of clinical trials on stroke using the International Classification of Functioning, Disability and Health as a reference. *Journal of Rehabilitation Medicine*. 2004;36(0):56-62.

73. Lord, S.E. and L. Rochester. Measurement of community ambulation after stroke: current status and future developments. *Stroke*. 2005;36(7):1457-1461.

74. McCabe, P., et al. Community reintegration following acquired brain injury. *Brain Injury*. 2007;21(2):231-257.

75. Nichol, A.D., et al. Measuring functional and quality of life outcomes following major head injury: common scales and checklists. *Injury*. 2011;42(3):281-287.

76.   Steins, D., et al. Wearable accelerometry-based technology capable of assessing functional activities in neurological populations in community settings: a systematic review. *Journal of Neuroengineering and Rehabilitation.* 2014;11(1):1-13.

77.   Verceles, A.C. and E.R. Hager. Use of accelerometry to monitor physical activity in critically ill subjects: a systematic review. *Respiratory Care*. 2015;60(9):1330-1336.

78.   Wang, Q., et al. Interactive wearable systems for upper body rehabilitation: a systematic review. *Journal of Neuroengineering and Rehabilitation*. 2017;14(1):1-21.

79.   Wang, S., et al. Evaluation of performance-based outcome measures for the upper limb: a comprehensive narrative review. *PM&R*. 2018;10(9):951-962.

80.   Williams, G., V. Robertson, and K. Greenwood. Measuring high-level mobility after traumatic brain injury. *American Journal of Physical Medicine & Rehabilitation*. 2004;83(12):910-920.

81.   Zheng, H., N.D. Black, and N.D. Harris. Position-sensing technologies for movement analysis in stroke rehabilitation. *Medical and Biological Engineering and Computing.* 2005;43(4):413-420.

Table 1. Updated criteria for good measurement properties

Measurement property	Rating[1]	Criteria
Structural/content validity	+	CTT CFA: CFI or TLI or comparable measure > 0.95 OR RMSEA < 0.06 OR SRMR < 0.08[2] IRT/Rasch No violation of unidimensionality[3]: CFI or TLI or comparable measure > 0.95 OR RMSEA < 0.06 OR SRMR < 0.08 AND no violation of local independence: residual correlations among the items after controlling for the dominant factor < 0.20 OR Q3's < 0.37 AND no violation of monotonicity: adequate looking graphs OR item scalability > 0.30 AND adequate model fit IRT: $\chi2 > 0.001$ Rasch: infit and outfit mean squares ≥ 0.5 and ≤ 1.5 OR Z-standardized values > -2 and < 2
	?	CTT: not all information for '+' reported IRT/Rasch: model fit not reported
	-	Criteria for '+' not met
Internal consistency	+	At least low evidence[4] for sufficient structural validity[5] AND Cronbach's alpha(s) ≥ 0.70 for each unidimensional scale or sub-scale[6]
	?	Criteria for "At least low evidence for sufficient structural validity[5] not met
	-	At least low evidence for sufficient structural validity AND Cronbach's alpha(s) < 0.70 for each unidimensional scale or sub-scale[6]
Reliability	+	ICC or weighted Kappa ≥ 0.70
	?	ICC or weighted Kappa not reported
	-	ICC or weighted Kappa < 0.70
Measurement error	+	SDC or LoA < MIC[5]
	?	MIC not defined
	-	SDC or LoA > MIC[5]
Hypotheses testing for construct validity	+	The result is in accordance with the hypothesis[7]
	?	No hypothesis defined (by the review team)
	-	The result is not in accordance with the hypothesis[7]
Responsiveness	+	The result is in accordance with the hypothesis[7] OR AUC ≥ 0.70
	?	No hypothesis defined (by the review team)
	-	The result is not in accordance with the hypothesis[7] OR AUC < 0.70

The criteria are based on COSMIN guidelines

AUC = area under the curve, CFA = confirmatory factor analysis, CFI = comparative fit index, CTT = classical test theory, DIF = differential item functioning, ICC = intraclass correlation coefficient, IRT = item response theory, LoA = limits of agreement, MIC = minimal important change, RMSEA: Root Mean Square Error of Approximation, SEM = Standard Error of Measurement, SDC = smallest detectable change, SRMR: Standardized Root Mean Residuals, TLI = Tucker-Lewis index

1 "+" = sufficient, " –" = insufficient, "?" = indeterminate

2 To rate the quality of the summary score, the factor structures should be equal across studies

3 unidimensionality refers to a factor analysis per subscale, while structural validity refers to a factor analysis of a (multidimensional) patient-reported outcome measure

4 As defined by grading the evidence according to the GRADE approach

5 This evidence may come from different studies

6 The criteria 'Cronbach alpha < 0.95' was deleted, as this is relevant in the development phase of a PROM and not when evaluating an existing PROM.

7 The results of all studies should be taken together and it should then be decided if 75% of the results are in accordance with the hypotheses

Table 2. Linking to the International Classification of Functioning, Health and Disability Framework (ICF)

Name of the measure	Area of assessment	Number of domain/items	Activity and Participation	Body Functions	Environmental Factors	Personal Factors
Clinician-Reported Outcomes (ClinROs)						
Action Research Arm test (ARAT)	ADL, Coordination, Dexterity, Upper extremity function	4 domains and 19 items	x			
Actual Amount of Use Test (AAUT)	ADL, Dexterity, Upper extremity function	14 items	x			
Balance Assessment in Sitting and Standing Position (BASSP)	Functional mobility	2 items	x	x		
Box and Block test	ADL, Coordination, Dexterity, Upper extremity function	1 item	x			
Brunel Balance Assessment	Balance	12 items	x			
Chedoke McMaster Stroke Assessment (CMSA)	Functional mobility	Impairment: 6 domains; Activity: Gross motor function: 10 items; Walking index: 5 items	x	x		
Four Square Step	ADL and Balance	1 item	x			
Frenchay Arm Test (FAT)	ADL, Upper extremity function, Dexterity	5 items	x			
Fugl-Meyer Assessment (FMA)	ADL, Functional mobility, Pain	5 domains and 226 items		x		
Fugl-Meyer Assessment-Upper extremity (FMA-UE)	Upper extremity function	33 items		x		
Fugl-Meyer test-Balance subscale (FM-B)	Balance	7 items		x		
Functional Ambulation Category (FAC)	Functional mobility and Gait	1 item	x			
Functional Ambulation Classification Hospital (FACHS)	Functional ambulation	1 item	x			
Functional Independence measure (FIM)	ADL	18 items (Motor tasks: 13; Cognitive tasks: 5)	x	x	x	
Functional Test for the Hemiplegic Upper Extremity (FTHUE)	Upper extremity functioning	7 domains	x	x		
Grip strength	Strength, Upper extremity	1 item		x		
Grooved Pegboard Test (GPT)	Coordination, Dexterity	5 items		x		
Manual Function Test (MFT)	Strength	Determined by the number of muscles being tested				
Mini Mental State Examination (MMSE)	ADL and Cognition	7 domains and 11 items		x		
Modified Ashworth Scale	Spasticity	Depends on number of muscles/joints tested				
Modified Emory Functional Ambulation Profile (M-EFAM)	Functional ambulation	5 items	x			
Motor Assessment Scale (MAS)	ADL and Functional mobility	8 items	x			
Motor Assessment Scale-Upper limb (MAS-UL)	Upper extremity function	6 items	x			
Motor Evaluation Scale for Upper Extremity in Stroke Patients (MESUPES)	Dexterity, ROM, Upper extremity function	17 items (Arm function: 8 items, Hand function: 9 items)	x			
Motor Free Visual Perception Test	Vision and Perception	36 items		x		
Motor status scale	Upper extremity function, ROM	4 domains		x		
Motricity index (MI)	Upper extremity function and Functional mobility	6 items				
National Institute of Health Stroke Scale (NIHSS)	Aphasia, Behavior, Cognition, Dysarthria, Vision and Perception	15 items		x		
Neurobehavioral Cognition Status Exam (NCSE)	Cognition	62 items		x		

Name of the measure	Area of assessment	Number of domain/items	Activity and Participation	Body Functions	Environmental Factors	Personal Factors
Nine-Hole Peg test (NHPT)	Dexterity, Upper extremity Function	1 item	x	x		
Ottawa Sitting Scale (OSS)	Functional mobility	1 item	x	x		
Pens taped to feet	Motor control	1 item		x		
Quadriplegia Index of Function	ADL	37 items	x			
Sitting Rising Test (SRT)	Functional mobility and Balance	1 item	x			
Sodring motor evaluation for stroke patients	Motor Function	2 domains and 32 items	x			
Step test	Balance	1 item	x			
Stroke Arm Ladder (SAL)	Upper extremity Function	34 items	x			
Stroke Rehabilitation assessment of movement (STREAM)	Coordination, Functional mobility, ROM	3 domains and 30 items	x	x		
Trunk Control Test (TCT)	Balance, Functional mobility	4 items				
Trunk Impairment Scale	Balance, Coordination, Functional mobility	17 items	x			
Trunk Recovery Scale (TRS)	Recovery	12 items		x		
Upper Body Dressing Scale (UBDS)	Upper body dressing	7 items	x	x		
Upper Extremity Functional Index (UEFI)	Upper extremity function	20 items	x	x		
Upper Extremity Performance Test for Elderly (Test d'Evaluation des Members supérieurs de Personnes Agées (TEMPA)	Upper extremity function	9 items	x	x		
Van Lieshout Test	Dexterity, Functional mobility, ROM	10 items	x			
Observer-Reported Outcomes (ObsROs)						
Activities of Daily Living scale	Functional mobility	25 items	x			
Functional Arm Activity Behavioral Observation System (FAABOS)	Behavior, Activity		x	x		
Performance-Reported Outcome (PerfOs)						
10-meter walking test	Functional mobility, Gait	1 item	x			
12-meter walking test	Functional mobility, Gait	2 items	x			
2-meter walking test	Functional mobility, Gait	3 items	x	x		
300mWT (Three hundred metre Walk Test in community)	Functional mobility, Gait	1 item	x			
30mCWT (Thirty metre Comfortable Walk Test)	Functional mobility, Gait	1 item	x			
3-meter walking test	Functional mobility, Gait	1 item	x			
4mCWT (Four metre Comfortable Walk Test)	Functional mobility, Gait	1 item	x			
5-meter walking test	Functional mobility, Gait	1 item	x			
6-minute walking test	Functional mobility, Gait	1 item	x			
Arm Motor Ability Test (AMAT)	ADL and Upper extremity function	13 items	x			
Assessment of Life habit (LIFE-H)	ADL, Communication, ADL, Executive functioning, Life participation, Quality of life	2 domains and 77 items	x			
Assessment of Motor and Process Skills (AMPS)	ADL, Attention and Working memory, Executive functioning, Insight, Processing speed, Reasoning, Balance, Coordination, Functional mobility, Gait	36 items (ADL motor skill: 16; ADL process skill: 20)	x			
Balance Evaluation System test (BESTest)	Balance, Gait and Strength	6 domains and 36 items	x			
Barthel Index (BI)	ADL, Functional mobility, Gait	10 items	x			

Name of the measure	Area of assessment	Number of domain/items	Activity and Participation	Body Functions	Environmental Factors	Personal Factors
Berg Balance Scale (BBS)	Balance and Functional mobility	14 items	x			
Berg Balance Scale three point (BBS-3P)	Balance and Functional mobility	7 items	x			
Chedoke Arm and Hand Inventory (CAHAI)	ADL and Upper extremity function	13 items	x			
Community balance and mobility scale (CB&M)	Balance and Functional mobility	13 items	x			
Dynamic Gait Index (DGI)	Balance, Functional mobility, Gait	8 items	x			
Fitts Reaching test	Balance	4 items		x		
Five times Sit to Stand test (5xSTST)	Functional mobility and Strength	1 item	x			
Function in Sitting Test (FIST)	Balance	14 items	x			
Functional Gait Assessment (FGA)	Balance and Gait	10 items	x			
Grasp-Release test	Upper extremity function	6 items	x	x		
High Level Mobility Assessment (HiMAT)	Functional mobility, Vestibular	5 domains and 13 items	x	x		
Jebsen Hand Function Test (JHFT)	ADL, Upper extremity function	7 items	x			
Modified Functional Reach test (MFRT)	Balance, Functional mobility and Vestibular	1 item	x			
Postural Assessment Scale for Stroke Patients (PASS)	Balance	12 items	x	x		
Postural Assessment Scale for Stroke Patients Trunk Control (PASS-TC)	Balance	12 items		x		
Postural Control and Balance for Stroke (PCBS)	Balance	12 items	x	x		
Rivermead motor assessment (RMA)	Functional mobility	38 items	x			
Short Form Berg Balance Scale (SFBBS)	Balance and Functional mobility	7 items	x			
Short form of the Wolf Motor Function Test (S-WMFT)	Dexterity, Strength, Upper extremity function	6 items	x			
Short Form Postural Assessment Scale for Stroke Patients-6 items (6 SFPASS)	Balance	6 items	x			
Sollerman hand function test	Functional mobility	20 items	x	x		
Three Point Postural Assessment Scale for Stroke Patients (PASS-3P)	Balance	6 items	x	x		
Timed Up and Go test (TUG)	Balance, Functional mobility, Gait, Vestibular	2 trials	x			
Timed walk	Gait, Balance	3 trials	x	x		
Wolf Motor Function Test (WMFT)	Dexterity, Strength, Upper extremity function	21 items	x			
Patient-Reported Outcome (PROs)						
ABILHAND	ADL, Dexterity, Upper extremity function	23 items	x			
Activity Card Sort (ACS)	ADL, Life participation	4 domains and 89 items (IADL: 20; low physical demand leisure activities: 35; high physical demand leisure activities: 17; social activities: 17)	x			
Beck Depression Inventory (BDI)	Depression	21 items		x		
Brain injury community rehabilitation outcome scale (BICRO)	Community functioning in areas of Activity, Social participation, and Psychological components	39 items	x	x		
Canadian Occupational Performance Measure (COPM)	ADL, Functional mobility, Life participation	3 domains and 9 items	x			

Name of the measure	Area of assessment	Number of domain/items	Activity and Participation	Body Functions	Environmental Factors	Personal Factors
Centre for Epidemiological Studies Depression	Depression	20 items		x		
Climbing stairs questionnaire (CSQ)	Climbing stairs	15 items	x	x		
Coded activity diary	Physical activity and energy expenditure		x	x		
European Quality of life scale-EQ5D	Functional mobility, ADL, Pain, Depression	5 domains and 6 items	x			
Geriatric Depression scale-long form (GDS)	Depression	30 items		x		
Human activity profile (HAP)	ADL	94 items	x			
Leeds Adults Spasticity impact scale (LASIS)	Arm Function	12 items		x		
London Handicap scale (LHS)	ADL, Functional mobility, Life participation, Quality of life, Social relationships	6 items	x			
Mayo-Portland Adaptability Inventory (MPAI-4)	Physical, cognition, emotional, behavioural, social and community re-integration	35 items	x			
Medical Outcomes Study 36-Item Short Form Health Survey (SF-36)	ADL, Quality of life	8 domains and 36 items	x	x		x
Modified Rankin Handicap Scale	ADL and Functional mobility	1 item	x			
Nottingham Extended ADL index (N-ADL)	ADL, independence, Functional mobility, leisure	4 domains and 22 items	x			
Nottingham leisure activity (NLA)	Leisure activities	38 items	x			
Outpatient Physical Therapy Improvement in Movement Assessment Log (OPTIMAL)	Balance, Coordination, Dexterity, Functional mobility, Gait, Upper extremity function	22 items	x	x		
Physical Ability Scale (PAS)	ADL and Life participation	12 items	x			
Reintegration to normal living index (RNLI)	ADL, Social relationships	8 domains and 11 items	x			
Satisfaction with Life Scale (SWLS)	Life participation and Quality of life	5 items	x			
Sickness Impact profile (SIP)	Behavior, Life participation, Mental health, Social relationships	3 domains and 68 items	x			
Stroke impact scale (SIS)	ADL, Cognition, Communication, Depression, Functional mobility, Gait, General health, Life participation, Quality of life, Social relationships, Social support, Upper extremity function	8 domains and 59 items	x			
Stroke Specific Quality of Life Scale (SSQOL)	Behavior, Cognition, Functional mobility, Language, Personality, Negative effect, Quality of life, Social relationships, Upper extremity function	12 domains and 49 items	x			
Subjective index of physical and social outcome (SIPSO)	Domestic life, Major life areas, Transportation, Interpersonal interactions and relationship, Community, Recreational and civic life	5 domains and 26 items	x			
Self-Reported Outcomes (SROs)						
Disabilities of the Arm, Shoulder and Hand (DASH)	Upper extremity function	30 items	x			x
Duruoz Hand Index (DHI)	ADL, Coordination,	18 items	x			

82

Name of the measure	Area of assessment	Number of domain/items	Activity and Participation	Body Functions	Environmental Factors	Personal Factors
	Dexterity, Functional mobility, General health, Life participation, Upper extremity function					
Frenchay Activities Index (FAI)	ADL	3 domains and 15 items	x			
Hand Function Survey (HFS)	Hand Function	13 items	x	x		
International Classification of Functioning, Health and Disability-Measure of Participation and Activities Screener	Life participation	32 items	x			
Motor activity log (MAL-14)	Upper extremity function	14 items	x			
Motor Activity Log-26 items	Upper extremity function	26 items	x			
Motor Activity Log-28 items	Upper extremity function	14 items	x			
Multimedia activity recall for children and adults (MARCA)	Physical activity and energy expenditure	10 domains	x	x		
Rivermead mobility index (RMI)	Balance, Functional mobility and Gait	15 items	x			
Technology-Reported Outcomes (TechOs)						
Accelerometer (ActiGraph)	Activity		x			
Actical	Activity		x			
Actiwatch	Activity		x			
Ambulatory Monitoring (AM Accelerometer)	Activity		x			
Biaxial accelerometer	Activity		x			
Caltrac accelerometer	Activity		x			
Computer Science and Applications Inc. Model 7164 activity monitors x 4	Activity		x			
Dimensional gait analysis (3-DGA)	Activity		x			
Finger Tapping (uniaxial accelerometer)	Activity		x			
Fitbit Ulta	Activity		x			
Footswitches	Activity		x			
Kinematics	Activity		x			
Nike+Fuelband	Activity		x			
OMRON HJ-113-E Piezoelectric Pedometers	Activity		x			
PAL2 (Gorman ProMed Pty. Ltd)	Activity		x			
Pedometers	Activity		x			
Sensewear Pro 3 Armband	Activity		x			
Smart Balance Master (SBM)	Activity		x			
SmartShoe	Activity		x			
StepWatch Activity Monitor or Step Activity Monitor (SAM)	Activity	1 item	x			
Stride analyzer system (SAS)	Activity		x			
The Intelligent Device for Energy Expenditure and Activity (IDEEA)	Activity		x			
Triaxial accelerometer/ RT3	Activity		x			
Uniaxial accelerometer	Activity		x			
Wireless Triaxial Accelerometers	Activity		x			

ADL: activity of daily living, ROM: range of motion

83

Table 3. The overall rating of summarized measurement properties and the quality of evidence

Name of the measure	SOI	Content validity Overall rating	Quality of evidence	Internal consistency Overall rating	Quality of evidence	Reliability Overall rating	Quality of evidence	Measurement error Overall rating	Quality of evidence	Construct validity Overall rating	Quality of evidence	Responsiveness Overall rating	Quality of evidence
Stroke at acute setting													
6-Minute Walking Test (6MWT) [25, 52]	PerfO	+	High			+	Moderate (-1)	+	Moderate (-1)	+	Moderate (-1)		
10-Meter Walking Test (10MWT) [25, 53]	PerfO					+	High					+	High
12-Meter Walking Test (12MWT) [25]	PerfO					+	Low (-2)						
2-Meter Waling Test (2MWT) [53]	PerfO					+	Low (-2)					+	Low (-2)
Actiwatch [45]	TechO									+	Moderate (-1)		
Ambulatory Monitoring (AM Accelerometer) [45]	TechO									+	Low (-2)		
Barthel Index (BI) [18]	PerfO			+	Low (-2)	+	Low (-2)			+	Low (-2)	+	Low (-2)
Beck Depression Inventory (BDI) [43]	PRO					+	High			+	High	-	Moderate (-2)
Berg Balance Scale (BBS) [18, 53]	PerfO			+	Low (-2)	+	Low (-2)			+	Low (-2)	+	High
Berg Balance Scale three point (BBS-3P) [53]	PerfO											+	High
Chedoke McMaster Stroke assessment scale (CMSA) [43]	ClinRO					+	Low (-2)			+	Low (-2)	+	Low (-2)
European Quality of life scale (EQ5D) [56]	PRO					+	Low (-2)			-	Low (-2)		
Frenchay Activities Index (FAI) [18]	SRO			+	Low (-2)	+	Low (-2)			+	Low (-2)		
Fugl-Meyer Assessment	ClinRO			+	Moderate (-1)	+	Moderate (-1)			+	Moderate (-1)	+	Moderate (-1)

Name of the measure	SOI	Content validity		Internal consistency		Reliability		Measurement error		Construct validity		Responsiveness	
		Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence
(FMA) [16, 47, 56]													
Fugl-Meyer test-Balance subscale (FM-B) [53]	ClinRO											+	High
Function in Sitting Test (FIST) [57]	PerfO	+	Low (-2)	+	Low (-2)			+	Low (-2)	+	Low (-2)		
Functional Ambulation Category (FAC) [46, 53]	ClinRO					+	Low (-2)			-	Low (-2)	+	High
Functional Independence measure (FIM) [18]	ClinRO			+	Moderate (-1)	+	Moderate (-1)			+	Moderate (-1)	+	Moderate (-1)
London Handicap scale (LHS) [58]	PRO	+	High			+	High			+	High		
Manual Function Test (MFT) [48]	ClinRO			+	Moderate (-1)	+	Moderate (-1)			+	Moderate (-1)		
Mini Mental State Examination (MMSE) [43]	ClinRO					+	High			-	Moderate (-2)		
Modified Ashworth scale (m-AS) [16, 27, 43, 56]	ClinRO					+	Low (-2)			-	Low (-2)		
Modified Emory Functional Ambulation Profile (M-EFAM) [53]	ClinRO											+	Low (-2)
Modified Rankin Handicap scale (m-RHS) [43]	PRO					+	High			-	Moderate (-1)	-	Moderate (-1)
Motor Assessment Scale (MAS) [53]	ClinRO											+	Moderate (-1)
Motor status scale (MSS) [56, 63]	ClinRO					+	Low (-2)			+	Low (-2)		
Postural Assessment	PerfO											+	High

Name of the measure	SOI	Content validity		Internal consistency		Reliability		Measurement error		Construct validity		Responsiveness	
		Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence
Scale for Stroke Patients (PASS) [53]													
Postural Assessment Scale for Stroke Patients Trunk Control (PASS-TC) [53]	PerfO											+	High
Postural Control and Balance for Stroke (PCBS) [53]	PerfO											+	Moderate (-1)
Rivermead mobility Assessment (RMA) [18]	PerfO					-	Moderate (-2)			+	Moderate (-1)		
Rivermead mobility index (RMI) [18, 21]	SRO	+	Low (-2)	+	Low (-2)	+	Low (-2)			+	Low (-2)	+	Low (-2)
Short Form Berg Balance Scale (SFBBS) [53]	PerfO											+	Moderate (-1)
Short Form Postural Assessment Scale for Stroke Patients-6 items (6 SFPASS) [53]	PerfO											+	High
Smart Balance Master (SBM) [53]	TechO											+	Low (-2)
Three Point Postural Assessment Scale for Stroke Patients (PASS-3P) [53]	PerfO											+	High
Uniaxial accelerometer [45]	TechO									+	Moderate (-1)		
Stroke at sub-acute setting													
10-Meter Walking Test (10MWT) [26, 46, 65]	PerfO	+	Moderate (-1)			+	Low (-2)	+	Low (-2)	+	Low (-2)	+	Low (-2)
12-Meter	PerfO	+	Low (-2)			-	Low (-2)			+	Low (-2)		

Name of the measure	SOI	Content validity		Internal consistency		Reliability		Measurement error		Construct validity		Responsiveness	
		Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence
Walking Test (12MWT) [52]													
3-Meter Walking Test (3MWT) [52]	PerfO	+	Low (-2)			+	Low (-2)			+	Low (-2)		
6-Minute Walking Test (6MWT) [26, 52]	PerfO	+	High			+	High	+	High	+	High		
ActiGraph [45]	TechO					+	Low (-2)			+	Low (-2)		
Arm Motor Ability Test (AMAT) [24]	PerfO			+	Low (-2)	+	Low (-2)			+	Low (-2)	+	Low (-2)
Berg Balance Scale (BBS) [46]	PerfO					+	Low (-2)			-	Low (-2)	+	Low (-2)
Dynamic Gait Index (DGI) [26]	PerfO	+	Low (-2)			+	Low (-2)			+	Low (-2)		
Footswitches [26]	TechO	+	Low (-2)			+	Low (-2)	+	Low (-2)	+	Low (-2)		
Functional Ambulation Category (FAC) [25, 26, 53]	ClinRO	+	Moderate (-1)			+	Moderate (-1)			+	Moderate (-1)	+	Moderate (-1)
Motor Activity Log-28 items (MAL-28) [24, 62]	SRO			+	High					-	Moderate (-1)		
Physical Ability Scale (PAS) [57]	PRO					-	Low (-2)						
Rivermead mobility index (RMI) [46]	SRO			+	Moderate (-1)	+	Moderate (-1)			-	Moderate (-2)	+	Moderate (-1)
Stroke impact scale (SIS) [59]	PRO	+	Low (-2)	+	Low (-2)	+	Low (-2)			+	Low (-2)		
Stroke at chronic setting													
10-Meter Walking Test (10MWT) [25, 26, 46, 60, 65]	PerfO	+	High			+	High	+	Moderate (-1)	+	High	+	Low (-2)
12-Meter Walking Test (12MWT) [26, 52, 53]	PerfO	+	Moderate (-1)			+	Low (-2)			+	Moderate (-1)	+	Low (-2)
2-Meter Walking Test (2MWT) [25, 26, 52]	PerfO	+	High			+	High	+	High				

Name of the measure	SOI	Content validity		Internal consistency		Reliability		Measurement error		Construct validity		Responsiveness	
		Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence
300-Meter Walking Test (300MWT) [26]	PerfO	+	Low (-2)			+	Low (-2)			+	Low (-2)		
30-Meter Walking Test (30MWT) [26]	PerfO	+	Low (-2)							+	Low (-2)		
4-Meter Comfortable Walking Test (4MCWT) [26]	PerfO	+	Low (-2)							+	Low (-2)		
5-Meter Walking Test (5MWT) [25, 26, 52]	PerfO	+	Moderate (-1)			+	Low (-2)	+	Low (-2)	+	Moderate (-1)	+	Moderate (-1)
6-Minute Walking Test (6MWT) [25, 26, 46, 52, 53, 65]	PerfO	+	High			+	High	+	High	+	High	+	Low (-2)
ABILHAND [23, 24, 42, 48, 55, 56, 62, 63]	PRO	+	High	+	Low (-2)	+	High			+	High	+	Low (-2)
Actical [22]	TechO					+	Low (-2)						
Action Research Arm test (ARAT) [23, 24, 27, 42, 44, 48, 55, 56, 63]	ClinRO	+	High	+	High	+	High			+	High	+	Low (-2)
Activities of Daily Living scale (ADL scale) [48]	ObserO					+	Moderate (-1)			+	Moderate (-1)		
Activity Cart Sort (ACS) [49, 59]	PRO	+	Low (-2)	+	Moderate (-1)	+	Moderate (-1)			+	Moderate (-1)		
Actiwatch [45]	TechO									+	Low (-2)		
Actual Amount of Use Test (AAUT) [48]	ClinRO					+	Low (-2)			+	Low (-2)		
Ambulatory Monitoring (AM Accelerometer) [26]	TechO									+	Low (-2)		
Arm Motor Ability Test (AMAT) [23, 48, 56]	PerfO	+	Low (-2)			+	Low (-2)						
Assessment of	PerfO	+	Moderate (-1)			+	High			+	Moderate (-1)		

Name of the measure	SOI	Content validity		Internal consistency		Reliability		Measurement error		Construct validity		Responsiveness	
		Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence
Life Habits (LIFE-H) [50, 59]													
Assessment of Motor and Process Skills (AMPS) [48]	PerfO					+	Moderate (-1)			+	Moderate (-1)		
Balance Assessment in Sitting and Standing Position (BASSP) [57]	ClinRO					+	High			+	High	+	High
Balance Evaluation System test (BESTest) [51]	PerfO	+	High			+	High			+	High	+	High
Barthel Index (BI) [28, 43, 56, 60]	PerfO					+	High			+	High	+	High
Beck Depression Inventory (BDI) [16]	PRO	+	High	+	High	-	Moderate (-2)			+	High	-	High
Berg Balance Scale (BBS) [43, 60]	PerfO					+	Moderate (-1)			+	Moderate (-1)	+	Moderate (-1)
Biaxial accelerometer [45]	TechO					+	Low (-2)			+	Low (-2)		
Box and Block test (BBT) [56, 63]	ClinRO					+	Moderate (-1)			+	Low (-2)	-	Low (-2)
Brunel Balance Assessment (BBA) [51]	ClinRO	+	Moderate (-1)			+	Moderate (-1)			+	Moderate (-1)		
Caltrac accelerometer [22, 45]	TechO					-	Low (-2)						
Canadian Occupational Performance Measure (COPM) [48]	PRO					+	Low (-2)			-	Low (-2)	+	Low (-2)
Centre for Epidemiological Studies Depression [43]	PRO			+	Low (-2)	+	Low (-2)			+	Low (-2)	+	Low (-2)

Name of the measure	SOI	Content validity		Internal consistency		Reliability		Measurement error		Construct validity		Responsiveness	
		Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence
Chedoke Arm and Hand Inventory (CAHAI) [24, 42, 48, 56]	PerfO	+	High	+	High	+	High			+	High	+	Low (-2)
Chedoke McMaster Stroke assessment scale (CMSA) [18, 44, 56]	ClinRO			+	High	+	High			+	High	+	High
Climbing stairs questionnaire (CSQ) [21]	PRO	+	Low (-2)	+	Low (-2)	+	Low (-2)			+	Low (-2)		
Coded activity diary [49]	PRO									-	Low (-2)		
Community balance and mobility scale (CB&M) [51]	PerfO									+	Low (-2)	+	Low (-2)
Computer Science and Applications Inc. Model 7164 activity monitors x 4 [22]	TechO									+	Low (-2)		
Dimensional gait analysis (3-DGA) [45]	TechO									+	Low (-2)		
Disabilities of the Arm, Shoulder and Hand (DASH) [23]	SRO			+	High	+	High			+	High		
Duruoz Hand Index (DHI) [48]	SRO					+	Moderate (-1)			+	Moderate (-1)		
Dynamic Gait Index (DGI) [26, 51]	PerfO	+	Low (-2)			+	Low (-2)						
European Quality of life scale (EQ5D) [17, 43, 50, 58]	PRO					+	Low (-2)			+	Low (-2)	+	Low (-2)
Finger Tapping [45]	TechO									-	Moderate (-1)		
Fitbit Ulta [22]	TechO									+	Low (-2)	+	Low (-2)
Fitts Reaching	PerfO					+	Low (-2)			-	Low (-2)		

Name of the measure	SOI	Content validity		Internal consistency		Reliability		Measurement error		Construct validity		Responsiveness	
		Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence
test [63]													
Five times Sit to Stand test (5xSTST) [54]	PerfO	+	Moderate (-1)			+	Moderate (-1)	?	Low (-2)	+	Low (-2)	+	Low (-2)
Footswitches [45]	TechO									+	Low (-2)	+	Low (-2)
Four Square Step (FSS) [51]	ClinRO	-	Low (-2)							+	Low (-2)	-	Low (-2)
Frenchay Activities Index (FAI) [49, 50, 59, 60]	PRO	+	High	+	High	+	High			+	High	-	High
Frenchay Arm Test (FAT) [43, 48, 56]	ClinRO					+	Moderate (-1)			+	Moderate (-1)	-	Low (-2)
Fugl-Meyer Assessment (FMA) [27, 43, 44]	ClinRO					+	High			+	Low (-2)	+	Low (-2)
Fugl-Meyer Assessment-Upper extremity (FM-UE) [23]	ClinRO	+	High			+	High			+	High		
Functional Ambulation Category (FAC) [25, 26, 60]	ClinRO	+	Low (-2)			+	Moderate (-1)			+	Moderate (-1)		
Functional Gait Assessment (FGA) [26]	PerfO	+	Low (-2)			+	Low (-2)			+	Low (-2)		
Functional Independence measure (FIM) [27, 28, 43, 50, 56]	ClinRO	+	High			+	Moderate (-1)			-	Moderate (-2)	+	Moderate (-1)
Functional Test for the Hemiplegic Upper Extremity (FTHUE) [48]	ClinRO					+	Moderate (-1)						
Functional Ambulation Classification Hospital (FACHS) [26]	ClinRO	+	Low (-2)							+	Low (-2)		
Geriatric	PRO			+	Low (-2)	+	Low (-2)			+	Low (-2)	+	Low (-2)

Name of the measure	SOI	Content validity		Internal consistency		Reliability		Measurement error		Construct validity		Responsiveness	
		Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence
Depression scale-long form (GDS) [43]													
Grasp-Release test [27]	PerfO			+	Low (-2)							+	Moderate (-1)
Grip strength [56]	ClinRO					+	Low (-2)						
Hand Function Survey (HFS) [48]	SRO					+	Low (-2)			+	Low (-2)		
Human activity profile (HAP) [21, 49]	PRO			+	Low (-2)	+	Low (-2)			+	Low (-2)	-	Low (-2)
International classification of functioning, health, and disability-Activity measure (ICF-AM) [23]	SRO					+	High			+	High		
Jebsen Hand Function Test [27, 48]	PerfO					+	Low (-2)			+	Low (-2)	+	Low (-2)
Kinematics [56]	TechO					+	Low (-2)			-	Low (-2)	+	Low (-2)
London Handicap scale (LHS) [58]	PRO	+	Low (-2)	+	Low (-2)	+	Low (-2)			-	Low (-2)		
Medical Outcomes Study 36-Item Short Form Health Survey (SF-36) [17, 27, 28, 43, 50]	PRO	+	Low (-2)	+	Low (-2)	-	Moderate (-2)			+	Low (-2)	-	Low (-2)
Mini Mental State Examination (MMSE) [16]	ClinRO			-	Moderate (-2)	+	Moderate (-1)			+	Moderate (-1)		
Modified Emory Functional Ambulation Profile (M-EFAM) [25, 51]	ClinRO					+	Moderate (-1)			+	High	+	Low (-2)
Modified Functional Reach test (MFRT) [53, 57]	PerfO					+	Low (-2)					+	Low (-2)

Name of the measure	SOI	Content validity		Internal consistency		Reliability		Measurement error		Construct validity		Responsiveness	
		Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence
Modified Rankin Handicap Scale (m-RHS) [18]	PerfO					+	Moderate (-1)			+	Moderate (-1)	+	Moderate (-1)
Motor activity log-14 items (MAL-14) [24, 27, 48, 62, 63]	SRO	+	Low (-2)	+	Low (-2)	+	Low (-2)			+	High	+	Low (-2)
Motor Assessment Scale (MAS) [43, 44, 47, 56]	ClinRO					+	Low (-2)			+	Low (-2)	-	Low (-2)
Motor Evaluation Scale for Upper Extremity in Stroke Patients (MESUPES) [23, 48]	ClinRO	+	High			+	High			+	High		
Motor Free Visual Perception Test [16, 43]	ClinRO			-	Low (-2)	+	Low (-2)			-	Low (-2)		
Motricity index (MI) [43, 44, 46, 47, 60]	ClinRO			+	Moderate (-1)	+	Moderate (-1)			+	Moderate (-1)		
Multimedia activity recall for children and adults (MARCA) [49]	SRO					+	Low (-2)			-	Low (-2)		
National Institute of Health Stroke Scale (NIHSS) [43]	ClinRO					+	Moderate (-1)			+	Moderate (-1)	-	Moderate (-2)
Neurobehavioral Cognition Status Exam (NCSE) [43]	ClinRO					-	Low (-2)			+	Low (-2)	+	Low (-2)
Nike+Fuelband [22]	TechO									+	Low (-2)	+	Low (-2)
Nine-Hole Peg test (NHPT) [44, 56, 63]	ClinRO					+	Moderate (-1)			+	Moderate (-1)		
Nottingham Extended ADL index (N-ADL) [21]	PRO	+	Moderate (-1)	+	Moderate (-1)	+	Moderate (-1)			+	Moderate (-1)	+	Moderate (-1)

Name of the measure	SOI	Content validity		Internal consistency		Reliability		Measurement error		Construct validity		Responsiveness	
		Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence
Nottingham leisure activity (NLA) [17, 49]	PRO			+	Low (-2)	+	Low (-2)			+	Low (-2)		
Ottawa Sitting Scale (OSS) [57]	ClinRO					+	Moderate (-1)						
Outpatient Physical Therapy Improvement in Movement Assessment Log (OPTIMAL) [23]	PRO									+	High		
PAL2 (Gorman ProMed Pty. Ltd) [22]	TechO									+	Low (-2)		
Pedometers [22, 26, 45]	TechO					-	Low (-2)			-	Low (-2)	+	Low (-2)
Postural Assessment Scale for Stroke Patients (PASS) [53, 57]	PerfO											+	High
Postural Assessment Scale for Stroke Patients Trunk Control (PASS-TC) [53]	PerfO											+	High
Quadriplegia Index of Function [27]	ClinRO					+	Moderate (-1)					-	Moderate (-2)
Reintegration to normal living index (RNLI) [58]	PRO					+	Moderate (-1)			+	Moderate (-1)		
Rivermead mobility Assessment (RMA) [23, 43, 44, 47, 56, 63]	PerfO			+	High	+	High	+	Low (-2)	+	Low (-2)	-	Low (-2)
Rivermead mobility index (RMI) [25, 28, 47, 53]	SRO			+	Low (-2)	+	Low (-2)			+	High	+	Moderate (-1)
Sensewear Pro 3 Armband [22]	TechO									-	Low (-2)	+	Low (-2)
Sickness Impact	PRO			+	Low (-2)	+	High			+	Moderate (-1)		

Name of the measure	SOI	Content validity		Internal consistency		Reliability		Measurement error		Construct validity		Responsiveness	
		Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence
profile (SIP) [17, 43, 50]													
Sitting Rising Test (SRT) [57]	ClinRO					+	Moderate (-1)			+	Moderate (-1)		
SmartShoe [22]	TechO									+	Low (-2)	+	Low (-2)
Sodring motor evaluation for stroke patients [47]	ClinRO			+	High	+	High			+	High	+	High
Sollerman hand function test [63]	PerfO					+	Low (-2)						
Step test [51]	ClinRO	+	Low (-2)			+	Low (-2)			+	Low (-2)	+	Low (-2)
StepWatch Activity Monitor or Step Activity Monitor (SAM) [22, 25, 45]	TechO					?	Low (-2)			+	High	+	Moderate (-1)
Stride analyzer system (SAS) [45]	TechO					+	Low (-2)			+	Low (-2)		
Stroke Arm Ladder (SAL) [23]	ClinRO	+	High			+	High			+	High		
Stroke impact scale (SIS) [17, 21, 43, 50, 55, 56, 58]	PRO	+	Low (-2)	+	Low (-2)	-	Moderate (-1)			+	High	+	Moderate (-1)
Stroke Rehabilitation assessment of movement (STREAM) [23, 42, 47, 63]	ClinRO	+	High	+	High	+	High			+	High	+	High
Stroke Specific Quality of Life Scale (SSQOL) [17, 43, 50]	PRO			+	Moderate (-1)	-	Moderate (-2)			+	Moderate (-1)	+	Moderate (-1)
The Intelligent Device for Energy Expenditure and Activity (IDEEA) [22, 45]	TechO					+	Low (-2)						
Timed Up and Go test (TUG)	PerfO	-	Low (-2)			+	High			+	Moderate (-1)	+	Moderate (-1)

Name of the measure	SOI	Content validity		Internal consistency		Reliability		Measurement error		Construct validity		Responsiveness	
		Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence
[18, 25, 43, 51, 65]													
Timed walk [28]	PerfO	+	Low (-2)			+	Low (-2)			+	Low (-2)	+	Low (-2)
Triaxial accelerometer/ RT3[22, 45]	TechO					+	Moderate (-1)			+	Low (-2)		
Trunk Control Test (TCT) [57, 60, 61]	ClinRO			+	Low (-2)	+	Low (-2)			+	Low (-2)		
Trunk Impairment Scale (TIS) [57, 61]	ClinRO	+	Moderate (-1)	+	Moderate (-1)	+	Moderate (-1)	+	Low (-2)	+	Low (-2)	+	Moderate (-1)
Upper Body Dressing Scale (UBDS) [48]	ClinRO					+	Moderate (-1)			+	Moderate (-1)	+	Moderate (-1)
Upper Extremity Functional Index (UEFI) [23]	ClinRO					+	High			+	High		
Upper Extremity Performance Test for Elderly (Test d'Évaluation des Membres supérieurs de Personnes Âgées (TEMPA) [48]	ClinRO					+	Low (-2)			+	Low (-2)		
Upper Limb-Motor Assessment Scale (UL-MAS) [23, 24]	ClinRO	+	Moderate (-1)	+	Moderate (-1)	+	Moderate (-1)			+	Moderate (-1)	+	Low (-2)
Van Lieshout Test Short Form [27]	ClinRO					-	Low (-2)					-	Moderate (-2)
Wireless Triaxial Accelerometers [22]	TechO									+	Low (-2)		
Wolf Motor Function Test (WMFT) [23, 24, 27, 43, 48, 55, 56]	PerfO	+	High	+	High	+	High			+	High	+	Low (-2)
Traumatic brain injury													
10-Meter	PerfO					+	High			+	Low (-2)		

Name of the measure	SOI	Content validity		Internal consistency		Reliability		Measurement error		Construct validity		Responsiveness	
		Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence
Walking Test (10MWT) [25, 65]													
6-Minute Walking test (6MWT) [25, 65]	PerfO					+	Low (-2)						
Brain injury community rehabilitation outcome scale (BICRO) [21]	PRO	+	High	+	High	+	High			+	High		
Community balance and mobility scale (CB&M) [25]	PerfO					+	Low (-2)			-	Low (-2)		
European Quality of life scale (EQ5D) [64]	PRO			+	Moderate (-1)								
Functional Arm Activity Behavioral Observation System (FAABOS) [48]	ObserO					+	Low (-2)						
Functional Independence measure (FIM) [64]	ClinRO	+	High			+	High						
Grooved Pegboard Test (GPT) [25]	ClinRO					+	Low (-2)			-	Low (-2)		
High Level Mobility Assessment (HiMAT) [25]	PerfO					+	High			+	High		
Mayo-Portland Adaptability Inventory (MPAI-4) [64]	PRO			+	High	+	High			+	High		
Medical Outcomes Study 36-Item Short Form Health Survey (SF-36) [64]	PRO			+	Low (-2)					+	Low (-2)		

Name of the measure	SOI	Content validity		Internal consistency		Reliability		Measurement error		Construct validity		Responsiveness	
		Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence	Overall rating	Quality of evidence
Pens taped to feet (PTF) [25]	ClinRO					+	Low (-2)			+	Low (-2)		
Rivermead mobility index (RMI) [25]	SRO									+	Low (-2)		
Satisfaction with Life Scale (SWLS) [64]	PRO	+	Low (-2)			+	Low (-2)						
Sickness Impact profile (SIP) [21]	PRO	+	Low (-2)	+	Low (-2)	+	Low (-2)			+	Low (-2)	+	Low (-2)
Timed Up and Go test (TUG) [65]	PerfO					+	Low (-2)						
Trunk Recovery Scale (TRS) [57]	ClinRO			+	Moderate (-1)	+	Moderate (-1)	+	Moderate (-1)	+	Moderate (-1)		

ClinRO: clinicians-reported outcome, ObserO: observation-reported outcome, PerfO: performance-reported outcome, PRO: patient-reported outcome, SRO: self-reported outcome, SOI: source of information, TechO: technology-based outcome

*blanks refer to Inconsistent (±) ratings, and were not graded to the modified-GRADE approach

sufficient (+), insufficient (-), inconsistent (±), or indeterminate (?)

Table 4. Interpretability and feasibility of mobility measures

Name of the measure	Type of population	Setting	Floor and Ceiling effect	Normative data	MID/MIC	Ease of administration	Length of the instruments	Ease of score calculation	Cost	Required equipment
Clinician Reported Outcomes (ClinRO)										
Action research arm test (ARAT) [24, 56, 63]	Stroke	Chronic	Yes	NR	MDC=6 points	Yes Paper and pencil	5-15 min	Yes	Not Free	Various sized wood blocks, cricket ball, stone, jug and glasses, a small and large tube, washer and bolt, ball bearing, a marble, a chair without arm rests, a table, a plank, a tin lid/not required training
Brunel Balance Assessment [51]	Stroke	Chronic	NR	NR	MCID= one level (1/12) due to hierarchical scale	Yes	10 min	Yes	Free	Plinth or suitable seating, ruler, step up block, stopwatch, tape to mark 5m walkway, 2 stools/required training (Reading articles/Manual)
Box and block test (BBT) [56, 63]	Stroke	Chronic	NR	NR	MDC=6 block (weak hand). 8 blocks (sound hand) MCID=6 min	Yes Paper and pencil	2-5 min	Yes	Not Free	Stopwatch, wooden box, partition, 150 wooden cubes/not required training
Chedoke McMaster stroke assessment scale (CMSA) [18, 43, 56]	Stroke	Chronic	Yes	NR	MDD= 8 points	Yes Paper and pencil	45 min-1 hour	Yes	Free	An adjustable table, chair with armrests, floor mat, pillows, a pitcher with water, a measuring cup, a ball 2.5 inch in diameter, a footstool, a 2m line marked on the floor, stopwatch/required training
Functional ambulation category (FAC) [25, 53, 60]	Stroke	Chronic	NR	NR	MCID =4.36 to 17.70 SDD= 1 point	Yes Paper and pencil	1 min	Yes	Free	No/not required training
Functional ambulation category (FAC) [26, 49]	Stroke	Sub-acute	NR	NR	SDD=1 point	Yes Paper and pencil	1 min	Yes	Free	No/not required training
Functional gait assessment (FGA) [25, 26, 46]	Stroke	Chronic	NR	NR	MDC=4.2 m	Yes Paper and pencil	5-20 min	No	Free	Stopwatch, measuring device to mark off area, obstacles, set of steps/not required training

Name of the measure	Type of population	Setting	Floor and Ceiling effect	Normative data	MID/MIC	Ease of administration	Length of the instruments	Ease of score calculation	Cost	Required equipment
Fugl-Mayer Assessment (FMA) [16]	Stroke	Acute	Yes	NR	MCID was estimated to be approximately 10% of total scale score	Yes Paper and pancil	30-45 min	Yes	Free	Tennis ball, a small spherical shaped container, a tool to administer reflex tests, enough space is needed for a patient to move around freely, if possible, space should be a quiet, private room with few distractions/required training (Reading article/manual)
Functional Test for the Hemiplegic Upper Extremity (FTHUE) [48]	Stroke	Chronic	Yes	NR	MCD= 9 mm	Yes	NR	Yes	Free	NR
Functional independence measure (FIM) [24, 43, 56]	Stroke	Acute	Yes	NR	FIM change scores from admission to discharge associated with MCID were 22, 17, 3 points for the total FIM, motor FIM and cognitive FIM respectively MCID=11 points	Yes Paper and pencil	20-45 min	Yes	Free (need a license)	May vary based on level and impairment category measured/required training (Reading articles/Manual)
Grip strength [56]	Stroke	Chronic	NR	NR	MCID=2.9 kg	Yes	5 min	Yes	Not Free	Yes/requires purchase of a handheld dynamometer/required training (reading articles/manual)
Motor evaluation scale for upper extremity in stroke patients (MESUPES) [48]	Stroke	Chronic	NR	NR	MDC for MESUPES total score (/58) at 95% CI = 7.43 points with the 3 outliers MDC95%CI for MESUPES-arm test (/40) = 6.10 points MDC95%CI for MESUPES-hand test (/18) =	Yes Paper and pencil	5-15 min	Yes	Free	Mat, desk and chair, ruler, plastic bottle, dice/not required training.

Name of the measure	Type of population	Setting	Floor and Ceiling effect	Normative data	MID/MIC	Ease of administration	Length of the instruments	Ease of score calculation	Cost	Required equipment
					2.61points					
Motricity index (MI) [43, 60]	Stroke	Chronic	NR	NR	MDD=12 points (arm) MDD= 13 points (leg) MCD (arm): 11 points, (Leg): 25 points)	Yes	5-20 min	Yes	Not Free	2.5 cm * 2.5 cm cube/not required training
Nine-hole pig test (NHPT) [56, 63]	Stroke	Chronic	NR	NR	MDC=32.8 sec. (more affected hand); 6.2 sec (less affected hand) MCID=32 sec	Yes Paper and pencil	2 - 10 min	Yes	Free	Wood or plastic with 9 holes, a container for the pegs, 9 pegs, stopwatch/not required training.
Trunk Control Test (TCT) [60]	Stroke	Chronic	NR	NR	SDD= 25 points	Yes Paper and pencil	5-10 min	NR	Free	Bed or treatment table. Required training (Reading articles/Manual)
Mini Mental State Examination (MMSE) [43]	Stroke	Chronic	NR	NR	A score of 23 is the generally accepted cut off point indicating presence of cognitive. impairment	Yes Paper and pencil	10 min	Yes	Free	Yes Score sheet that demonstrate figure to copy, writing instrument/not required training
Performance-Reported Outcomes (PerfOs)										
Arm mobility ability test (AMAT) [24]	Stroke	Sub-acute	NR	NR	AMAT detected the difference in change occurring as a result of the passage of 1 versus 2 weeks in sub- acute patients	Yes	30-60 min	Yes	Not Free	Silverware and plate, play-doh, mug, comb, foam sandwich, towel, jar, shirts, light switch, door, dried beans, shoe and shoelaces, telephone/required training (reading articles/manual)
Barthel index (BI) [18, 43, 56, 60]	Stroke	Chronic Acute	Yes	NR	MCID=16 points MDD= 4 points	Yes Papaer and pencil	5-15 min	Yes	Free	No
Berg balance scale (BBS) [18, 26, 43, 45, 46, 60]	Stroke	Acute	Yes	NR	MDC90= 5.8 points MDC95= 6.9 points	Yes Paper and pencil	10-15 min	Yes	Free	Stopwatch, standard height chair (18-20 inch) with and without arm sets, step or stool

Name of the measure	Type of population	Setting	Floor and Ceiling effect	Normative data	MID/MIC	Ease of administration	Length of the instruments	Ease of score calculation	Cost	Required equipment
					SDD= 6 points					of average height (7.75-9 inch), ruler, slipper or shoe/not required training
Berg balance scale (BBS) [18, 26, 43, 46, 60]	Stroke	Chronic	Yes	NR	MDD= 6 points MIC= 3 points	Yes Paper and pencil	10-20 min	Yes	Free	Stopwatch, standard height chair (18-20 inch) with and without arm step or stool of average height (7.75-9 inch), ruler, slipper or shoe/not required training
Balance Evaluation System test (BESTest) [51]	Stroke	Chronic	NR	NR	MCID= 3 points	Yes	20-30 min	Yes	Free	Stopwatch, measuring tape mounted on wall, a block, 10-degree incline ramp, stair step, shoe boxes, 2.5 kg free weight, firm chair with arms with 3 m in front marked with tape, measuring tape/required training (Reading articles/Manual)
Chedoke arm and hand inventory (CAHAI) [24, 56]	Stroke	Chronic	Yes	NR	MCID=6.3 points	Yes Paper and pencil	25 min	Yes	Free	Jar of coffee, phone, ruler and pen, toothpaste and toothbrush, knife, fork, putty, glass of water, wet washcloth, eyeglasses, jacket and zipper, shirt with 5 buttons, towel, rubbermaid 38 liter container, plastic grocery bag with 4 pounds weight/required training (reading articles/manual)
Dynamic gait index (DGI) [26]	Stroke	Sub-acute	Yes	NR	MDC=4 m	Yes Paper and pencil	10-15 min	No	Free	Shoe box, two obstacles, stairs, 6 m pathway/not required training
Five-meter walking test (5MWT) [25, 26, 43, 52, 53, 60]	Stroke	Chronic	NR	NR	MDC90= 19.3 MDC95= 24.5 MDC=4.5	Yes Paper and pencil	6-10 min	Yes	Free	Stopwatch Clear pathway 5-meter length/not

Name of the measure	Type of population	Setting	Floor and Ceiling effect	Normative data	MID/MIC	Ease of administration	Length of the instruments	Ease of score calculation	Cost	Required equipment
					second (aid); 1.12 (no aid) MDC (with aid) =4.5; MDC (no aid) =1.12 s; MDC=0.3 m/s)					required training
Five times sit to stand test (5x STST) [56]	Stroke	Chronic	NR	NR	MDC=5	Yes Paper and pencil	< 5 min	Yes	Free	Stopwatch and standard height chair with a backrest/not required training
Fugl-Mayer Assessment (FMA) [43, 56]	Stroke	Chronic	Yes	NR	MCID=7 points MCID= 10 points	Yes Paper and pancil	20-40 min	Yes	Free	Tennis ball, a small spherical shaped container, a tool to administer reflex tests, enough space is needed for a patient to move around freely, if possible, space should be a quiet, private room with few distractions/required training (reading article/manual)
High level mobility assessment (HiMAT) [25]	TBI		NR	NR	MDC=1.36	Yes Paper and pencil	< 10 min	No	Free	Stopwatch, tape measure, house brick, 20m walkway, stairs/requiring training (reading articles/manual)
Rivermead mobility assessment (RMA) [18, 43, 56]	Stroke	Chronic	Yes	NR	MCID= 3 points MCD= 2points	Yes Paper and pencil	20-45 min	Yes	Free	Block of 20 cm height, pencil, volleyball, tennis ball, piece of paper, fork and knife, plate and container, beanbag, cord, putty, watch with chronometer, non-slip mat/not require training
Six-minute walking test (6MWT) [25, 43, 46, 52]	Stroke	Chronic	Yes	NR	MCD=0.15 m/s at usual pace; 0.25 m/s at fast pace) MIC:50 m MCID: 54m MDC90%=28.6-42.1 m	Yes Paper and pencil	6-10 min	Yes	Free	Stopwatch Clear pathway 6-meter length/not required training

Name of the measure	Type of population	Setting	Floor and Ceiling effect	Normative data	MID/MIC	Ease of administration	Length of the instruments	Ease of score calculation	Cost	Required equipment
					MDC95%=50.2 m					
Six-minute walking test (6MWT) [26]	Stroke	Sub-acute	Yes	NR	MDC= 54.1 m	Yes Paper and pencil	6 min	Yes	Free	Stopwatch Clear pathway 6-meter length/not required training
Six-minute walking test (6MWT) [25, 52]	Stroke	Acute	Yes	NR	MDC=54.1 MDC=61 MDC=39	Yes Paper and pencil	6 min	Yes	Free	Stopwatch Clear pathway 6-meter length/not required training
Six-minute walking test (6MWT) [25]	TBI		Yes	NR	MDC =82 m; 0.25 m/s (fast pace) MDC= 0.18 (comfortable)	Yes Paper and pencil	< 10 min	Yes	Free	Stopwatch Clear pathway 6-meter length/not required training
Time up and go test (TUG) [18, 25, 43]	Stroke	Chronic	Yes	NR	MDC=1.63 m/s	Yes Paper and pencil	< 3 min	No	Free	Standardized armchair, stopwatch/not required training
Time up and go test (TUG) [43]	TBI		Yes	NR	MDD= 14 sec	Yes Paper and pencil	< 10 min	No	Free	Bed or treatment table/required training (reading articles/manual)
Ten-meter walking test (10MWT) [25, 43, 46, 60]	Stroke	Chronic	Yes	NR	MDD=0.16 m/s SDD=0.16 m/s MCIC=0.4 m/s (household ambulation) MCIC= 0.4-0.8 m/s (limited community ambulation) MCIC= 0.8 m/s (community ambulation) MDC=0.19m/s	Yes Paper and pencil	5-10 min	Yes	Free	Stopwatch Clear pathway 10-meter length/not required training
Ten-meter walking test (10MWT) [25]	TBI		Yes	NR	MDC=0.19 m/s	Yes Paper and pencil	10 min	Yes	Free	Stopwatch Clear pathway 10-meter length/not required training
Ten-meter walking test (10MWT) [26, 46]	Stroke	Sub-acute	Yes	NR	MCID=0.16 m/s	Yes Paper and pencil	5-10 min	Yes	Free	Stopwatch Clear pathway 10-meter length/not required training
Two-meter walking test (2MWT) [52]	Stroke	Chronic	NR	NR	MDC=11.2-11.6 m	Yes Paper and pencil	< 10 min	Yes	Free	Stopwatch Clear pathway 2-meter length/not

Name of the measure	Type of population	Setting	Floor and Ceiling effect	Normative data	MID/MIC	Ease of administration	Length of the instruments	Ease of score calculation	Cost	Required equipment
										required training
Wolf motor functional test (WMFT) [24, 43, 56]	Stroke	Chronic	Yes	Preliminary normative data have been collected from able-bodied participants (age range 40-80 years), which clinicians may find useful for interpreting client scores and goal setting	MDD= 0.04 sec MCID=12 points	Yes Computer	30-40 min	Yes	Free	Standardized table and chair, box, wrist weight, unopened can, pencip, paper clip, checkers, note cards, standardized lock and key board, face towel, basket, dynamometer, stopwatch/not required training
Patient-Reported Outcomes (PROs)										
ABILHAND [24, 62, 63]	Stroke	Chronic	Yes	NR	Yes	Yes Paper and pencil	10-30 min	Yes	Free	Paper questionnaire/required training (reading articles/manual)
Beck depression inventory (BDI) [43]	Stroke	Chronic	NR	NR	A score of 10 is generally accepted cut off score for the indication of possible depression	Yes Paper and pencil	10 min	Yes	Not free	Testing form and writing instrument/not required training
Mayo-Portland Adaptability Inventory (MPAI-4) [64]	TBI		Yes	NR	MCID= 5 times positive changes	Yes	minutes	Yes	Free	No/not requiring training
Modified Rankin handicap scale [43]	Stroke	Chronic	NR	NR	Score of 2 reflects a good outcome	Yes Paper and pencil	5-15 min	Yes	Free	No/not required training
Nottingham leisure activity (NLA) [17]	Stroke	Chronic	Yes	Yes	Yes	Yes Paper and pencil	5-15 min	Yes	Free	No/not requiring training
Short form 36 health survey questionnaire (SF-36) [17]	Stroke	Chronic	Yes	Yes	Yes	Yes Paper and pencil	10-60 min	Yes	Free	No/requiring training (reading articles/manual
Sickness impact profile (SIP) [17, 43]	Stroke	Chronic	Yes	Yes	Patients with a total score of 33 have poor health profiles	Yes Paper and pencil	20-30 min	Yes	Free	No/not requiring training.
Sickness impact profile	TBI		NR	NR	SDD=10.51	Yes	NR	Yes	Free	No/not requiring

Name of the measure	Type of population	Setting	Floor and Ceiling effect	Normative data	MID/MIC	Ease of administration	Length of the instruments	Ease of score calculation	Cost	Required equipment
(SIP) [17, 21]						Paper and pencil				training.
Stroke impact scale (SIS) [17, 43, 56, 58]	Stroke	Sub-acute Chronic	A floor effect in hand function was reported in moderate stroke patients (40.2%) and a ceiling effect in the communication domain among mild-moderate stroke patients (35% vs. 67.5 % Barthel index ceiling effect). Rasch analysis confirmed these two effects-a ceiling effects in the memory and emotion domains was also reported composite physical function domain displayed floor and ceiling effects of less than 3%.	Ceiling effects noted in communication and memory domains. Floor effect in hand function domain. Study population 96% male and limited to those with no co-morbidity and good potential from rehabilitation.	MDD= 10-15 points	Yes Paper and pencil	10-20 min	Yes	Free	No/requiring training (reading articles/manual)
Stroke specific quality of life scale (SSQOL) [17, 43]	Stroke	Chronic	Yes	Yes	Yes	Yes Paper and pencil	10-15 min	Yes	Free	No/not requiring training
Self-Reported Outcomes (SROs)										
Duruoz Hand Index (DHI) [48]	Stroke	Chronic	NR	NR	MDC= 1.4 points	Yes Paper and pencil	3-7 min	Yes	Free	Yes/paper survey and writing utensil/not required training
Disabilities of the Arm, Shoulder and Hand (DASH) [23]	Stroke	Chronic	Yes	NR	MDC= 10 points	Yes Paper and pencil	5-30 min	Yes	Free	No/not required training

Name of the measure	Type of population	Setting	Floor and Ceiling effect	Normative data	MID/MIC	Ease of administration	Length of the instruments	Ease of score calculation	Cost	Required equipment
Frenchay activities index (FAI) [43, 56, 60]	Stroke	Acute, Chronic	Yes	NR	SDD=1.3 points Patients with a score of 15 are classified as "inactive."	Yes Paper and pencil	5-10 min	Yes	Free	No/pencil and form/not required training
Motor activity log-14 items [24, 62, 63]	Stroke	Chronic	Yes	NR	LoA < ±1 point	Yes Paper and pencil	20 min	Yes	Free	Yes, survey instruments/required training (reading articles/manual)
Rivermead mobility index (RMI) [21, 25, 46, 49, 63]	Stroke	Acute, Sub-acute, Chronic	Yes	NR	MIC= 3 points MDC= 2 points	Yes Paper and pencil	4 -15 min	Yes	Free	No/not required training
Rivermead mobility index (RMI) [25]	TBI		Yes	NR	MDC= 2 point	Yes Paper and pencil	< 10 min	Yes	Free	No/not required training
Technology-Reported Outcomes (TechOs)										
Step activity monitor (SAM) [25, 45]	Stroke	Chronic	NR	Extreme slow stride counts (mean/d steps/d: 2837-1503) compared with norms for older and/or sedentary adults (5000-7000)	NR	Yes	> 1 hour	No	Pricing provided by company upon request	Step watch, computer/required training (reading articles/manual)
Triaxial accelerometer/RT3[22, 45]	Stroke	Chronic	NR	NR	MDD=23%	Yes	NR	No	Pricing provided by company upon request	Yes computer/required training (reading articles/manual)

CI: confidence interval, cm: centimetre, Kg: kilogram, LoA: limits of agreement, MID: minimal importance difference, MIC: minimal importance change, MCID: minimal clinical important difference, MDD: minimal detectable difference, MDC: minimal detectable change, MCIC: minimal clinical important change, min: minute, NR: not reported, SDD: smallest detectable difference, TBI: traumatic brain injury

Figure 1. Steps of conducting the umbrella review
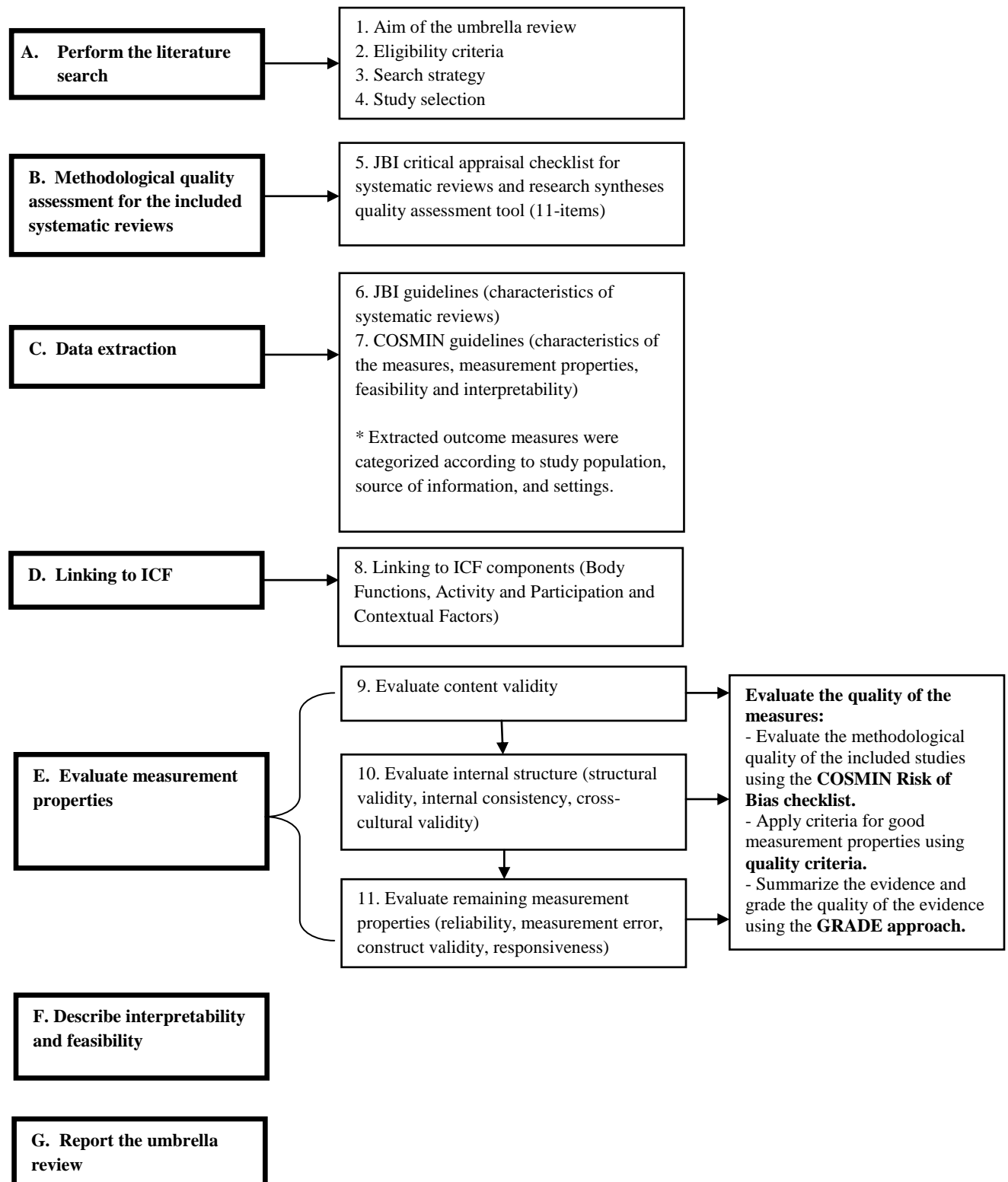
Figure 2. PRISMA flowchart of the study selection process
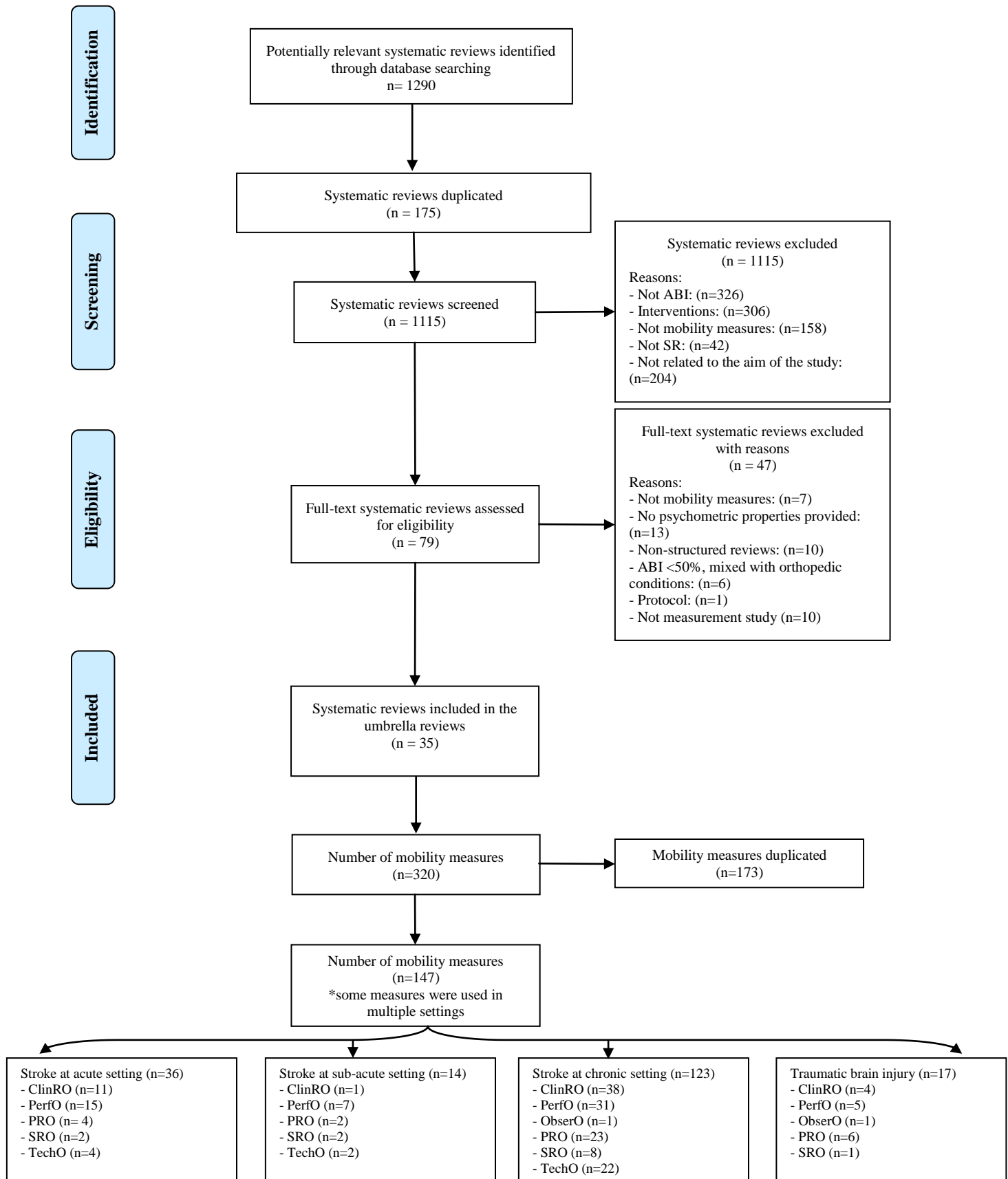
CHAPTER 4 THE INTEGRATION BETWEEN MANUSCRIPTS 1 AND 2

4.1   Research questions

Manuscript 1

Research question: What are the measurement properties, the interpretability, and the feasibility of mobility measures using various sources of information (patient, clinician, and technology) among individuals with acquired brain injury (Stroke, TBI)?

Objective: to synthesize the measurement properties, the interpretability, and the feasibility of mobility measures, from various sources of information (patients, clinicians, technology), through an umbrella review of published systematic reviews among individuals with acquired brain injury (Stroke, TBI).

Manuscript 2

Research question: What are the perceptions of clinicians, individuals with acquired brain injury, and their caregivers about factors influencing mobility among individuals with acquired brain injury (Stroke and TBI) important enough to be considered while evaluating mobility?

 Objective: to identify factors influencing mobility which need to be considered while evaluating mobility, and incorporating patients' needs and preferences into individualized care management plans among individuals with acquired brain injury (stroke, TBI) , as perceived by clinicians, individuals with acquired brain injury, and their caregivers.

4.2   Integration of manuscripts 1 and 2

Mobility is a multi-dimensional construct, and it is important to understand mobility in a holistic way to select a suitable outcome measure to accurately characterize and monitor changes in mobility during rehabilitation interventions for individuals with acquired brain injury (ABI) [1]. Planning rehabilitation and comparing impact of different interventions on mobility requires an understanding of the severity of mobility limitations among individuals with ABI. Also, it is important to evaluate the interplay between the determinants that influence mobility (i.e. cognitive, physical, psychosocial, environmental, and financial) [2] to better understand what influences each patient's mobility.

To address the impairments and limitations experienced by individuals with ABI in research or practice, the International Classification of Functioning, Disability and Health Framework (ICF) [3] is useful for performing such

a comparative examination of mobility measures. It will provide researchers and health professionals with the information needed to select the best outcome measure(s). It can be used to systematically classify the different domains of available outcome measures and therefore provide an additional basis for selection of a measure, based on a comparison of content [3-6].

A synthesis of evidence through an umbrella review of published systematic reviews on mobility measures among individuals with ABI is required to provide a comprehensive review of measures of mobility among individuals with ABI. Given that the umbrella review may not cover all measures that evaluate the determinants influencing mobility, focus group discussions were conducted among clinicians, individuals with ABI, and their caregivers. Results of the focus groups identified the measures used in clinical practice and the determinants that influence mobility as perceived by clinicians, individuals with ABI, and their caregivers' perspectives.

4.3 References

1. Murphy, M.A., et al. An overview of systematic reviews on upper extremity outcome measures after stroke. *BMC Neurology*. 2015;15(1):29.

2. Webber, S.C., M.M. Porter, and V.H. Menec, Mobility in older adults: a comprehensive framework. *The Gerontologist*. 2010;50(4):443-450.

3. World Health Organization. *International Classification of Functioning, Disability and Health: ICF*. Geneva; 2001.

4. Geyh, S., et al. ICF Core Sets for stroke. *Journal of Rehabilitation Medicine*. 2004;36(0):135-141.

5. Stucki, G., T. Ewert, and A. Cieza. Value and application of the ICF in rehabilitation medicine. *Disability and Rehabilitation*. 2003;25(11-12):628-634.

6. Cieza, A., et al. Refinements of the ICF Linking Rules to strengthen their potential for establishing comparability of health information. *Disability and Rehabilitation*. 2019;41(5):574-583.

CHAPTER 5 MANUSCRIPT 2

Title: Clinicians', Patients', and Caregivers' Perspectives about Factors that Influence Mobility: Creating a Core Set of Mobility Domains among Individuals with Acquired Brain Injury

Rehab Alhasani,[1,2,7] Dennis Radman,[1,2] Claudine Auger,[2-4] Anouk Lamontagne,[1,2,5] Sara Ahmed.[1,2,6,8]

This manuscript has been submitted to Annals of Medicine Journal

[1]School of Physical and Occupation Therapy, Faculty of Medicine, McGill University, Montréal, Canada

[2]Centre for Interdisciplinary Research in Rehabilitation of Greater Montreal (CRIR), Montréal, Quebec, Canada

[3]School of Rehabilitation, Faculty of Medicine, Université de Montréal, Montréal, Canada

[4]Institut universitaire sur la réadaptation en déficience physique de Montréal, CIUSSS du Centre-Sud-de-l 'Île-de-Montréal, Montréal, Canada

[5]Jewish Rehabilitation Hospital, CISSS de Laval, Laval, Canada

[6]Constance Lethbridge Rehabilitation Center, CIUSSS Centre- Ouest de l'Île de Montréal, Montréal, Canada

[7]Department of Rehabilitation Sciences, College of Health and Rehabilitation Sciences, Princess Nourah Bint Abdulrahman University, Riyadh, Saudi Arabia

[8]McGill University Health Center Research Institute, Clinical Epidemiology, Center for Outcome Research and Evaluation (CORE), Montréal, Canada

Corresponding author

Sara Ahmed, PhD.
School of Physical and Occupation Therapy, Faculty of Medicine, McGill University
3655 Sir William-Osler
Montreal, QC, Canada, H3G 1Y6
Tel.: 514-398-4400 ext. 00531
E-mail: sara.ahmed@mcgill.ca
ORCID Identifier: 0000-0001-5172-6790

5.1 Abstract

Objectives: To identify factors influencing mobility which need to be considered while evaluating mobility, and incorporating patients' needs and preferences into individualized care management plans among individuals with acquired brain injury (ABI), as perceived by clinicians, patients, and their caregivers.

Methods: Five focus groups were held, three with clinicians; two with individuals with ABI, and the perspective of one caregiver was considered. Focus group discussions were transcribed and analyzed using an inductive and a deductive thematic content approaches.

Results: Four themes were identified: considering mobility holistically and individual needs, preferences, and unique experiences; assessment and intervention guidelines; support network; and uncertainty about symptoms and recovery. Using the ten-rule International Classification, Functioning, Disability, and Health framework linking process, codes were categorized into Body Functions, Activity and Participation, and Environmental factors exploring the prominent domains that mostly identify factors influencing mobility.

Conclusions: Comprehensive measurement of mobility remains an ongoing challenge owing to multiple contributing factors, ranging from personal and psychosocial factors to the influence of a myriad of environmental and community considerations. Preparing individuals with ABI for community mobility can be substantially improved if healthcare professionals employ communicative tools to facilitate shared decision making with patients and to deliver patient-centred rehabilitation care.

Key words: Mobility, Acquired Brain Injury, International Classification of Functioning, Health and Disability Framework, Focus group, Assessment

5.2   Introduction

Acquired Brain Injury (ABI), including traumatic brain injury (TBI) and stroke, are the leading causes of disability globally [1-3]. According to the World Health Organization, the global incidence of all-severity TBI is estimated at 69 million people, while 15 million people suffer a stroke worldwide each year [4-6]. Among the 1.5 million Canadians with ABI, over 60% report ongoing restrictions in mobility and participation in societal roles [5]. Individuals with ABI face challenges especially once discharged from acute care or rehabilitation and with uncertainty regarding recovery and regaining independence [7, 8]. Mobility limitations in the community are common [9] and affects 30% of persons with a TBI [10-12], and up to 50% of stroke survivors [13], even after extensive rehabilitation [9]. Long-term follow-ups of individuals with ABI show that impairments in mobility appear to undergo little change, even ten years after the initial injury [11, 12, 14]. Most individuals with ABI have decreased levels of community mobility, significantly reducing their quality of life [15]. Identifying effective strategies and interventions to mitigate the long-term consequences, management, and rehabilitation of people with ABI is a priority [16].

Mobility is a multidimensional construct defined through both theoretical and empirical approaches. Theoretically, mobility consists of the ability to move oneself independently within a 'life-space', expanding from one's home to the neighbourhood and beyond [17-23]. Webber's framework adds that mobility is influenced by five vital interrelated determinants, including physical, environmental, cognitive, psychosocial, and financial influences [23], and this broadness and complexity is reflected in the International Classification, Functioning, Disability, and Health framework (ICF) mobility core set [24]. Empirically, studies have focused on the effects of the built environment on mobility within the community [25, 26].

Selection of a suitable measure to evaluate mobility is critical to accurately characterize mobility limitations, to plan intervention objectives, and to monitor changes in mobility during rehabilitation for individuals with ABI [27]. Choosing a measure of mobility, however, can be challenging for clinicians, as mobility is multidimensional, owing to the complex interaction of bio-psychosocial factors. There is no comprehensive measure to evaluate the myriad of factors that influence mobility for individuals with ABI [28, 29]. Further, to measure mobility in research, we rely on expensive laboratory technologies [30-32] and performance-based tools [33] that are burdensome in terms of setup, staff time for administration, and analysis. Notably, these tools may not be readily applied in "real-life" community contexts. Further, electronic platforms that can collect real-time patient-reported

115

and clinician-reported data are in their early stages [34], particularly in rehabilitation. To build these platforms correctly, a common language of the information collected in these systems is important to ensure that the data can be used to evaluate changes within and between patients. Therefore, to plan rehabilitation effectively and compare between different interventions, an understanding of the nature and severity of mobility among individuals with ABI is needed, which requires a comprehensive evaluation of mobility.

Comprehensive and accurate evaluation of mobility can help clarify differential benefits and harms of interventions. Measures that capture challenges in measuring mobility from clinicians', patients', and caregivers' perspectives are especially necessary during recovery, rehabilitation, and community reintegration. Identified factors that influence mobility can further inform clinicians on how to incorporate patients' needs and preferences into individualized care management plans to generate health outcomes that matter most to patients.

5.3   Objectives

To identify factors influencing mobility which need to be considered while evaluating mobility, and incorporating patients' needs and preferences into individualized care management plans among individuals with ABI, as perceived by clinicians, individuals with ABI, and their caregivers.

5.4   Methods

5.4.1   Statement of ethics

Approval of this study was granted by the Comité d'éthique de la recherche des établissements du centre de recherche interdisciplinaire en réadaptation (CRIR) [CRIR 1387-1218].

5.4.2   Research design, type of sampling and data collection

Focus group discussions were selected as the best method to meet the aims of this study [35]. Focus groups are useful methodology to obtain information on perspectives and experiences of a homogenous group of people related to a common topic [36], as they facilitate discussion and produce a variety of ideas in a short time among participants [37, 38]. Data collection took place at three rehabilitation sites of Centre for Interdisciplinary Research in Rehabilitation of Greater Montreal (CRIR) in the province of Quebec, Canada.

Pre-recruitment of individuals with ABI was accomplished using a computer-generated random list of previous rehabilitation clients in the sites since November 2019 using the following eligibility criteria: age $\geq$ 18 years, men or women with a primary diagnosis of stroke or TBI, files currently open or discharged $\leq$ 6 months, ability to speak French or English, and living in Montreal. Based on purposeful sampling strategy, a member of the

clinical team called eligible participants to obtain initial verbal consent, and then a researcher contacted interested participants, explained the study objectives, and answered questions.

Clinical research coordinators sent clinicians email invitations to participate, explaining the objective of the study. Interested clinicians contacted the researcher via email. Clinicians from different professions in rehabilitation, of all years of experience working with individuals with ABI in inpatient, outpatient rehabilitation hospital settings, community care, or delivering home rehabilitation, and who spoke English or French were recruited based on purposeful sampling strategy. All participants signed a consent form before attending the focus group discussions.

5.4.3   Procedure

Step 1: To facilitate the discussion during the focus group, a description of the purpose of the study was sent to participants ahead of time, along with a demographic questionnaire. Clinicians were also asked a general question to identify mobility measures used in their clinical setting. One week was given to complete the inventory that was compiled across rehabilitation sites and sent to clinician participants.

Step 2: A team of three clinical researchers with expertise in ABI and mobility (RA, SA, CA), reviewed the focus group interview guides and questions for individuals with ABI and clinicians. Iterative changes and reviews of all materials sent to participants were conducted to ensure clarity of the documents. Three focus group discussions with clinicians, one with individuals with stroke, and one with individuals with TBI were conducted between November 2019 and May 2020, and lasted for 90 to 120 minutes. A private room was provided for in-person focus groups at all rehabilitation sites except for individuals with TBI, whose focus group was held virtually via a web video-conferencing platform (Zoom Video Communications Inc., 2020) due to the COVID19 pandemic. All focus groups were secured using McGill University servers with security protocols. The data from both in-person and virtual focus groups was combined and analyzed as one source [39]. After each focus group, a verbal summary was provided at the end of the discussion to participants to ensure clarity and accuracy of the content.

Two researchers (RA, SA) conducted the focus group discussions with open-ended questions, derived from the study objectives (Table 1). Two co-moderators attended the focus groups and took notes. An observer was present to record non-verbal communication and additional notes. Pseudonyms were assigned to each participant. The audio-recordings complemented the notes and were transcribed verbatim afterwards.

5.4.4   Data analysis

Descriptive statistics summarized the characteristics of participants. As described below, the thematic analysis was based on an inductive thematic content analysis, as described by Creswell [38], and a deductive thematic content analysis using the ten rules for the ICF linking process [40] (Appendix 1).

A. Data coding

In the first stage, a short debriefing was completed after each focus group. Notes taken by the co-moderators assisted in the analysis. All focus groups were transcribed verbatim by the first author. The first author familiarized herself with the data by repeatedly reading and listening to the recordings and documenting initial ideas arising from the audio and verbal materials [38].

During the second stage, two independent researchers (RA, DR) read each of the transcripts to gain a sense of the data. Then, line-by-line coding was undertaken independently using an open-ended approach to capture ideas expressed by participants. The process was done by coding terms that were as broad-based as possible to avoid premature closure on interpretation. Handwritten notes from the co-moderators and observer were also consulted. Final codes were established by comparing the codes of both researchers and reviewing the content considering the explicit aims of the study [38].

During the third stage, ten rules established for the ICF linking process [40] were used to analyze the data deductively by the first author and then verified by the second author. The codes of each quote were linked to the ICF domains of Body Functions, Activity and Participation and Contextual factors. Then, linked at a general level (1-level classification) and expanded to levels of greater detail (2nd and 3rd specific ICF category) when the information was available.

A third researcher (SA) independently reviewed the provisional theme summaries from the second and third stage. Through iterative discussion and consultation during a series of virtual meetings, the reviewers verified the themes, and mapped the relationships between them. Reviewers met regularly to resolve any discrepancies, increasing the consistency of the findings.

B. Code rating

In the second stage, the code rating was performed by calculating the frequency of each identified code corresponding to each theme among all participants. This helped to assess saturation based on the level of repetition of codes across all participants [41].

During the third stage, we calculated the proportion of each code in each theme in relation to the ICF domains divided by the total number of codes in the theme. Calculating the proportion of codes within ICF domains helped to explore the prominent ICF domains that mostly identify factors influencing mobility that need to be considered while evaluating mobility among individuals with ABI.

5.4.5   Triangulation, credibility, and reflexivity

The primary means for ensuring trustworthiness was through triangulation, reflexivity, credibility, and peer debriefing. Conducting a focus group with individuals with ABI to corroborate or contrast with clinician perceptions served as a form of data source triangulation [42]. Meetings between the focus group moderators, co-moderators, and observer to compare notes and to discuss expected and unexpected tangents facilitated reflexivity. Credibility [43] of data collection was established by cross-checking audio-files and transcripts to ensure trustworthiness [44]. Additionally, a verbal summary of the discussions was provided to the focus group participants to ensure the accuracy and credibility of the data. Data analysis involved regular discussions between the reviewers in assessing independently coded data and themes. Having multiple independent researchers code transcripts and compare codes through peer debriefing was a form of researcher triangulation and encouraged reflection on and refinement of categories as they were formulated [42].

5.5   Results

5.5.1   Participant characteristics

Seventeen clinicians from different professions agreed to participate in the study (Table 2). Each group included 3 to 10 participants. They had an average of 11.89±7.04 and 10.82±7.05 years of experience working with stroke and TBI population; respectively. The fourth focus group among individuals with stroke included 5 participants and one caregiver. The majority of the sample was men (80%), and the mean age was 58.4±15.69 years. The severity of the injury for most participants was moderate (60%). The last one was conducted among five female participants with TBI. The mean age was 43±17.24 years, and the severity of injury for most participants was mild (80%). The demographic information of individuals with ABI is presented in Table 3. The inventories we received from three CRIR rehabilitation sites between August-September 2019 included 49 measures used to evaluate mobility among individuals with ABI (Appendix 2).

5.5.2   Emerging themes

The coding rating for each theme by clinicians, individuals with ABI and their caregivers was presented in Appendix 3. Figure 1 summarized all the emerged themes and sub-themes.

Theme 1: Considering mobility holistically and individual needs, preferences, and unique experiences

1.1. A comprehensive definition of mobility

It was first necessary to understand how clinicians and individuals with ABI define mobility. Individuals with ABI defined mobility as the ability of the person to walk independently (n=4; 40%). Also, clinicians and individuals with ABI explained that mobility is not only walking, as it is influenced by many factors such as cognition (clinicians: n=2; 12%; patients: n=2; 20%) followed by emotions such as anxiety (clinicians: n=2; 12%; patients: n=1; 10%), fear (clinicians: n=2; 12%), and safety perceptions (clinicians: n=3; 17%).

> *C01: "mobility is a big topic that we deal with; it is not just a physical capacity, all the motivation, cognitive, planning"*
> *C05: "the notion of feeling safe of being comfortable with moving versus moving from point A to point B"*
> *S05: "I just think mobility, is getting from point A to point B, pretty much"*
> *S04: "it was just for me very psychological, that would hinder [mobility]"*

1.2. Factors hindering mobility, participation, and reintegration into the community

The most common factors limiting mobility identified by individuals with ABI were cognition (n=4; 40%) and fatigue (n=4; 40%) among individuals with stroke; headache (n=4; 40%), fear (n=2; 20%), nausea (n=2; 20%), and dizziness (n=2; 20%) among individuals with TBI. Individuals with ABI explained that some factors such as cognition lead to a change in self-identity (n=3; 30%). The caregiver explained that the factors extended to family members, who experienced difficulty with the care recipient's deficits and loss in identity. Clinicians reported that cognition (n=1; 6%) and fear of falling (n=1; 6%) resulted in insecurity and limited persons' mobility.

> *T05: "It has been almost a year since my concussion symptoms have been lingering. I am confused, have headaches, nausea, double vision, hallucinations, memory problems"*
> *S04: "And it gets tiring to [to do your work], but maybe lazy tired, discouraged, depressed, whatever it is"*
> *S03: "I remember saying I do not feel like myself"*
> *S03: "when something happens to you it affects your family as it did with me"*
> *C05: "fear of falling even if their the balance has improved, they have remained really insecure"*

1.3. Impacts of bio-psychosocial factors on everyday life and mobility

Participants with ABI discussed that cognitive impairments (n=8; 80%), sensitivity to stimulation (n=4; 40%), comprehension (n=4; 40%), followed by visual (n=2; 20%) and auditory (n=2; 20%) impairments, impacted their ability to participate in daily activities, including social events with family and friends (n=2; 20%), returning to work (n=6; 60%), leisure activities (n=3; 30%) and driving (n=2; 20). All these factors led to self-isolation that impacted their mobility and ability to participate in the community (n=2; 20%).

T02: "I love my brain. I want it back"
T04: "I have too much fear all the time when I am driving"
T02: "going specializing in any kind of sort of taking socializing family gatherings with going to restaurants, cafes you know whether, it was in movies or anything that was loud; all those things were very difficult for me"
T02: "I couldn't do the basic work of checking their work and sending emails that I've developed an anxiety and phobia around this, and I had to give it up yesterday"
T03: "I was already self-isolating because I couldn't handle all the noise"

Theme 2: Assessment and intervention guidelines

2.1. Finding common goals with patients

Clinicians explained various assessment methods to evaluate patients' mobility. Clinicians explained that they tended to integrate the proficiency and judgment they acquired in clinical practice in deciding what tool to use to assess mobility (n=8; 47%). Also, they tended to evaluate mobility among individuals with ABI using alternative methods such as situational assessment and observations (n=9; 53%) more often than standardized measures.

C07: "[we assess our patients focusing] more at the level of functional mobility, then more in the community and in using public transportation"
C01: "we all use our clinical decision making, our experience to say what would be the most important tool to use"

Clinicians explained that patient objectives and their clinical judgements (n=8; 47%) were an essential part of the assessment and treatment cycle, highlighting the importance of tailoring rehabilitation to specific deficits and working towards the person's recovery progress goals. Also, they mentioned that identifying red flags (such as risk of falls) is essential, as these may require additional evaluation (n=2; 12%).

C03: "part of the assessment is also establishing the persons' self-reported difficulties, what they perceived to be difficult is a good starting to evaluate"
C03: "what are the red flags that require an intervention? Fear, problems with vision, pain, depression, fatigue, dizziness, headaches, if they mention any of these problems it may require other evaluations"

Some clinicians expressed that using only self-reported questionnaires may not identify disability in patients lacking awareness (n=4; 23%). Also, they reported that self-report measures and screening assessment can only be used on the first contact to highlight individuals' needs (n=10; 59%). They expressed that it is difficult to use self-report questionnaires in cases of aphasia, comprehension or cognitive impairments (n=6; 35%), and it is better to use proxy-reported outcomes (n=1; 6%).

C03: "We have what the clients subjectively report is their difficulty, but we also have a professional responsibility to screen everything that they might not think of"
C07: "using a questionnaire, it's still too much at the beginning if there is a bit of aphasia in there, comprehension problem, are not able to read, or you know they are able to just say simple answers"

Clinicians reported that standardized measures could be used when assessing patients to point out their impairment and limitation levels and to be able to track changes during follow-up sessions (n=2; 12%). They highlighted the importance of using both standardized measures and clinical judgment when assessing mobility (n=11; 65%). A clinician reported the importance of using standardized measures when a situational assessment alone cannot give the full picture of a patient's impairment. Another clinician suggested the importance of consistency in measures used across the continuum of care to enable comparison between patients and to track individual progress.

> C04: "clinical judgment and the degree of the sensitivity to change to target functional abilities in the community"
> C02: "if the inpatient and the acute outpatient and the chronic outpatient all use the same test, then we can track measures across the time"
> C02: "I would say that the only time I go with score it is for driving because I cannot go and evaluate a driving by a mise en situation [i.e. situational]"

Also, a clinician highlighted that standardized measures are becoming more practical to support clinician's recommendations, tracking changes, and discharge planning, but not to establish an intervention plan.

> C01: "I use the objective tool as an argument to support my recommendation"

Furthermore, clinicians in rehabilitation acknowledge the importance of information exchange, as interdisciplinary collaborative decision-making facilitated aligning treatment planning with patients' needs (n=10; 59%).

> C07: "the intervention plan depends if it's the disciplinary or interdisciplinary plan"

2.2. Challenges clinicians face when they evaluate mobility

Clinicians expressed challenges with using standardized measures (n=9; 32%), as some of them take up an entire patient evaluation session, leaving no time for delivering treatment or education. Other measures can be fatiguing for individuals, which may affect the assessment and treatment cycle. They also reported that some standardized measures are not adapted for use in the community. Clinicians explained that limited tools use guidelines make evaluating mobility more challenging (n=2; 12%). Thus, a shortlist of the most important mobility measures covering different domains is needed.

> C04: "Berg is really good but it took 30 minutes, the BESTest took 45 minutes to finish, I mean there are too many things to look at instead of using a tool"
> C03: "fatigue is another obstacle if you have to do the BORG over three visits"
> C05: "sometimes in the community, it's hard to use a standardize measure to evaluate mobility because of a different environment, so it is more functional"
> C03: "what we need to know and you know in terms of research questions, what are the top 5, top 10 tests that are going to be helpful"

A clinician reported the importance of using a practice style that allows the patient to trust the clinician's guidance while also being involved in their care plan, to the extent that the patient wishes to be involved. Other barriers to assessment reported by clinicians were related to environmental factors such as winter weather (n=2; 12%), as persons with ABI tend to isolate themselves at home. This may increase the difficulties in using assistive devices. Also, alcohol and drug abuse (n=2; 12%) may result in falls and harms assessment and treatment sequences that impact mobility negatively.

> C01: "another barrier for sure is the client themselves in term of fear, do they trust you, or even if they trust you are they able to put themselves in a situation where they are challenged"
> C01:"[Clients were] homebound in winter because either they don't have the confidence or just very difficult to get out in a wheelchair, probably a combination of the two?"
> C05: "We have clients with a problem of abusive consumption when they return home and resume their consumption, they will have falls"

Clinicians reported that safety issues (n=8; 47%), cognitive impairment (n=7; 41%), and patients' confidence (n=3; 17%) were significant barriers to assessment. They explained that some patients with ABI overestimated their abilities and showed a lack of fear, awareness, and judgement that impacted their safety when they reintegrated into the community.

> C07: "when we talk about cognitive versus physical, it depends on the clients, there are clients for whom the cognitive dominates, which make them unsafe to cross the street, they don't orient themselves in their neighbourhood"

2.3. Engaging the patient and considering their perspective in their care

Individuals with ABI, specifically stroke, explained that using an engaging communication style can help them feel comfortable and involved in the care process (n=7; 70%). They usually ask questions regarding the purpose of the evaluation and treatment provided to understand their benefits. On the other hand, some participants with stroke tend not to ask questions related to the evaluation or the treatment provided to them (n=2; 20%). They reported that healthcare providers know exactly what to do as they follow a strict protocol for evaluations and treatments. One participant with stroke reported that he learned how to say "no" for certain evaluations and treatments because he thought it was a bad decision made by healthcare providers.

> S02: "I would actually stop at the beginning and ask what do you want to gain out of this, like what the purpose of it is"
> S03: "I assumed that's what should happen because you know this is how they going to treat me"
> S05: "I learned there to say no to certain things because they would really bad decision"

Theme 3: Support Network

The theme of support network described a number of influential factors around an individual (e.g., family) sharing responsibility with individuals with ABI to influence mobility and help them reintegrate better into the community.

3.1. Caregiver support

Clinicians highlighted the importance of caregiver support (n=5; 29%) as a secondary source of care for individuals with ABI, especially if they have cognitive impairments, to facilitate their mobility and provide the essential support to discuss their limitations. Communication was often hindered by temporary or permanent impairment. Therefore, a family member is needed to communicate with clinicians on behalf of people with such impairments.

C06: "a family member or a caregiver can help especially for patients with cognitive issues"

One of the adjustments to new life roles that clinicians perceived as important to improve the self-identity and coping skills of individuals with ABI was to have support from their family members, especially when they are new to using assistive devices (e.g., wheelchair). Also, individuals with ABI reported the importance of having support from a family member, as they can make a positive adjustment to their life (n=8; 80%).

C01: "a lot of people maybe it is a new thing that their loved one is using a wheelchair"
T04: "I think the psychologist and the support from your family is more effective"

3.2. Providers support

Participants with ABI acknowledged the support and services provided by some healthcare providers in rehabilitation centres (n=3; 30%). They explained the importance of the healthcare professional listening to the patient's complaints and understanding what the patient needs, which is not always the case among healthcare professionals.

T02: "I thought the team of the [rehabilitation] was very good. They were on board, I felt finally really supported"

A social worker explained that they offer support to families who have loved ones with a disability to develop coping strategies to help them understand the patient's impairment and how they can assist them in integrating into daily activities within the community.

C13: "we work with the families, so it is important to get their point of view and their input and to help them to cope into the situation to help the patient"

3.3. Community Support

Individuals with ABI explained that community support by the public and the availability of governmental resources to meet the needs of persons with disabilities is needed (n=4; 40%). Participants with ABI reported how

the perceptions of people at some institutions versus community differed, and how stigma associated with ABI

impacts mobility (n=2; 20%).

> S06: "I find one thing quite annoying is that when you are put around in a wheelchair, people look at you, and some taxi drivers, they think your brain is gone, they think you stupid"

Clinicians explained the importance of supporting persons with disabilities to facilitate their mobility, but

because of limited community resources, clinicians cannot provide the needed support (n=4; 23%). There is a need

to determine the best way to provide community support through guidelines and policy services that are limited.

Also, clinicians discussed that support services are especially lacking in the community for persons who live alone.

> C05: "[the support services are missing, especially when the patient] is not [obtaining] the necessary balance, the necessary endurance or because it is not well oriented and safe to cross the street"
> C06: "they end up after that feeling like there's no one left, there are no services that can be provided for them"

Theme 4: Uncertainty about symptoms and recovery

Participants with TBI described experiencing confusion and uncertainty about their symptoms and

diagnosis when their own experiences did not make sense to them or match what they were being told by the

healthcare providers. The uncertainty left them feeling increased distress and impacted their participation in the

community (n=3; 30%). Also, they reported that there was uncertainty regarding expected recovery and

consequences associated with their injury. Furthermore, participants experienced uncertainty about whether they

were still recovering, how to tell if they were getting better, why it was taking so long, and how recovery could be

hastened, so they could reintegrate into the community (n=4; 40%).

> T05: "I ask myself if I would ever return normal and would my symptoms last for a lifetime. They recently told me to at xxx that my physiotherapy sessions have ended"

Moreover, most participants with TBI described the benefits of having constructive strategies to manage

their symptoms, but some appeared less confident in their strategies and more concerned about making their

symptoms worse by "getting it wrong" (n=4; 40%).

> T03: "I simply write things down, like using notes in my phone or just like a notepad. So, I can remind myself, but sometimes I forgot"

5.5.3   The ICF linking process

Codes for each theme were mapped to the ICF domains as follows: Theme 1: Body functions (n=46; 54%),

followed by Activity and Participation (n=30; 35%), Environmental factors (n=7; 8%), and Personal factors (n=2;

2%); Theme 2: Environmental factors (n=74; 69%), followed by Body functions (n=21; 19%), and Activity and

Participation (n=12; 11%); Theme 3: Environmental factors (n=20; 77%), followed by Body functions (n=6; 23%);

Theme 4: Body functions (n=4; 21%), and not covered health conditions (n=15; 79%) (Appendix 1).

5.6   Discussion

Individuals with ABI, clinicians, and a caregiver's perspectives yielded an understanding of the factors influencing mobility which need to be considered while evaluating mobility among individuals with ABI. Participants mainly focused on challenges that limit mobility and provided suggestions of how to address these to incorporate patients' needs and preferences into individualized care management plans. Through an inductive thematic analysis, four main themes emerged: considering mobility holistically and individual needs, preferences, and unique experiences; assessment and intervention guidelines; support network; and uncertainty about symptoms and recovery. To our knowledge, this is the first time that the ten-rule ICF linking process [40] was used in a deductive thematic analysis to explore the prominent ICF domains that mostly identify factors influencing mobility that need to be considered while evaluating mobility among individuals with ABI.

A combined inductive and deductive thematic analysis was chosen by the authors to best address the research questions. While inductive thematic analysis searched for patterns from raw data, deductive thematic analysis addressed the set of information and searched for consistencies and anomalies [45]. Combining inductive and deductive thematic analysis approaches allowed for a complete analysis and a critical realism ontological approach [45]. While the inductive thematic analysis allowed the reality of others to be clearly represented, the deductive thematic analysis provided an initial grounding of using a common language based on the ICF framework.

Our study evaluated the emphasis on factors influencing mobility among individuals with ABI which was not explored in earlier published studies. While discussing factors influencing mobility, most post-stroke survivors mentioned cognition and fatigue, whereas post-TBI survivors mentioned headache, fear, nausea, and dizziness. Clinicians were mostly concerned with individuals' safety and wanted to prevent falls. Also, we did explore clinicians', individuals with ABI and their caregivers' perspectives on factors influencing mobility across the continuum of care to better understand how mobility needs to be evaluated over time. Previous studies did not evaluate mobility comprehensively and focused mainly on evaluating the perspectives of individuals with stroke and their caregivers about mobility in the context of walking and falling following inpatient rehabilitation or skilled nursing facilities [46-48].

Participants with ABI stated that cognitive impairments and sensitivity to stimulation have a considerable impact on their daily activities, resulting in developing psychological and emotional factors that would lead to self-isolation. Individuals with ABI experience a process of reconstitution of self in response to the burden of living with a deficit or disability. Studies have shown that individuals with chronic conditions tend to actively engage in daily life routines by reflecting on their deficit or disability, which helps them make sense of who they are, experiencing self in a new conscious way [49]. Restoring a sense of control and self-identity is essential for persons with ABI to be able to move and integrate into their community.

Individuals with ABI identified their needs for encouragement and feedback from healthcare professionals, to facilitate their mobility, increase their understanding, and progress to goals within a rehabilitation setting. Fulfilling these needs would increase patients' ability to learn, improve their level of achievement, and underpin their motivation [50]. Several studies included interpretations of data from participants discussing feelings of anxiety and depression during the rehabilitation process [51, 52]. Not engaging patients as whole persons into their care and respecting their needs and preferences may lead to a perceived lack of control on the patient's part, ultimately resulting in feelings of futility, decrease in confidence, and self-isolation [53].

Our findings revealed that the interchangeable common goals between clinicians and patients can help establish shared goals and priorities to evaluate mobility comprehensively. In evaluating mobility, some clinicians rely on clinical experience and judgment, while others rely on situational assessment and observations. Inventories identified 49 measures that clinicians used to evaluate mobility among individuals with ABI. Clinicians assessed factors that influence mobility (such as cognition). Overall, clinicians appear to regard measurement of mobility in ABI survivors as necessary, but acknowledged the complexity and challenges associated with measuring community mobility in ABI survivors. One challenge identified by participating clinicians was the lack of specific tools for measuring mobility, compelling clinicians to rely on a range of measures that infer mobility, such as tools to assess balance and walking. Even then, clinicians were not consistent in which measures to use.

Despite the increased use of validated and available mobility measures, there is still a broad range of measures being used that limits the ability to compare findings from centre to centre or client to client, which has an impact on identification and implementation of best practices. The ICF is a universally accepted tool used to foster the inclusion of the critical domains which impact an individual with ABI. From our identified themes, it is clinically useful when the stroke and TBI published core sets [54, 55] are used to describe mobility domains

measured by standardized measures to inform the measures best suited to a holistic approach to care, linking impairments, activity limitations, and participation restrictions with contextual factors [56]. This allows the development of an inclusive treatment plan for the individual with ABI where the functional profile is fully considered. Standardizing the measurement of mobility would provide individuals with ABI with information they need to engage them better into their care. There is a need to consider measuring mobility at the endpoint of any given treatment decision or pathway. Also, there is a need to use an appropriate combination of instruments suitable for the clinical context, including patients, clinicians, and technology-based tools. Thus, a future step of our work is to develop a Core Outcome Set of mobility to standardize measures used across clinical sites and studies among individuals with ABI.

Clinicians also tend to believe that patients usually focus on ultimate outcomes and not the specific deficits or limitations that need to be considered while evaluating mobility. Clinicians identified the importance of adapting assessments and their decisions to the deficits to help patients integrate into the community safely. It might be essential to educate ABI survivors and caregivers to know their deficits and limitations to promote and facilitate information exchange. Clinicians rarely use self-reported questionnaires, as they require considerable time and effort especially if the individuals with ABI are cognitively impaired. It is essential to use alternative methods (such as proxy-reported outcomes) to get the required information and set patient goals.

Individuals with ABI and their caregivers prefer to be actively involved in the rehabilitation process, instead of allowing clinicians to make judgments and decisions on their behalf based only on functional assessments. Previous studies showed that shared decision making between patients and clinicians impacts engagement in rehabilitation [57-59]. Clinicians tend to integrate their proficiency and judgment through clinical practice in deciding which tool to use to assess mobility. Clinicians need to understand the reasoning behind patient preferences to tailor the needed treatment [60]. They should be encouraged to explore how treatment preference matches patient goals, as well as the individuals' understanding of associated pros and cons. Treatment preferences adapted to patients' goals should be seen as a process of shared decision making. Patients and clinicians are expected to collaborate and make decisions together that are informed by the best available evidence and genuinely aligned with patient preferences [48]. Thus, healthcare professionals must consider involving patients during all stages of rehabilitation care.

The disconnect between the expectations of clinicians and ABI survivors and their caregivers can be linked to patient's characteristics, availability of support, social determinants, and health system factors adapted towards discharging patients sooner from the hospital [48]. One way to address this problem is by engaging patients from the outset in the selection of outcome measures and linking evaluations to a care plan that they develop together. In the absence of a support network, patients may be less likely to participate when they feel their emotional needs are not considered, resulting in a decreased sense of self-perception in conjunction with a decreased sense of belonging [49, 61]. A patient-centred response to emotions requires reacting to emotional cues [62, 63]. Thus, healthcare providers should communicate their understanding of an emotional response and express acknowledgement by showing sympathy, empathy, and reassurance.

Healthcare professionals need to openly acknowledge, support, and express commitment to the continuity of their patient's care and provide extra attention to the way social, cultural, psychological and other factors impact a patient's ability to be involved in their care [64]. The most significant concern for participants was the uncertainty they faced throughout the social distancing and isolation measures during the COVID-19 pandemic, as well as their ability to cope longer-term. There was also uncertainty as to how they would act, with some fear of lingering anxiety over social contact and health, and others eager to return to normal levels of social activity. Another critical component of responding to emotional needs is managing uncertainty among individuals with ABI. It is essential to recognize that sharing information is a value, a behaviour and a skill that may vary depending on a patient's perspective [62]. Sustaining trust between patient and clinician has both instrumental and intrinsic value, as it leads to better patient outcomes while improving the therapeutic experience for both of them [62]. For example, some patients lose trust when uncertain information was given [65]. Thus, providing a patient-centred exchange of information requires sensitivity to the goals and expectations of the patient.

5.6.1 Online methodology

Conducting focus group discussions online has become a popular method for collecting qualitative data. Advances in technology have enabled researchers to adapt in-person focus group methods for use in an online environment [39, 66]. Although there is a great deal of interest in online focus group methods, less attention has been given to the quality of data they generate in comparison with the in-person focus group. In comparison to the in-person focus group, the virtual one allows the participants to take part from a familiar environment instead of meeting in the same space [66]. This may reduce costs for both researchers and participants, such as the unnecessary

need to travel. The results suggest that the role of the moderator in either setting could influence the data that was generated [39]. In the in-person focus group, not every participant was able to speak due to time constraints and some participants dominating the conversation. In the virtual one, nearly all the participants were able to express their opinions. Moderators in an in-person focus group must work harder to control the flow of the discussion. Questioning, however, proved to be more difficult in the virtual focus group, as non-verbal or visual cues were observed to allow the moderator to clarify further discussions [39, 66]. Although it is difficult to determine whether the differences occurred as a result of the focus group type, the findings suggest that the themes obtained from both formats were similar despite variations in word count per response.

5.7   Study limitations

Findings of this study are based on a purposive sample and therefore may not represent views of a broader population of clinicians working in a different setting, specifically in the community. Since most of the participants with ABI in the same focus group were recruited from one rehabilitation site, we were unable to reach saturation in the findings between them as well as caregivers' perspectives, as only one caregiver participated. It is also possible that participants might not have mentioned all the factors that influence mobility because of the open-ended discussions. Hence, the results of this study should be interpreted cautiously. Future researchers may further distinguish the impact on caregiver experiences along the care continuum, contributing to the provision of timely support to improve health outcomes.

5.8   Conclusion

This study has presented clinicians', patients', and caregivers' perspective of factors influencing mobility that need to be considered while evaluating mobility, and incorporate patients' needs and preferences into individualized care management plans among individuals with ABI. Comprehensive measurement of mobility remains an ongoing challenge owing to multiple contributing factors, ranging from personal and psychosocial factors to the effect of myriad environmental community situations. This study suggests a need to raise awareness about engaging patients in their care, and respecting their needs and preferences. Healthcare professionals should provide the needed communicative tools to their patients to improve patient-centred care.

5.9   References

1.   Maas, A.I., N. Stocchetti, and R. Bullock. Moderate and severe traumatic brain injury in adults. *The Lancet Neurology*. 2008;7(8):728-741.

2.   Patil, M., et al. Cognitive and functional outcomes following inpatient rehabilitation in patients with acquired brain injury: a prospective follow-up study. *Journal of Neurosciences in Rural Practice*. 2017; 8(3):357.

3.   Prabhakaran, V. Non-communicable diseases in India: Transitions, burden of disease and risk factors-A short story. *India Health Beat*. 2012;6(1).

4.   Dewan, M.C., et al. Estimating the global incidence of traumatic brain injury. *Journal of Neurosurgery*. 2018;130(4):1080-1097.

5.   Chambers-Richards, T.L.-T.A. Risk factors, trends, health care and general life satisfaction for select neurological conditions among an aging population in Canada. 2020.

6.   Thrift, A.G., et al. Global stroke statistics. *International Journal of Stroke*. 2017;12(1):13-32.

7.   Han, P., et al. Clinical evidence of exercise benefits for stroke, in Exercise for Cardiovascular Disease Prevention and Treatment. *Springer*. 2017;131-151.

8.   Wein, T., et al. Canadian stroke best practice recommendations: secondary prevention of stroke, practice guidelines. *International Journal of Stroke* 2018;13(4):420-443.

9.   Miniño, A. and S. Murphy, xu J, kochanek kD. Deaths: final data for 2008. *Natl Vital Stat Rep*. 2011; 59(10):1-126.

10.   Mohamed Ludin, S. and N.a. Abdul Rashid. Functional Outcomes and Health-Related Quality of Life After Severe Traumatic Brain Injury: A Review. *Clinical Nursing Research*. 2018.

11.   Ponsford, J.L., et al. Longitudinal follow-up of patients with traumatic brain injury: Outcome at two, five, and ten years post-injury. *Journal of Neurotrauma*. 2014;31:64-77.

12.   Scholten, A.C., et al. Health-related quality of life after mild, moderate and severe traumatic brain injury: Patterns and predictors of suboptimal functioning during the first year after injury. *Injury*. 2015;46:616-624.

13.   Robinson, C.A., et al. Understanding physical factors associated with participation in community ambulation following stroke. *Disability and Rehabilitation*. 2011;33:1033-1042.

14.   Polinder, S., et al. Health-related quality of life after TBI: A systematic review of study design, instruments, measurement properties, and outcome. *Population Health Metrics*. 2015;13.

15.   Park, H.-J., et al. Action observation training of community ambulation for improving walking ability of patients with post-stroke hemiparesis: a randomized controlled pilot trial. *Clinical Rehabilitation*. 2017; 31(8):1078-1086.

16.   Feigin, V.L., et al. Global and regional burden of stroke during 1990-2010: findings from the Global Burden of Disease Study. *Lancet*. 2014.

17.   Baker, P.S., E.V. Bodner, and R.M. Allman. Measuring life-space mobility in community-dwelling older adults. *Journal of the American Geriatrics Society*. 2003;51(11):1610-1614.

18.   May, D., U. Nayak, and B. Isaacs. The life-space diary: a measure of mobility in old people at home. *International Rehabilitation Medicine*. 1985;7(4):182-186.

19.   Peel, C., et al. Assessing mobility in older adults: the UAB Study of Aging Life-Space Assessment. *Physical Therapy*. 2005;85(10):1008-1019.

20.   Shumway-Cook, A., et al. Environmental demands associated with community mobility in older adults with and without mobility disabilities. *Physical Therap.* 2002;82(7):670-681.

21.   Stalvey, B.T., et al. The Life Space Questionnaire: A measure of the extent of mobility of older adults. *Journal of Applied Gerontology*. 1999;18(4):460-478.

22.   Tsai, L.-T. Walking, physical activity and life-space mobility among older people. *Studies in Sport, Physical Education and Health*. 2017;(254).

23.   Webber, S.C., M.M. Porter, and V.H. Menec. Mobility in older adults: A comprehensive framework. *Gerontologist.* 2010;50:443-450.

24.   World Health Organization. *International Classification of Functioning, Disability and Health: ICF*. Geneva; 2001.

25.   Clarke, P., et al. Mobility disability and the urban built environment. *American Journal of Epidemiology*. 2008;168(5):506-513.

26.   Nagel, C.L., et al. The relation between neighborhood built environment and walking activity among older adults. *American Journal of Epidemiology.* 2008;168(4):461-468.

27. Murphy, M.A., et al. An overview of systematic reviews on upper extremity outcome measures after stroke. *BMC Neurology.* 2015;15(1):29.

28. Guralnik, J.M., et al. Physical performance measures in aging research. *Journal of Gerontology.* 1989; 44(5):M141-M146.

29. Rikli, R.E. and C.J. Jones. Assessing physical performance in independent older adults: Issues and guidelines. *Journal of Aging and Physical Activity.* 1997;5(3):244-261.

30. Butte, N.F., U. Ekelund, and K.R. Westerterp. Assessing physical activity using wearable monitors: measures of physical activity. *Medicine & Science in Sports & Exercise.* 2012;44(1S):S5-S12.

31. Mallik, S., et al. Imaging outcomes for trials of remyelination in multiple sclerosis. *J Neurol Neurosurg Psychiatry.* 2014.

32. Webber, S.C. and M.M. Porter. Monitoring mobility in older adults using global positioning system (GPS) watches and accelerometers: a feasibility study. *Journal of Aging and Physical Activity.* 2009;17(4):455-467.

33. US Food and Drug Administration. Clinical outcome assessment (COA): Glossary of terms. Drug Development Tools Qualification Programs. *Silver Spring.* 2015.

34. Ahmed, S. and D. Andrich. *International Society for Quality of Life Research (ISOQOL) Dictionary of Quality of Life and Health Outcomes Measurement*; 2015.

35. Kinalski, D.D.F., et al. Focus group on qualitative research: experience report. *Revista Brasileira de Enfermagem.* 2017;70(2):424-429.

36. Morgan, D.L. and R.A. Krueger. Analyzing and reporting focus group results. *Sage.* 1998.

37. Carpenter, C. Using qualitative focus groups to evaluate health programmes and service delivery, in Qualitative research in evidence-based rehabilitation. *Elsevier.* 2004;51-64.

38. Creswell, J.W. Qualitative inquiry & research design : choosing among five approaches. 2007;395.

39. Woodyatt, C.R., C.A. Finneran, and R. Stephenson. In-person versus online focus group discussions: A comparative analysis of data quality. *Qualitative Health Research.* 2016;26(6):741-749.

40. Cieza, A., et al. Refinements of the ICF Linking Rules to strengthen their potential for establishing comparability of health information. *Disability and Rehabilitation.* 2019;41(5):574-583.

41. Kegler, M.C., et al. Using the consolidated framework for implementation research to understand safety net health system efforts to increase colorectal cancer screening rates. *Health Education Research*. 2018;33(4): 315-326.

42. Carter, N., et al. The use of triangulation in qualitative research, in Oncology Nursing Forum. *Oncology Nursing Society*. 2014;545-547.

43. Hayashi, P., G. Abib, and N. Hoppen. Validity in Qualitative Research: A Processual Approach. *The Qualitative Report*. 2019.

44. Wood, L.M., B. Sebar, and N. Vecchio. Application of Rigour and Credibility in Qualitative Document Analysis: Lessons Learnt from a Case Study. *The Qualitative Report*. 2020.

45. Boyatzis, R.E. Transforming qualitative information: Thematic analysis and code development. *Sage*. 1998.

46. Kristensen, H.K., et al. The importance of patient involvement in stroke rehabilitation. *PloS One*. 2016. 11(6):e0157149.

47. O'Brien, E.C., et al. Clinical commentary on "Certain uncertainty: life after stroke from the patient's perspective". *Circulation: Cardiovascular Quality and Outcomes*. 2014;7(6):970-970.

48. Krishnan, S., et al. Patient-centered mobility outcome preferences according to individuals with stroke and caregivers: a qualitative analysis. *Disability and Rehabilitation*. 2018;40(12):1401-1409.

49. Hole, E., et al. The patient's experience of the psychosocial process that influences identity following stroke rehabilitation: a metaethnography. *The Scientific World Journal*. 2014.

50. Schunk, D.H. and B.J. Zimmerman. Motivational Role of Self-Efficacy Beliefs in Self-Regulated Learning, in Motivation and Self-Regulated Learning. *Routledge*. 2012;123-152.

51. Petersen, R.L. Perceptions and expectations of patients regarding a new rehabilitation model to encompass the vision of the new health plan 2030. 2017.

52. Pereira, C.M., N. Greenwood, and F. Jones. From recovery to regaining control of life–the perspectives of people with stroke, their carers and health professionals. *Disability and Rehabilitation*. 2020;1-12.

53. Moorley, C., et al., Impact of stroke: a functional, psychological report of an inner-city multiracial population. *Primary Health Care*. 2014;24(4):26-34.

54. Geyh, S., et al. ICF Core Sets for stroke. *Journal of Rehabilitation Medicine*. 2004;36(0):135-141.

55.   Pistarini, C., et al. Functioning and disability in traumatic brain injury: the Italian patient perspective in developing ICF Core Sets. *Disability and Rehabilitation*. 2011;33(22-23):2333-2345.

56.   Prinsen, C.A., et al. How to select outcome measurement instruments for outcomes included in a "Core Outcome Set" a practical guideline. *Trials.* 2016;17(1):449.

57.   Knutti, K., et al. Impacts of goal setting on engagement and rehabilitation outcomes following acquired brain injury: a systematic review of reviews. *Disability and Rehabilitation.* 2020;1-10.

58.   Plant, S.E., et al. What are the barriers and facilitators to goal-setting during rehabilitation for stroke and other acquired brain injuries? A systematic review and meta-synthesis. *Clinical Rehabilitation.* 2016;30(9): 921-930.

59.   Rosewilliam, S., C.A. Roskell, and A. Pandyan. A systematic review and synthesis of the quantitative and qualitative evidence behind patient-centred goal setting in stroke rehabilitation. *Clinical Rehabilitation.* 2011;25(6):501-514.

60.   Kjörk, E.K., et al. Experiences, needs, and preferences for follow-up after stroke perceived by people with stroke and healthcare professionals: A focus group study. *PloS One.* 2019; 14(10):e0223338.

61.   Epstein, R.M. and R.L. Street. The values and value of patient-centered care. *Annals Family Medicine*. 2011.

62.   Clarke, S., et al. Defining elements of patient-centered care for therapeutic relationships: A literature review of common themes. *European Journal for Person Centered Healthcare.* 2017;5(3):362-372.

63.   Håkansson, E.J., et al. " Same same or different?" A review of reviews of person-centered and patient-centered care. *Patient Education and Counseling*. 2019;102(1):3.

64.   Fix, G.M., et al. Patient-centred care is a way of doing things: How healthcare employees conceptualize patient-centred care. *Health Expectations.* 2018;21(1):300-307.

65.   Snell, D.L., et al. Wrestling with uncertainty after mild traumatic brain injury: a mixed methods study. *Disability and Rehabilitation.* 2020;42(14):1942-1953.

66.   Stewart, D.W. and P. Shamdasani. Online focus groups. *Journal of Advertising.* 2017;46(1):48-60.

TABLES

Table 1. Focus group questions

Clinicians guiding questions	
1)	What are the questions that you have in relation to your practice delivering rehabilitation to individuals with acquired brain injury (ABI)?
2)	In general, what are the areas that you would like to improve either in your individual practice or rehabilitation among individuals with ABI?
3)	How do you define mobility? [The focus group members will agree on a definition on mobility that will be read back to the focus group participants].
4)	What are the important factors that you believe influence mobility?
5)	What do you feel you need to evaluate to have a good picture of a person's mobility while the person with ABI in rehabilitation (inpatient/outpatient)?
6)	What do you feel you need to evaluate to have a good picture of a person's mobility while the person with ABI in community?
7)	From the inventory, how did you choose these measures? Is it capturing all aspects of mobility?
8)	What is your perception in regard to mobility measures that were captured from the literature and were not proposed in the inventory?
9)	Consider mobility in rehabilitation setting; what do you see are the challenges of using outcome measures in this environment and what can be done to make it easier to use them?
10)	Now consider mobility in the community; What do you see are the challenges of using outcome measures in this environment and what can be done to make it easier to use them?
11)	From your experience regarding the use of mobility measures, how do you use the scores to guide the development of the intervention plan?
Individuals with acquired brain injury and their caregivers guiding questions	
1)	As an individual with stroke or brain injury, what are the questions that you have in relation to your condition and to care you received since you have your incidence. (This can include care at the hospital, rehabilitation, or with community care providers including your family doctor)?
2)	What are the areas that you would like to improve in rehabilitation health care system (if any) to get better care?
3)	What has been your experience in terms of your daily activities, including work or school, or in participating in social activities with family and friends?
4)	Were you involved as much as you wanted to be in decisions about your care and treatment?
5)	How do you define mobility? [The focus group members will discuss a definition of mobility that will be read back to the focus group participants for further feedback].
6)	What are the important factors (e.g., cognition, and environment) that you believe influence mobility?
7)	As someone lives with stroke or brain injury and/or a caregiver supporting someone with stroke or brain injury, what do you feel needs to be measured or monitored in relation to mobility while someone is in the hospital?
8)	As someone lives with stroke or brain injury and/or a caregiver supporting someone with stroke or brain injury, what do you feel needs to be measured or monitored in relation to mobility in community?
9)	Please explain how rehabilitation care prepared you to return home/ back to your work (if relevant)/ school (if relevant), and community?
10)	Consider mobility in rehabilitation setting; what are the challenges that you face in this environment and what can be done to overcome these challenges?
11)	Now consider mobility in the community; what are the challenges that you face in this environment and what can be done to overcome these challenges?

Table 2. Characteristics of clinicians

Variables	Focus groups (n=3); sample size: (n=17) N (%)
Age (years)	
20-39	6 (35)
40-59	11 (65)
60-79	
Age (M±SD) years	41.35±10.28 years
Sex	
Male	1 (6)
Female	16 (94)
Affiliated rehabilitation sites of CRIR	
CRDM	4 (23)
IURDPM	3 (17)
JRH	10 (59)
Profession	
Physiotherapists	6 (35)
Occupational therapists	6 (35)
Speech therapists	1 (6)
Psychologist	2 (12)
Social worker	2 (12)
Work position	
Full time/Permanent	13 (76)
Full time/Temporary	1 (6)
Part time/Permanent	2 (12)
Part time/Temporary	1 (6)
Work Settings	
Primary care	2 (12)
Secondary care	10 (59)
Tertiary care	5 (29)
Years of work experience (M±SD) years	
Practice (in general)	15.79±8
Practice with stroke	11.89±7.04
Practice with TBI	10.82±7.05

ABI: acquired brain injury; CRIR: Centre for Interdisciplinary Research in Rehabilitation of Greater Montreal; CRDM: Constance Lethbridge Rehabilitation Center; IURDPM:

Institut universitaire sur la réadaptation en déficience physique de Montréal; JRH: Jewish Rehabilitation Hospital; TBI: traumatic brain injury

Table 3. Characteristics of individuals with acquired brain injury

Variables	Individuals with stroke Focus group (n=1); sample size (n=5 and a caregiver) N (%)	Individuals with TBI Focus group (n=1); sample size (n=5) N (%)
Age (years)		
20-39	1 (20)	2 (40)
40-59	2 (40)	3 (60)
60-79	2 (20) and 1 caregiver	
Age (M±SD) years	58.4±15.69	43±17.24
Sex		
Male	4 (80)	
Female	1 (20) and one caregiver	5 (100)
Affiliated rehabilitation sites of CRIR		
CRDM	5 (100) and one caregiver	5 (100)
IURDPM		
JRH		
Education		
Secondary school	2 (40)	
Bachelor degree	3 (60) and one caregiver	5 (100)
Marital status		
Married	3 (60) and one caregiver	2 (40)
Divorced	1 (20)	1 (20)
Widowed		
Single	1 (20)	2 (40)
Employment		
Full time worker	1 (20) and one caregiver	2 (40)
Part time worker		1 (20)
Volunteer work		
Unemployment	2 (40)	2 (40)
Retired	2 (40)	
Severity of injury		
Mild	2 (40)	4 (80)
Moderate	3 (60)	1 (20)
Severe		
Number of years living with ABI		
≤ 6 months		1 (20)
6 months-1 year	1 (20)	2 (40)
1 year-2 years		2 (40)
≥ 2 years	4 (80)	
Number of years (range)	9 months-3 years	6 months- 2 years
Type of focus group	Face-to-face	Virtual conferencing
Type of technology used		
iPhone/iPad	Not applicable	2 (40)
Desktop		2 (40)
Laptop		1 (20)

ABI: acquired brain injury; CRIR: Centre for Interdisciplinary Research in Rehabilitation of Greater Montreal; CRDM: Constance Lethbridge Rehabilitation Center; IURDPM: Institut universitaire sur la réadaptation en déficience physique de Montréal; JRH: Jewish Rehabilitation Hospital; TBI: traumatic brain injury

Figure 1. Identification of themes and sub-themes

Theme 1: Considering mobility holistically and individuals needs, preferences and unique experiences	Theme 2: Assessment and intervention guidelines	Theme 3: Support network	Theme 4: Uncertainty about symptoms and recovery
1.1. A comprehensive definition of mobility 1.2. Factors hindering mobility, participation, and reintegration into the community 1.3. Impacts of bio-psychosocial factors on everyday life and mobility	2.1. Finding common goals with patients 2.2. Challenges clinicians face when they evaluate mobility 2.3. Engaging the patient and considering their perspective in their care	3.1. Caregivers support 3.2. Providers support 3.3. Community support	

miro

CHAPTER 6 THE INTEGRATION BETWEEN MANUSCRIPTS 2 AND 3

6.1 Research questions

Manuscript 2

Research question: What are the perceptions of clinicians, individuals with acquired brain injury, and their caregivers about factors influencing mobility among individuals with acquired brain injury (Stroke and TBI) important enough to be considered while evaluating mobility?

Objective: to identify factors influencing mobility which need to be considered while evaluating mobility, and incorporating patients' needs and preferences into individualized care management plans among individuals with acquired brain injury (stroke, TBI), as perceived by clinicians, individuals with acquired brain injury, and their caregivers.

Manuscript 3

Research question: What are the perceptions of clinicians, individuals with ABI, and their caregivers of care experiences and service design related to rehabilitation for mobility and participation in the community among individuals with acquired brain injury (Stroke and TBI)?

Objective: to explore the care experiences and service design related to rehabilitation for mobility and participation in the community among individuals with acquired brain injury (Stroke and TBI), as perceived by clinicians, individuals with acquired brain injury, and their caregivers.

6.2 Integration of manuscripts 2 and 3

Perspectives of clinicians, individuals with acquired brain injury (ABI), and their caregivers on their experiences about mobility help identify areas for measuring mobility in different rehabilitation settings among individuals with ABI. Identifying factors influencing mobility among individuals with ABI can impact patient-centred care, including engaging patients in their care, respecting patients' needs and preference, and shared decision making between clinicians and patients [1]. It can further inform clinicians on how to incorporate individualized care management plans to generate health outcomes necessary during recovery, rehabilitation, and community reintegration [1]. Also, a comprehensive long-term follow-up that is accessible to all patients is essential for equal support [2]. The International Classification of Functioning, Disability and Health Framework (ICF) [3]

was presented to promote understanding the myriad of individual and environmental factors while evaluating mobility among individuals with ABI to promote patient engagement in rehabilitation.

Many individuals with ABI were unable to access rehabilitation services due to organizational policies inequities, which contributed to a disempowering rehabilitation process for them and placed barriers on consistent, supported rehabilitation and recovery across the continuum of care. A potential implication for practice is to form a link between healthcare services and community services to support equitable rehabilitation and recovery among individuals with ABI. Strengthening connections between hospitals and community healthcare may have the potential to improve mobility among individuals with ABI. A holistic patient-centred care approach to rehabilitation may address these inadequacies and improve some of the healthcare services and community social structural inequities in the rehabilitation care process. Also, patient-centred care focuses on environmental factors at the societal level in which healthcare services received fully integrate the patient's perspectives, experiences, and needs into every phase of medical consultation, evaluation, treatment, and follow-up. Clinicians, individuals with ABI, and their caregivers expressed many themes related to environmental factors and services provision that warranted a separate manuscript to be able to cover this.

6.3 References

1. Clarke S, Ells C, Thombs BD, Clarke D. Defining elements of patient-centered care for therapeutic relationships: A literature review of common themes. *European Journal for Person Centered Healthcare*. 2017;5(3):362-372.

2. Kjörk EK, Gunnel C, Lundgren-Nilsson Å, Sunnerhagen KS. Experiences, needs, and preferences for follow-up after stroke perceived by people with stroke and healthcare professionals: A focus group study. *PloS One*. 2019;14(10):e0223338.

3. World Health Organization. *International Classification of Functioning, Disability and Health: ICF*. Geneva; 2001.

Title: Clinicians', Patients', and Caregivers' Perspectives about Service Provision across the Continuum of Care to Improve Mobility and Participation among Individuals with Acquired Brain Injury

Rehab Alhasani,[1,2,7] Dennis Radman,[1,2] Claudine Auger,[2-4] Anouk Lamontagne,[1,2,5] Sara Ahmed[1,2,6,8]

* This manuscript has been submitted to Qualitative Health Research Journal

[1]School of Physical and Occupation Therapy, Faculty of Medicine, McGill University, Montréal, Canada

[2]Centre for Interdisciplinary Research in Rehabilitation of Greater Montreal (CRIR), Montréal, Canada

[3]School of Rehabilitation, Faculty of Medicine, Université de Montréal, Montréal, Canada

[4]Institut universitaire sur la réadaptation en déficience physique de Montréal, CIUSSS du Centre-Sud-de-l'Île-de-Montréal, Montréal, Canada

[5]Jewish Rehabilitation Hospital, CISSS de Laval, Laval, Canada

[6]Constance Lethbridge Rehabilitation Center, CIUSSS Centre- Ouest de l'Île de Montréal, Montréal, Canada

[7]Department of Rehabilitation Sciences, College of Health and Rehabilitation Sciences, Princess Nourah Bint Abdulrahman University, Riyadh, Saudi Arabia

[8]McGill University Health Center Research Institute, Clinical Epidemiology, Center for Outcome Research and Evaluation (CORE), Montreal, Montréal Canada

Corresponding author

Sara Ahmed, PhD.
School of Physical and Occupation Therapy, Faculty of Medicine, McGill University
3655 Sir William-Osler
Montreal, QC, Canada, H3G 1Y6
Tel.: 514-398-4400 ext. 00531
E-mail: sara.ahmed@mcgill.ca
ORCID Identifier: 0000-0001-5172-6790

7.1 Abstract

The objective was to explore the care experiences and service design related to rehabilitation for mobility and participation in the community among individuals with acquired brain injury (ABI), as perceived by clinicians, patients, and their caregivers. Five focus groups were held: three with clinicians, two with individuals with ABI, and the perspective of caregivers was considered, with one participant. Focus group discussions were transcribed and analyzed using an inductive and a deductive thematic content approaches. Five themes were identified: Enabling continuity of care; System design; Accessibility and services in the community; Transportation services; and Uncertainty about the provided services. The results of participants' experiences contributed to developing recommendations of service provision for mobility, leading to a patient-centred continuum of rehabilitation services. Accessibility to rehabilitation care needs to improve quality of care by addressing needs during transitions and mobility-related deficits, providing needed information, coordinated care, and self-management support in the community.

Keywords: Mobility, Continuum of Care, Acquired Brain Injury, Patient-centred care, Services.

7.2   Introduction

Acquired brain injury (ABI) including stroke and traumatic brain injury (TBI) is a significant cause of disability [1-4]. Approximately 1.5 million Canadians with ABI go through the acute and rehabilitation care continuum [5], costing the health system more than $26.8 billion annually [6]. Individuals with ABI face significant challenges especially once discharged from acute care, in adjusting to a new phase of life, needing to manage expectations for recovery and potential functional independence [7, 8]. Mobility limitations are estimated to affect 30% of persons with TBI [1, 3, 4], and up to 50% of stroke survivors [9], even after extensive rehabilitation. Such mobility restrictions constrict community engagement and increase negative health outcomes and premature mortality [10, 11].

Mobility is a broad and multidimensional construct with various operational definitions coming from theoretical and empirical approaches. From a theoretical point of view, some authors use an environmental continuum to define mobility as 'life-space mobility' which consists of the ability to move oneself within environments that expand from one's home to the neighbourhood and regions beyond [12-15]. Webber's framework adds to this theoretical definition that mobility is influenced by five vital inter-related determinants, including physical, environmental, cognitive, psychosocial, and financial influences [15]. Also, the broadness and complexity of all mobility-related domains is reflected in the International Classification, Functioning, Disability, and Health framework (ICF) mobility core set [16]. Empirical studies based on the preceding frameworks showed that diagnosis alone is not enough to predict mobility limitations, and that length of hospitalization, and intensity of care are needed to accurately predict return to work potential, work performance, or social integration [17, 18]. Also, social and healthcare decision makers recognise that to decrease the incidence and severity of disability and enhance mobility and participation requires modifying features of the social and physical environment [16].

Alongside greater recognition of the importance of improving an individual's health and independence, current literature suggests a philosophical shift in how health professionals understand, respect and support impairment [19-21]. This shift has led to the creation of a patient-centred care approach underpinned by acknowledging the patient's characteristics. The Institute of Medicine defined patient-centred care as "*care that is respectful of and responsive to individual patient preferences, needs, and values*" and that ensures "*that patient values guide all clinical decisions* [22]" Patient-centred care focuses on healthcare systems to increase patient satisfaction and improve health outcomes [23]. The World Health Organization recognized the necessity of an active

participatory role for patients to improve both the quality of care and ease access to healthcare services [24]. The benefits of patient-centred care, when supported, include increasing patient satisfaction, greater enablement, more significant improvement in symptom burden, and positive health outcomes [25].

While there have been significant efforts to optimise acute care and inpatient rehabilitation, there has been a lack of attention paid to long-term community care post-ABI [26, 27]. Once individuals with ABI are discharged from institutional care, many of them cannot access essential rehabilitation services such as physiotherapy, occupational therapy, and speech therapy [28]. Evidence has shown that the lack of community and primary care and services has led to a perception of marginalization and abandonment of ABI survivors and caregivers following inpatient discharge [29]. Systemic barriers to rehabilitation for individuals with ABI included a lack of a coordinated approach among healthcare and community service providers, difficulties in locating appropriate services, challenges in identifying professionals with ABI expertise, and an inability to find employment [26, 27]. There is a growing need for sufficient continuity from the time of rehabilitation admission to reintegration into the community, including availability of healthcare and community services that need to be accessed by individuals with ABI to improve mobility and participation into the community. The perspectives of individuals with ABI, their caregivers, and clinicians are important to identify and develop solutions to gaps in healthcare services.

7.3   Objective

The objective was to explore the care experiences and service design related to rehabilitation for mobility and participation in the community among individuals with ABI, as perceived by clinicians, individuals with ABI, and their caregivers.

7.4   Method

7.4.1   Statement of ethics

Approval of this study was granted by the Comité d'éthique de la recherche des établissements du centre de recherche interdisciplinaire en réadaptation (CRIR) [CRIR 1387-1218] on August 21, 2019.

7.4.2   Research design, type of sampling and data collection

Focus group was chosen to facilitate discussions and exchange experiences of thoughts among a homogenous group of people related to a common topic [30, 31], and to produce a variety of ideas in a short time among participants [32, 33]. Data collection took place at three rehabilitation sites of Centre for Interdisciplinary

Research in Rehabilitation of Greater Montreal (CRIR) in the province of Quebec, Canada. Details of data collection and recruitment are presented elsewhere (please see chapter 5, section 5.4.2)

7.4.3   Procedure

Five focus group discussions were conducted, three with clinicians at each rehabilitation sites of CRIR, one focus group discussion with individuals with stroke, and one virtual focus group discussion with individuals with TBI. A team of three clinical researchers (RA, SA, CA), reviewed the focus group interview guides, and iterative changes and reviews of all materials were carried on ensuring clarity of the documents.

Focus group discussions among clinicians and individuals with stroke were conducted between November and December 2019, and lasted for two hours. For individuals with TBI, we used an online tool (Doodle), to find a common time across all participants with TBI for the focus group. Due to the current COVID-19 pandemic, we could not conduct the in-person focus group with individuals with TBI. Thus, an online focus group among individuals with TBI was held in May 2020. The group met virtually via a web video-conferencing platform (Zoom Video Communications Inc., 2020) for 90 minutes.

Participants connected to the meeting through Zoom via their computer, smartphone, or tablet, and joined using both video and audio. A key advantage of Zoom is its ability to securely record and store sessions without recourse to third-party software. This particular feature is essential in research where the protection of highly sensitive data is required. Other essential security features include user-specific authentication, real-time encryption of meetings, and the ability to backup recordings to online remote server networks ("the cloud") or local drives, which can then be shared securely for the purpose of collaboration [34, 35]. The data from both formats (in-person and virtual) were combined and analyzed as one source [36]. After each focus group, a verbal summary was provided to participants to ensure clarity and accuracy of the content.

Two researchers (RA, SA) conducted the focus group discussions with open-ended questions, derived from the study objectives. Two co-moderators took notes during focus group discussions. An observer took additional notes and documented non-verbal communication. Pseudonyms were assigned to each participant. Quotes from French-speaking participants were translated into English. Focus group discussions were audio- recorded and transcribed verbatim after each session.

7.4.4.   Data analysis

Data were analysed using an inductive thematic content analysis, as described by Creswell [33]; and a deductive thematic content analysis using the ten rules for the ICF linking process [37] (Appendix 1).

A) Data coding

In the first stage, the first author immersed herself in the data by repeatedly reading and listening to the recordings to become familiar with the data and document initial ideas arising from the audio and verbal material [33].

During the second stage, two independent reviewers (RA, DR) read each of the transcripts and line by line coding was undertaken independently using an open-ended approach to identify important concepts. Reviewers discussed and coded identified concepts. Codes were further discussed, and sub-themes were identified. These sub-themes were sorted, named, and organised into relevant themes considering the explicit aims of the study [33].

During the third stage, the ICF linking process, was used to analyze the data deductively [37] by the first author and then verified by the second author. The domains of each quote were linked to the ICF components of Body Functions, Activity and Participation and Contextual Factors. Domains were then linked at a general level (1-level classification) and expanded to levels of greater detail (2nd and 3rd specific ICF category) when the information was available. Resulting initial patterns were brought together, summarized, and refined. The two independent reviewers compared and debated their findings.

A third reviewer (SA) independently reviewed the provisional theme summaries from the second and third stages. Through iterative discussion and consultation during a series of virtual meetings among the reviewers (RA, DR, SA), themes were verified. Reviewers met regularly to resolve any discrepancies contributing to the consistency of the findings.

B) Code rating

In the second stage, the code rating was performed by calculating the frequency of each identified codes corresponding to each theme among all participants. This process helped assess saturation based on the level of repetition of codes across all participants [38].

During the third stage, we mapped each code within each theme to the ICF domains, and then calculated the proportion of each code in each theme in relation to the ICF domains divided by the total number of codes in the theme. By this, the prominent ICF domains that mostly impact service provision related to rehabilitation for mobility and participation in the community among individuals with ABI were explored.

7.4.5   Triangulation, credibility, and reflexivity

The primary means for ensuring trustworthiness was through triangulation, reflexivity, credibility, and peer debriefing. Triangulation of the data was achieved by conducting a focus group with individuals with ABI to corroborate or contrast with clinician perceptions [39]. Comparing notes and discussing expected and unexpected tangents between the focus group moderators, co-moderators, and observer throughout the data collection process facilitated reflexivity. After each focus group, a verbal summary was provided to participants to ensure the clarity and credibility of the data. Credibility [40], and trustworthiness [41] of data collection were ensured by cross-checking audio-files and transcripts by the reviewers, and the results were presented from all perspectives combined. Having multiple independent researchers code transcripts and compare codes through peer debriefing was a form of researcher triangulation and encouraged reflection on and refinement of categories as they were formulated [39].

7.5   Results

7.5.1   Participants' characteristics

Seventeen clinicians from different professions were recruited and agreed to participate in the study. Three in-person focus groups were conducted, including 3 to 10 participants in each group. The fourth in-person focus group with individuals with stroke included five participants and one caregiver. The last focus group was conducted virtually among five female participants with TBI (please refer to chapter 5, section 5.5.1, and Table 1 and 2 for more information about the demographic information). The recruitment process for individuals with ABI is presented in Figure 1.

7.5.2   Emerged themes

The emerged themes were presented in Figure 2, and the number of codes for each theme by individuals with ABI, caregiver, and clinicians was presented in Appendix 2.

Theme 1: Enabling continuity of care

In healthcare contexts, continuity of care refers to care that occurs in consistent and coherent relationships with the patient about their care plan to sustain patient adherence to treatment goals [42, 43]. It includes the following sub-themes:

1.1. Experiences with acute rehabilitation care

Participants with ABI and a caregiver expressed a feeling of mixed satisfaction with the rehabilitation services received in the acute setting. Some of them judged access to rehabilitation services to be easy in this type of

setting because they were admitted to inpatient rehabilitation directly from emergency care (n=2; 20%). Some

participants experienced difficulty obtaining the services of a speech therapist or to have the opportunity to talk to

their physician in the hospital setting (n=6; 60%).

> Cs01: "the services that he got other than the emergency you know when he had to get the further scans
> and set up with her neurologist there was fantastic"
> S03: "the services I found the least helpful, [......] the speech therapy"

Participants with ABI expressed their satisfaction with the quality of rehabilitation care services offered

mainly by the physiotherapists and the occupational therapists (n=4; 40%). However, some of them expressed how

they felt very disappointed when the provider did not consider their reported deficits (such as cognition (n=3; 30%))

and engage them as a whole person into their care (n=5; 50%).

> S04: "I said why [it] seem to be having problems with my memory, I will go see my neurologist, and she
> [the speech therapist] said no neurologist can't help you, she discouraged me"
> S03: "[...] I found the physiotherapist very helpful and the occupational therapist over the speech therapy"

Clinicians reported that they provide the needed education to the patient at the acute care setting to manage

their symptoms and time to facilitate mobility and participation into the community (n=2; 12%).

> C04: "we educate [clinicians working at acute setting] our patients with time management, because that
> has an impact into mobility, when to stop, when to start"

1.2. Transition from acute to rehabilitation settings

Participants with ABI mentioned the importance to ease access to rehabilitation services to help with

mobility and progress with recovery (n=6; 60%); the wait to receive outpatient rehabilitation services after discharge

from the acute setting was long (n=3; 30%). This delay could affect the ability to improve their mobility. They were

worried about their progress and claimed a reduction in wait times would fulfil their needs. A caregiver points out

that many persons with stroke were uncertain about how long they need to wait till they get the needed services, due

to a lack of information provision after discharge from acute care. A participant with stroke suggested that it is better

to access private clinics, if possible, to continue to improve while waiting for outpatient rehabilitation services.

Furthermore, a clinician discussed that outpatient waiting lists are long for patients that were discharged from the

acute care setting, and they do not know how to solve the problem.

> S03: "Everybody wants to get better. Everybody wants access to; we need access to health services"
> S02: "the whole general system, it's the waiting to get to [rehabilitation], so you don't progress"
> S03: "as I probably speak mine, honestly unless you have like access to private"
> C03: "we've got a huge waiting list"
> Cs01: "They don't tell you like OK, well it [i.e. the transition] will be approximately three weeks, we don't
> know"

The caregiver also expressed her feeling about not being respected emotionally from some clinicians, which upset the participant.

> Cs01: "I just found like it was I mean he did get good service with the occupational therapist, but he also had the physiotherapist"; "[the physiotherapist] was like how come your wife can't pick up in here you know, like in which I didn't appreciate"; "it was just upsetting"

Clinicians discussed many challenges that lead to substantial gaps between acute and rehabilitation care levels (n=15; 88%). One of these challenges was related to workflow design which impacts clinical efficiency (n=4; 23%). Another challenge was regarding young patients with impairments, as they usually get lost in the system after discharge from the acute care setting (n=1; 6%). Clinicians suggested improving efficiency along the continuum of care, by increasing the speed of sharing discharge summaries from acute care settings using electronic health records instead of receiving paper summaries (n=3; 17%). Using electronic health records can save time, and the patients can be admitted faster to outpatient rehabilitation.

> C04: "there is a gap between acute care and rehab"
> C03:" the thing to bring in the table is in getting the discharge summaries, I mean that is not even knowledge transfer that's only information transfer"
> C04:" the young clients are mostly lost in the system and get no service [when] they are the ones who they have the most potential to go back to work"
> C03: "talking about having you know informatics electronic health records, so if it there it is saves time"

Clinicians expressed their uncertainty and difficulty to tailoring patient needs as the number of sessions is capped (n=2; 12%). Prolonging services is not tenable due to the lack of resources.

> C03: "one of the challenges in outpatient rehab is we have to know when we stop treatment? And when they need to go to the next phase?"

Clinicians discussed the factors that need to be considered when the patient is discharged from the acute care setting and has discharge planning (n=9; 53%). Clinicians at acute care settings need to consider other deficits, and not just refer patients with mobility limitations to outpatient rehabilitation (n=6; 35%). They explained that clinicians at acute care settings need to determine factors beyond the physical part of mobility, including safety perception, visual impairments, cognitive impairments, and aphasia impairments, and if they have a family member who can provide support once the patient is discharged. They highlighted that these factors would affect a patient's mobility and be considered during transitions of care to ensure patients continue to receive the services needed. Clinicians described the importance of providing education and training for clinicians in acute care settings about not discharging patients based solely on their physical abilities (n=1; 6%).

> C04: "if the [clients] had vision issues, vestibular issues, cognitive issues, or speech issues but physically they are fine, they will discharge with no service"

C01: "the education has to go back to the acute care teams in terms of rehabilitation"
C06: "if the [patient] have a family support, to compensate, patients will be discharged faster, versus the person who is alone"

1.3. Access to rehabilitation setting in the community

Clinicians pointed to the potential benefits of alternative secondary care services to persons with disability

in the community while waiting for their admission to outpatient rehabilitation to facilitate mobility (n=3; 17%).

Due to limited resources in healthcare rehabilitation sectors, clinicians could not provide community services (n=2;

12%).

C05: "I find it's the difficult area when our patients are discharged, when we know that he would have the potential to become independent but it's as if the services don't exist in a certain way or at least not in an optimal way to continue that with him"

Clinicians discussed that some patients with stroke, who were discharged from the acute care setting, have

access to Canadian Physiotherapy Association's (CPA) programs and can get the needed care at their home (n=2;

12%). In contrast, a participant with stroke felt that the quality of community-based services was lacking and

clinicians tend not to show up on time at a home visit.

C06: "Even for the stroke clientele, some patients don't have access to the CPA program after discharge"
S03: "I watched CLSC come to their house [disabled friend] and they don't show up on time"

1.4. Reintegration into the community

Some clinicians reported challenges with patients applying what they have learned during outpatient

rehabilitation sessions in the community (n=4; 23%). Similarly, participants with ABI reported that applying what

they have learned into their life was challenging specifically when the provider did not provide the right guidance,

support and honesty about the challenges and path of recovery that helped with re-integration into the community

(n=6; 60%).

C05: "we can do training [for people with cognitive impairments at the clinic] but they will have difficulty making the connections in their real environment"
T01:"my first occupational therapist wasn't really like telling me how to integrate myself really into regular life, like they were kind of just giving me some activities to do while I was there. And then we'd have a little talk but I didn't like it I didn't connect with them very much"

Clinicians cited the importance of having support services in the community that consider safety issues

when assisting persons with ABI in becoming more functional and integrate into the community. Clinicians reported

that safety should be considered before discharging patients to their home, especially for persons who live alone

(n=3; 17%).

C06: "[for persons who lives alone], it is important to make sure that they are safe, so it's always a must to have the notion of safety at home"
C06: "we try to put [the patients who are alone] in places [that offer] services to compensate for their safety"

Participants with ABI explained that some rehabilitation centres offered programs that were structured to simplify activities to facilitate mobility and reintegration into the community (n=3; 30%).

S04:"Like I remember one of the classes, they are talking occupation, like if you got to fold clothes, don't stand over the table and do it, sit down and do it"

1.5. Follow-up in the community

Clinicians explained that the focus of the follow-up visits in the community varied depending on the site, ranging from mainly medical concerns to broad rehabilitation issues (n=15; 88%). Clinicians were aware of the importance of adapting the visit to the participants' home and often initiated the visit with a broad question "how are you doing?" or using a survey to facilitate the follow-up process (n=1; 6%).

C03: "if they got a survey monkey of something to say are there any problems, how are you doing? Would help"

Clinicians in specialized care had a clear premise of the needs, and conducted a follow-up after 6 months from discharging individual with ABI from rehabilitation via phone calls (n=6; 35%).

C05: "[....] we do follow-ups, which last between 6 months to sometimes 2 years"
C06: "We do [the follow-up] more often by phone call, that would be useful for a certain category of people"

Clinicians proposed some ways to follow up and plan long-term by guiding the patients to be functional and safe (n=8; 28%). Also, clinicians pointed out the limited resources to do the follow-up appropriately once patients were in the community (n=2; 12%).

C06: "if we take charge to do the follow up and do the training immediately at their home after discharge, we will save time but the reality is that other clinician will take the responsibility and this will take a very long time"
C07: "We're not the team that can do the training at their environment, [and the service] may take six months, we don't have the Resources and service to train our patients at their home. I think that's one of our big problems"

Clinicians suggested some ways to follow up with their patients in the community using technology (n=10; 59%). The follow-up would be facilitated by adapting tele-rehabilitation to be able to maintain the patient's recovery. Some clinicians also described some challenges in using technology to follow up patients in the community, especially if they experienced cognitive impairments impacting their safety (n=2; 12%).

C01: "offering tele-rehab to those clients during wintertime"
C03: "so if the patient has a smart watch that would help"

C06: "[using a tele-rehab] is not safe to cross the streets"
C05: "but for patients who are not completely safe, who is at risk of falling at home, tele-rehab would not work"

Also, clinicians expressed challenges with following participants with TBI in the community. They added that they would be uncertain of how the patient was integrating into the community, especially if he had a cognitive impairment (n=3; 17%).

C05: "it's over 60% of our entire clientele, older people with mild TBI and we have hard time following them up"
C05: "30% with moderate to severe TBI may be better to have them here than they leave to their home"

Theme 2: System design

System design defined as systematic changes to care practices and health systems to improve patient care quality, efficiency, and effectiveness [44]. It includes the following sub-themes:

2.1. Quality of care

Participants with ABI highlighted some difficulties when accessing specialized services (n=6; 60%) and a perceived lack of expertise or knowledge from healthcare providers such as neurologists or general practitioners (n=8; 80%). For example, participants with TBI report that some healthcare providers seemed to know little about TBI and its consequences and the TBI challenges of being an invisible disability. They could not provide the needed guidance. In contrast, they described that some healthcare providers know how to guide symptom management (n=2; 20%).

T01: I felt like the doctors that I saw didn't really know, like they didn't have very good suggestions of what to do and how to help"
T01:"but I feel like nobody could really give you good education or like information about what was going on, they kind of just, you know, give you short answers that kind of thing"
T01:"they definitely help [the healthcare providers] with like symptom management so symptom management was obviously like one of the biggest things"

Participants with ABI reported not being consulted as much as they wished about important decisions such as therapeutic options or discharge (n=4; 40%). They expressed a sense of emptiness after returning home and a feeling of being left behind.

S03: "because she said there's only so much she can do for me and I had to do it on my own [the speech therapist], I was discouraged actually to hear when she said that to me, I don't know, I could have wanted more"
T02: "So we set some goals they never said after you finish those goals or you're going to be finished"
S04: "I was there [at rehabilitation centre] for the stroke not for the pain right, so they didn't take the pain into consideration at all"

Participants with ABI who benefited from specialized rehabilitation care provided by some rehabilitation facilities claimed to be very satisfied with the expertise, the quality of care received, and the altruism of the care providers (n=8; 80%). However, participants with ABI (n=3; 30%), a caregiver, and a clinician expressed doubts about the other services that were provided by other healthcare providers, as they conclude that the healthcare services are not good enough and cannot adapt for all patients considering all their needs.

> C01: "I have some real concerns about [the health system] down the road even getting like worse with like the elderly you know, like it should have been more of a demand"
> S04: "It's good though, I found that the rehab centers are good, the doctors well good luck with that one! And then, it's actually service that are missed still"
> S03: "the system is very broken, it's very broken, and it's very sad, and it's very discouraging"
> Cs01: "I know how the system works, but I see the problems a lot"

2.2. Information services

Participants with ABI often found the information provided in the hospital setting to be limited, especially regarding their recovery prognosis, and to care planning and services to improve their mobility following discharge (n=7; 70%). They expressed their needs in getting information services (n=7; 70%), case management services (n=5; 50%), to facilitate information exchange, ensure information retention, accountability (n=2; 20%) and enhance patients' navigation (n=3; 30%). This need for information was directed toward outpatient rehabilitation services and highlighted their need to understand the evolution of their deficits and prevent further complications. Without information services, participants felt that they were left behind without guidance. They reported that they start to navigate the system by themselves and try to find a solution to prevent further complications (n=3; 30%). Furthermore, some participants with ABI mentioned that some clinicians provide honest and proper information to understand their deficits and plan for long-term solutions (n=2; 20%).

> T01: "I don't know, it's kind of hard to navigate what to do because you didn't really know who to listen to for where to turn"
> S01: "where do I get that information or how do I get, you know this or like, anticipatory guidance"
> S04: "Accountability and oversight! Who is he going to complain to? The manager?"
> "T03: "my concussion was considered mild, but my therapist at xxx said sometimes there are a small percentage of cases with mild that just go on a very long time"

2.3. Oriented teamwork approach

Participants with ABI found poor communication of salient information between healthcare providers, and they perceived the fragmentation of the information was greatest when some providers were stressed or overworked (n=2; 20%).

> S03: "Some are really stressed out, in the health care system, they may start off with more ideal vision of what they like, and then in the end they end up being you know, overworked"

S04: "the Healthcare in Canada is great, but the disconnect with the doctor and the others is the problem"

They explained a lack of coordination among healthcare providers and the absence of a teamwork-oriented culture (n=7, 70%). This lack of coordination and education provision was misleading, leaving ABI survivors confused, and uncertain about their deficit and how to improve their mobility (n=9; 90%).

T03: "It was just not super contradicting but difference of opinions and you kind of don't really know exactly what to listen to"

Furthermore, participants with ABI reported that some healthcare providers might benefit from further training to improve the needed quality of care (n=4; 40%).

S06: "Proper training for the provider and teach them how to take care of the old man"
T01: "I think maybe like education [to the healthcare providers] about what exactly is going on and how they like see them like evolution like recovery"

2.4. Self-management

Participants with ABI reported that the support they had anticipated was not available, be it a lack of therapy, lack of equipment, or difficulty arranging appointments with appropriate professionals. This makes it challenging to maintain therapy to bridge gaps while waiting to get the needed treatment in outpatient rehabilitation. For example, participants with ABI tend to use meta-cognitive strategies to progress their recovery and improve their mobility (n=8; 80%).

S03: "[the work] fell on me as well to make sure that I continue everything that I learned, you know and practicing it";"and I really push through that to bridge my gap"
T02: "[self-management and writing] helped me to work with my symptoms like you know pacing, managing symptoms, and it also helps with the scheduling"

Theme 3: Accessibility and services in the community

Participants with ABI (n=6; 60%) and clinicians (n=4; 23%) reported environmental barriers in the city that limit mobility; for example, there is no unique path for persons who are using a wheelchair. Also, with snow, there is a lack of services to keep pathways clean and accessible for persons with a disability, leading to social isolation and restricting their participation in the community. Also, they explained difficulties navigating areas of the city under construction, especially if the person has a cognitive impairment and uses a wheelchair at the same time. They added that they could not use metros because of the lack of escalators. Participants with ABI (n=7; 70%) and clinicians (n=4; 23%) reported that government policies related to disabilities and access to services did not meet patients' needs.

C02:"I find the city of Montreal, during the snowstorm, they don't care if you are a handicap person, that's it, and you are stuck inside"

157

S01: "[in the metro station] there is no escalators right, so it's like stairs, so how are you supposed to get down there, if like we do have a walker, you know. So, there's a limitation
"S04: "I think the laws about handicap service is disabled"
C03: "construction is a big thing and navigating, especially if you have clients have cognition issue on top of that, they have hard time figuring out how to do it"
C02:" I think that the intervention doesn't need to be with clients in itself, but with the city and the community"

Others claimed that they had difficulty obtaining assistance or care at home, especially when their problems were not physical. One participant reported that he adapted his home to make it more accessible, as he has a balance problem. Theses accessible design features included a shower bench, and bars in the house to enhance indoor mobility without using assistive devices.

S05:"I have bars in my house, so I don't use a cane inside; I got bars in the shower, now I don't have to use a bench anymore"

One participant with TBI reported that COVID19 impacted mobility and participation in the community, as the government closed the gym and recreational services.

T02: "Well they close the gym [because of COVID]. So, I had just started, I started just walking on the treadmill. I was a runner before so I can run"

Theme 4: Transportation services

Individuals with stroke discussed how transportation services in the community were limited. They explained that the poor services were related to adapted transport services (n=4; 23%), which accommodates for physical disability but not offered to those with cognitive limitations. There is a lack of transportation services for people with cognitive challenges, which impacts mobility. They also discussed challenges with adapting to using adapted transport services, which requires pre-planning, is more time-consuming, and can lead to being uncomfortable while in transport. The option of using other community transit services that offer help with mobility (buses, taxi) facilitates participation. However, the impact of noises and sensitivity to stimulation and tolerance to crowds limited their ability to use these services (n=9; 90%). Participants discussed that some transportation services are beneficial as long as the people who provide the services have appropriate training (n=2; 20%).

S05: "I can do the buses for a decent amount now, as long as it's not in rush hour or something"
S05: "they drive you around for 2 hours, like crammed in the back of a hatchback with two other people, [while using transport adapted]"
S05: "And you have an autistic person screaming the whole time. I can't handle noises, and it was unbelievable, [while using transport adapted]"
S04: "Exactly, but the thing about the para transit is yeah you have this para transit service when you call and they are good, if they hire the taxis, and or they put them on the training course"

Clinicians (n=8; 47%) and a caregiver discussed the problems with adapted transport, as getting those

services would typically take a long time. Also, adapted transport is not a good solution for persons with cognitive

impairments, as it is difficult for them to manage or call for the service.

> C05: "the transport adapted is not easy to use for patients with too much cognitive impairment"; "it's too
> difficult to manage, they're not able to call, they're not able to give all the information"
> Cs01: "I would say after 2 months we've got the transport adapted, and he was able to book him more
> often"

Clinicians discussed some of the environmental limitations such as a snowstorm that make the

transportation for persons with a disability difficult and limits their mobility, so they cannot get to their

appointments at the outpatient rehabilitation setting (n=3; 17%).

> C04: "if there is a snowstorm, just forget it [because] the transportation is very late or transport adapted
> doesn't park close to them"

Clinicians discussed the importance of the availability of transportation services, as limits of public

transportation services and limits of out-of-pocket access due to limited funds may limit mobility among individuals

with ABI (n=1; 6%).

> C06: "they don't have the money to pay for a taxi every time, and transport adapted takes 2 months before
> they are accepted"

Moreover, individuals with stroke point out a lack of social norms (n=5; 50%) for accessible seating on

community transportations. They think that improving social norms on community transportation would help with

mobility. Some people who provide public transportation were fighting for rights of persons with a disability and

provide help to them, such as getting a seat on the bus.

> S05: "people really do not give us those handicap seats, if you have a cane they do not care, oh my
> goodness, I guess I'm too young or something"
> S06: "I was taking the bus to the general [hospital] I think and I had my cane, when we got there, the bus
> driver stopped, looked up and said, hold on I will help you cross the street"; "that was exceptional, I was
> shocked, and I said, No, it's okay, relax. But that's one of how many?"

Theme 5: Uncertainty about the provided services

Participants reported that once discharged from formal rehabilitation care, provision for ABI was rationed,

often leaving them with feelings of uncertainty regarding how best to manage their impairments and facilitate their

mobility to participate better into the community (n=5; 50%). Furthermore, in terms of whether or not people

received information about the transition to community-based care concerning secondary prevention of ABI after

discharge from either acute or rehabilitation level of care, the majority of participants initially reported having

received little or no information when they were in hospital or rehabilitation, leaving them uncertain about how to

progress or maintain recovery (n=5; 50%). This disruption in rehabilitation services makes it hard for individuals with ABI to maintain progress.

> T01:"nobody can give you like a timeline or you're never going to really be able to give a timeline, but more kind of an evolution symptoms, or maybe what to kind of expect based on your initial symptoms"

Also, participants reported that the lack of transition services post-acute care and not getting the appropriate services because of the recent COVID19 pandemic impacted their recovery and mobility and left participants feeling uncertain about their progression (n=2; 20%).

> T03:"But I just started my therapy when all this, when the COVID19 started so I really haven't made any progress and I have no idea how to make progress at this point"

7.5.3 The ICF linking process

All identified codes within all of the themes mapped to the ICF Environmental Factors. The exception was for theme 1, enabling continuity of care, where 80% (n=100) mapped to the ICF Environmental Factors domain and the other 20% to Body Functions (n=6), Activity and Participation (n=5), and not covered health conditions (n=14) (Appendix 1).

7.6 Discussion

Experiences from the focus group discussions yielded an in-depth understanding of care experiences and service design related to rehabilitation for mobility and participation in the community among individuals with ABI. Through an in-depth inductive thematic analysis, five main themes, and nine subthemes emerged from the perceptions of clinicians, individuals with ABI, and their caregivers. All themes align with the patient-centred care concept, including (1) Enabling continuity of care; (2) System design; (3) Accessibility and services in the community; (4) Transportation services; (5) Uncertainty about the provided services. Also, through a deductive thematic analysis using the ten-rule ICF linking process, most of the identified domains within each theme was mapped to the ICF Environmental Factors. The current study contributed to clinicians', patients', and caregivers' experience with service provision for mobility. Participants identified the need to address access to rehabilitation care, and specific areas needed to improve quality of care by addressing needs during transitions, addressing mobility-related deficits including cognition, vision, perceived safety, providing needed information, coordinated care, and self-management support in the community.

Combining inductive and deductive thematic analysis approaches allowed for a complete analysis and a critical realism ontological approach. While the inductive thematic analysis searched for patterns from raw data

enabling the reality of others to be clearly represented, the deductive thematic analysis searched for consistencies and anomalies to provide an initial grounding of using a common language based on the ICF framework [45].

Generally, individuals with ABI and their caregivers experienced limited access to information related to recovery, prognosis, and to care planning following discharge from the acute setting. This included limited information about the available support services and resources in the community, therefore limiting their mobility and return to community activities. Additionally, participants with ABI and their caregivers had trouble accessing specialized services across the continuum of care, leading to feelings of abandonment. Overall, our results concur with recently published experiences of individuals with stroke and their caregivers with primary care and community healthcare services. Participants identified four essential services that were needed to improve quality of care: continuity of care, accessibility, information, and communication [29].

When considering rehabilitation care for mobility, individuals with ABI felt they needed information about their recovery and the rehabilitation process to enable them to make decisions related to their goals. Studies have shown that rehabilitation outcomes are improved when individuals with ABI actively participate in decision making and engage in their care [46]. Plant et al. [47] questioned whether individuals with ABI required directed goals during acute care given that some individuals expected to be guided by their providers, whereas in both rehabilitation and community settings, individuals were able to identify their goals and needs such that clinicians were able to embrace a patient-centred care process. Patients' perceptions of clinician engagement in their care and the communication between patients and clinicians is essential in improving partnerships between patients and clinicians and influences individuals' rehabilitation care experience [48].

Lack of engaging individuals with ABI and their caregivers, in rehabilitation decision processes may lead to disempowerment and may create a mismatch between individuals with ABI, their caregivers and healthcare provider expectations for recovery. A systematic review [49] reported that individuals with ABI more often chose goals to improve their level of participation in the community while most providers focused mainly on impairments and activity levels. Thus, engaging individuals in goal setting and treatment planning and aligning patient and clinician expectations is important to achieve patient-centred care.

Our findings revealed that the level of knowledge and expertise of healthcare providers was considered to be an important factor for quality of care across the continuum. Individuals with ABI felt that some healthcare providers were not knowledgeable enough to provide guidance and the needed care. Evidence in the literature

showed that individuals with ABI and their caregivers prefer to receive their care from expert clinicians in a specialized care unit [50].

Moreover, results of this study showed that access to information was considered an essential concern among individuals with ABI and their caregivers across the continuum of care. They expressed wanting information on wait times for outpatient rehabilitation once discharged from acute care, expectations for recovery progress and expected improvements in mobility, and available community support services. ABI survivors and their caregivers reported their needs for more information on the availability of rehabilitation services and how to navigate access to services. Not getting the needed information can lead to fear, depression, and anxiety among individuals with ABI and their caregivers [51]. Additionally, it can hinder engaging the patient in their care as well as information exchange between patients and clinicians [52]. Not being equipped with information can also impede recovery progress and impact patients' rehabilitation outcomes [51, 52].

Introducing the best way to provide information is not clear in the literature, but authors suggest using different active strategies that could engage patients and their caregivers into their care [53]. This could be done by providing education and counselling either face to face or through online technologies such as telehealth [53]. Studies have found that exchanging the needed information between clinicians, patients, and their caregivers was essential for fostering a therapeutic alliance by sustaining trust and sharing power with patients [52]. Therefore, effective provision of information needs to consider the content, format, mode of delivery, and timing.

Limited access to specialized rehabilitation services once discharged from acute care settings was raised as an important barrier to recovery by individuals with ABI and the caregiver, and they felt services were non-existent in community settings. They needed to make substantial efforts to receive rehabilitation services when they were re-integrating into the community. Our results concur with results from published studies in the literature that have highlighted the difficulty to access rehabilitation services among individuals with ABI [26, 54].

Participants with ABI shared that it was difficult to access rehabilitation services when their mobility limitations were related to non-walking related deficits. Evidence in the literature showed that most rehabilitation services offered to individuals with ABI concern mobility limitations; however, fewer rehabilitation services were offered to individuals with cognitive, speech, or visual impairments [54]. It is essential that individuals with impairments (such as cognition) limitations other than walking benefit from the rehabilitation services to ensure their safe integration into the community. Thus, raising awareness among the stakeholders about invisible

disabilities and patients' needs would result in better accessibility to rehabilitation services among individuals with ABI.

Results from this study indicated that there is a need to implement community education groups to better promote equitable rehabilitation services in the community. Community groups may create new social networks, and support learning, educational, and therapeutic opportunities among individuals with ABI [55]. Community-based therapy [56], such as group exercise [57] or aphasia therapy [57, 58] would support coping strategies and resilience and understanding physical limitations as well as emotional cues. Thus, collaboration between stakeholders would create a better therapeutic relationship between individuals with ABI, caregivers and clinicians and could support an empowering environment.

A structured follow-up process initiated before discharge could improve access to healthcare services and help individuals with ABI identify solutions to address their needs. The problem of unequal follow-up was brought to light in this study and was represented by different prerequisites for specialized care in different settings. Problems discovered at a later stage, after discharge (such as cognitive impairments), indicate the need for long-term follow-up. In our study, clinicians in the rehabilitation setting were mainly satisfied with their current follow-up services; however, the follow-up only covered the first six months and did not provide continuity for longer-term support in the community. There is a lack of longer-term services that include holistic and coordinated support beyond the first six months [59]. Individuals' preferences and needs, including previous experience with the available support services in the community, should be considered. In this way, recommendations and discharge rehabilitation goals and follow-up can be tailored to individuals' physical and social context, and considers that individuals frequently prefer services they already know.

7.6.1   Suggested solutions to make the continuity of care possible

Improving rehabilitation to enhance mobility will require increasing accessibility to healthcare services across the continuum of care. Inpatient rehabilitation facilities often have limited access to specialized services [60]. Access to more comprehensive specialized care (e.g. speech therapy, cognitive retraining) in acute care is needed to address deficits early and minimize acute care transfers. One solution might be to embed an acute care hospital within the rehabilitation hospital to promote its capabilities. A triage room can allow for rapid evaluation and perhaps allow a return to the inpatient rehabilitation facilities, avoiding an acute care transfer [27, 29, 56, 60].

At the other end of the rehabilitation continuum, healthcare professionals and other stakeholders must engage patients, prepare them for discharge, and address their expectations. As there is increased demand for a shorter length of stay in hospitals, discharge planning must begin sooner [50, 60]. Support and training to the caregiver about the available resources in the community, and early evaluation of potential barriers to discharge are crucial. There is also a need for a multicenter study to examine whether specialized discharge programs for individuals with ABI, including individualized follow-up after discharge, can influence the transition to the community [50, 60].

Healthcare providers working at acute inpatient rehabilitation should ensure accurate and comprehensive information regarding the acute care stay. Involvement of a dedicated team member to provide systematic information, a psychologist or social worker or peer navigator, in the acute care hospital may facilitate information exchange [59, 60]. However, having a social worker or psychologist to do this is expensive. It takes asking the patient questions, active listening, and filling in information gaps. A more realistic way is to have good quality educational material online to share with patients over time, adapting information to their stage of care. Also, a robust electronic health record system can assist in this process, which has the potential to help with information exchange, reduce practice differences, increase clinical productivity, and tailor care plans [60].

Using technology such as tele-rehabilitation to provide the needed care, education, and support to individuals with ABI and their caregivers outside the hospital is needed. Tele-rehabilitation allows long-term follow-up among individuals with ABI who may have difficulty with transportation, or are isolated by their disability, and need more efficient and timely access to their care. Using tele-rehabilitation is expected to result in a reduction of hospitalizations and lengths of hospital stay, and improve individuals' quality of life [60]. Thus, tele-rehabilitation is one strategy that allows clinicians to assess and treat patients in different environments, especially in the community, exchanging the needed information and provide guidance to their clients [61].

Although tele-rehabilitation approaches have varied in the literature and often been developed and evaluated with a limited theoretical basis [62], there are studies demonstrating results similar to traditional rehabilitation interventions. For example, providing an interactive and stimulating setting using a virtual reality approach can be achieved by 3-dimensional simulation that delivers a sense of engagement in a virtual environment that has been used for cognitive rehabilitation [63]. This could be enhanced by using, for example, robotic devices,

data gloves, and smart glasses, that when combined with tele-rehabilitation technology would have the potential to enhance optimal rehabilitation care to improve patient's mobility [63].

It is essential to understand the patient's needs and preferences that would facilitate a long-term follow-up process to improve mobility. The current healthcare environment requires the implementation of innovative care models such as a patient-centred care model [64] as well as the ICF framework [16] to promote optimal outcomes and facilitate accessibility to healthcare services, and the use of available resources. Healthcare providers with expertise are essential to the successful implementation of the needed models, and help to facilitate the use of the available resources over the long term to achieve optimal outcomes [16, 64]. Thus, ongoing evaluation of patient-centred care can help to ensure rehabilitation for mobility meets person's needs.

7.7   Study limitations

Findings of this qualitative study were based on a purposive sample and therefore may not represent views of a broader population of clinicians working in a different setting, specifically in the community. Since most of the participants with ABI in the same focus group were recruited from one rehabilitation site, we were unable to reach saturation in the findings between them as well as caregivers' perspectives, as only one caregiver participated. It is also possible that participants might not have mentioned all the needed services in the community because of the open-ended discussions. Hence, the results of this study should be interpreted cautiously. Future researchers may further distinguish the impact on caregiver experiences along the care continuum, contributing to the provision of timely support to improve health outcomes.

7.8   Conclusion

The qualitative results of participants' experiences contributed to developing recommendations of service provision for mobility leading to a patient-centred continuum of rehabilitation services from the acute level of care to community reintegration. Accessibility to rehabilitation care, and specific areas needed to improve quality of care by addressing needs during transitions and mobility related deficits (such as cognitive or aphasia impairments), providing needed information, coordinated care, and self-management support in the community. The results of this study can inform policymakers, managers, administrators, clinicians, and researchers about services provision to improve mobility and participation in the community among individuals with ABI. The experiences can help identify the areas that need to be considered to develop ideal patient-centered rehabilitation services to improve individuals' mobility and participation in life roles.

DISCLOSURE OF INTEREST

Authors' contributions: All authors contributed to the design of this study, provided critical insights, and contributed to the final written manuscript.

Funding: None

Conflicts of interest: The Authors declare that there is no conflict of interest.

7.9   References

1.   Mohamed Ludin, S. and N.a. Abdul Rashid. Functional Outcomes and Health-Related Quality of Life After Severe Traumatic Brain Injury: A Review. *Clinical Nursing Research.* 2018.

2.   Ovbiagele, B. and M.N. Nguyen-Huynh. Stroke epidemiology: advancing our understanding of disease mechanism and therapy. *Neurotherapeutics.* 2011;8(3):319.

3.   Ponsford, J.L., et al. Longitudinal follow-up of patients with traumatic brain injury: Outcome at two, five, and ten years post-injury. *Journal of Neurotrauma.* 2014;31:64-77.

4.   Scholten, A.C., et al. Health-related quality of life after mild, moderate and severe traumatic brain injury: Patterns and predictors of suboptimal functioning during the first year after injury. *Injury.* 2015;46:616-624.

5.   Norris, E., et al. Identifying and evaluating ontologies related to human behaviour change interventions: a scoping review. 2018.

6.   Parachute. The Cost of Injury in Canada [Internet]. 2015.

7.   Han, P., et al. Clinical evidence of exercise benefits for stroke, in Exercise for Cardiovascular Disease Prevention and Treatment. *Springer.* 2017;131-151.

8.   Wein, T., et al. Canadian stroke best practice recommendations: secondary prevention of stroke, practice guidelines. *International Journal of Stroke.* 2018;13(4):420-443.

9.   Robinson, C.A., et al. Understanding physical factors associated with participation in community ambulation following stroke. *Disability and Rehabilitation.* 2011;33:1033-1042.

10.   Carroll, L., et al. Prognosis for mild traumatic brain injury: results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. *Journal of Rehabilitation Medicine.* 2004;36(0):84-105.

11.   Hole, E., et al. The patient's experience of the psychosocial process that influences identity following stroke rehabilitation: a metaethnography. *The Scientific World Journal.* 2014.

12.   Shumway-Cook, A., et al. Environmental demands associated with community mobility in older adults with and without mobility disabilities. *Physical Therapy.* 2002;82(7):670-681.

13.   Tsai, L.-T. Walking, physical activity and life-space mobility among older people. *Studies in Sport, Physical Education and Health.* 2017;(254).

14.   Peel, C., et al. Assessing mobility in older adults: the UAB Study of Aging Life-Space Assessment. *Physical Therapy.* 2005;85(10):1008-1019.

15.   Webber, S.C., M.M. Porter, and V.H. Menec. Mobility in older adults: A comprehensive framework. *Gerontologist.* 2010;50:443-450.

16.   World Health Organization. *International Classification of Functioning, Disability and Health: ICF.* Geneva; 2001.

17.   Reichard, A., et al. Diagnosis isn't enough: understanding the connections between high health care utilization, chronic conditions and disabilities among US working age adults. *Disability and Health Journal.* 2015;8(4):535-546.

18.   Wise, F.M., et al. Acute predictors of social integration following mild stroke. *Journal of stroke and Cerebrovascular Diseases.* 2018;27(4):1025-1032.

19.   Evans, D.W., N. Lucas, and R. Kerry. The form of causation in health, disease and intervention: biopsychosocial dispositionalism, conserved quantity transfers and dualist mechanistic chains. *Medicine, Health Care and Philosophy.* 2017;20(3):353-363.

20.   Holopainen, R., et al. From "Non-encounters" to autonomic agency. Conceptions of patients with low back pain about their encounters in the health care system. *Musculoskeletal Care.* 2018;16(2):269-277.

21.   Low, M. A novel clinical framework: the use of dispositions in clinical practice. A person centred approach. *Journal of Evaluation in Clinical Practice.* 2017;23(5):1062-1070.

22.   Barry, M.J. and S. Edgman-Levitan. Shared decision making-The pinnacle patient-centered care. 2012.

23.   McMillan, S.S., et al. Patient-centered approaches to health care: a systematic review of randomized controlled trials. *Medical Care Research and Review.* 2013;70(6):567-596.

24.   World Health Organization. *What is the Evidence on Existing Policies and Linked Activities and Their Effectiveness for Improving Health Literacy at National Regional and Organizational Levels in the WHO European Region?* Europe; 2018 (57).

25.   Fix, G.M., et al. Patient-centred care is a way of doing things: How healthcare employees conceptualize patient-centred care. *Health Expectations* 2018;21(1):300-307.

26.   Borg, D.N., et al. The effect of access to a designated interdisciplinary post-acute rehabilitation service on participant outcomes after brain injury. *Brain Injury.* 2020;34(10):1358-1366.

27. Harrison, A.L., et al. Living with traumatic brain injury in a rural setting: supports and barriers across the continuum of care. *Disability and Rehabilitation.* 2017;39(20):2071-2080.

28. Hartford, W., S. Lear, and L. Nimmon. Stroke survivors' experiences of team support along their recovery continuum. *BMC Health Services Research.* 2019;19(1):1-12.

29. Pindus, D.M., et al. Stroke survivors' and informal caregivers' experiences of primary care and community healthcare services–a systematic review and meta-ethnography. *PLoS One.* 2018;13(2):e0192533.

30. Kinalski, D.D.F., et al. Focus group on qualitative research: experience report. *Revista Brasileira de Enfermagem.* 2017;70(2):424-429.

31. Morgan, D.L. and R.A. Krueger. Analyzing and reporting focus group results. *Sage.* 1998.

32. Carpenter, C. Using qualitative focus groups to evaluate health programmes and service delivery, in Qualitative research in evidence-based rehabilitation. *Elsevier.* 2004;51-64.

33. Creswell, J.W. Qualitative inquiry & research design : choosing among five approaches. 2007;395.

34. Archibald, M.M., et al. Using Zoom Videoconferencing for Qualitative Data Collection: Perceptions and Experiences of Researchers and Participants. *International Journal of Qualitative Methods.* 2019;18.

35. Ting, D.S.W., et al. Digital technology and COVID-19, in Nature Medicine. *Nature Research.* 2020;459-461.

36. Woodyatt, C.R., C.A. Finneran, and R. Stephenson. In-person versus online focus group discussions: A comparative analysis of data quality. *Qualitative Health Research.* 2016;26(6):741-749.

37. Cieza, A., et al. Refinements of the ICF Linking Rules to strengthen their potential for establishing comparability of health information. *Disability and Rehabilitation.* 2019;41(5):574-583.

38. Bernard, H.R. *Research methods in anthropology: Qualitative and quantitative approaches*. Rowman & Littlefield; 2017.

39. Carter, N., et al. The use of triangulation in qualitative research, in Oncology Nursing Forum. *Oncology Nursing Society*. 2014;545-547.

40. Hayashi, P., G. Abib, and N. Hoppen. Validity in qualitative research: A processual approach. *The Qualitative Report*. 2019.

41. Wood, L.M., B. Sebar, and N. Vecchio. Application of rigour and credibility in qualitative document analysis: Lessons learnt from a case study. *The Qualitative Report*. 2020.

42. Ruben, M.A., D. Blanch-Hartigan, and J.A. Hall. In: Patients in Treatment. *The Wiley Handbook of Healthcare Treatment Engagement: Theory, Research, and Clinical Practice;* 2020;274.

43. Wang, D., C. Liu, and X. Zhang. Do physicians' attitudes towards patient-centered communication promote physicians' intention and behavior of involving patients in medical decisions? *International Journal of Environmental Research and Public Health.* 2020;17(17):6393.

44. Dabney, B.W. and H.-M. Tzeng, Service quality and patient-centered care. *Medsurg Nursing.* 2013;22(6).

45. Boyatzis, R.E. Transforming qualitative information: Thematic analysis and code development. *Sage.* 1998.

46. Lawrence, M. and S. Kinn. Defining and measuring patient-centred care: an example from a mixed-methods systematic review of the stroke literature. *Health Expectations.* 2012;15(3):295-326.

47. Plant, S.E., et al. What are the barriers and facilitators to goal-setting during rehabilitation for stroke and other acquired brain injuries? A systematic review and meta-synthesis. *Clinical Rehabilitation.* 2016; 30(9):921-930.

48. Bright, F.A., et al. Co-constructing engagement in stroke rehabilitation: a qualitative study exploring how practitioner engagement can influence patient engagement. *Clinical Rehabilitation.* 2017;31(10):1396-1405.

49. Rosewilliam, S., C.A. Roskell, and A. Pandyan. A systematic review and synthesis of the quantitative and qualitative evidence behind patient-centred goal setting in stroke rehabilitation. *Clinical Rehabilitation.* 2011;25(6):501-514.

50. Sugavanam, T., et al. The effects and experiences of goal setting in stroke rehabilitation–a systematic review. *Disability and Rehabilitation.* 2013;35(3):177-190.

51. Morris, R., O. Payne, and A. Lambert. Patient, carer and staff experience of a hospital-based stroke service. *International Journal for Quality in Health Care.* 2007;19(2):105-112.

52. Clarke, S., et al. Defining elements of patient-centered care for therapeutic relationships: A literature review of common themes. *European Journal for Person Centered Healthcare.* 2017;5(3):362-372.

53. Smith, J., et al. Cochrane review: information provision for stroke patients and their caregivers. *Clinical Rehabilitation.* 2009;23(3):195-206.

54. Vincent, C., et al. Provision of rehabilitation services in Québec following stroke: a comparative survey conducted by postal questionnaire. *Canadian Journal on Aging.* 2010;29(2):193-203.

55.   Hou, S.-I. Health education: theoretical concepts, effective strategies and core competencies. *Health Promotion Practice.* 2014;15(5):619-621.

56.   Graven, C., et al. Stroke survivor and carer perspectives of the concept of recovery: a qualitative study. *Disability and Rehabilitation.* 2013;35(7):578-585.

57.   Mayo, N.E., et al. Getting on with the rest of your life following stroke: a randomized trial of a complex intervention aimed at enhancing life participation post stroke. *Clinical Rehabilitation.* 2015;29(12):1198-1211.

58.   Gallacher, K., et al. Uncovering treatment burden as a key concept for stroke care: a systematic review of qualitative research. *PLoS Med.* 2013;10(6):e1001473.

59.   Kjörk, E.K., et al. Experiences, needs, and preferences for follow-up after stroke perceived by people with stroke and healthcare professionals: A focus group study. *PloS One.* 2019;14(10):e0223338.

60.   Watanabe, T.K., A. Esquenazi, and S. Flanagan. The transformation of the rehabilitation paradigm across the continuum of care. *PM&R.* 2018;10(9):S264-S271.

61.   Parmanto, B. and A. Saptono. Telerehabilitation: State-of-the-art from an informatics perspective. *International Journal of Telerehabilitation.* 2009;1(1):73.

62.   Peretti, A., et al. Telerehabilitation: Review of the State-of-the-Art and Areas of Application. *JMIR Rehabilitation and Assistive Technologies.* 2017;4(2):e7.

63.   Chen, J., et al. Telerehabilitation approaches for stroke patients: systematic review and meta-analysis of randomized controlled trials. *Journal of Stroke and Cerebrovascular Diseases.* 2015;24(12):2660-2668.

64.   Jayadevappa, R. and S. Chhatre. Patient centered care-a conceptual model and review of the state of the art. *The Open Health Services and Policy Journal.* 2011;4(1).

Figure 1. The recruitment process for individuals with acquired brain injury

```
┌─────────────────────────────────────┐
│     Initial list provided by the     │
│   clinical research coordinators     │
│   based on the eligibility criteria  │
│  (n=27 individuals with ABI (stroke: │
│   n=10; TBI: n=15; caregivers: n=2)  │
└─────────────────────────────────────┘
                  │
                  ▼
┌─────────────────────────────────────┐        ┌──────────────────────────┐
│  Pre-recruitment: Initial response   │        │  No response to initial  │
│   to phone calls conducted by the    │───────▶│      phone calls         │
│   clinical researcher (n=27          │        │         (n=5)            │
│   individuals with ABI (stroke:      │        └──────────────────────────┘
│   n=10; TBI: n=15; caregivers: n=2)  │
└─────────────────────────────────────┘
                  │
                  ▼
┌─────────────────────────────────────┐        ┌──────────────────────────┐
│  Recruitment: Phone calls conducted  │        │  Excluded (n=11)         │
│  by the researcher for persons       │        │  Reasons:                │
│  provide verbal consent              │───────▶│  experienced a fall (n=1)│
│  (n=22)                              │        │  not interested (n=1)    │
└─────────────────────────────────────┘        │  not feeling well (n=1)  │
                  │                             │  time restriction (n=3)  │
                  ▼                             │  limited access to       │
┌─────────────────────────────────────┐        │  technology              │
│  Persons agreed to participate in    │        │  (n=5)                   │
│  the study and provide consent       │        └──────────────────────────┘
│  (n=11; stroke (n=5) and one         │
│  caregiver; TBI (n=5)                │
└─────────────────────────────────────┘
```

Figure 2. Identified themes and sub-themes

Theme 3. Accessibility and services in the community

Theme 2. System design
2.1. Quality of care
2.2. Information services
2.3. Oriented teamwork approach
2.4. Self-management

Theme 4. Transportation services

Theme 1. Enabling continuity of care
1.1. Experiences with acute rehabilitation care
1.2. Transition from acute to rehabilitation settings
1.3. Access to rehabilitation in the community
1.4. Reintegration into the community
1.5. Follow-up in the community

Patient Centered Care

Theme 5. Uncertainty about the provided services

CHAPTER 8 THE INTEGRATION BETWEEN MANUSCRIPTS 3 AND 4

8.1   Research questions

Manuscript 3

Research question: What are the perceptions of clinicians, individuals with ABI, and their caregivers care experiences and service design related to rehabilitation for mobility and participation in the community among individuals with acquired brain injury (Stroke and TBI)?

Objective: to explore the care experiences and service design related to rehabilitation for mobility and participation in the community among individuals with acquired brain injury (Stroke and TBI), as perceived by clinicians, individuals with acquired brain injury, and their caregivers.

Manuscript 4

Research question: To what extent can Natural Language Processing be used to develop a comprehensive outcome set and preliminary banks of items for mobility among individuals with acquired brain injury (stroke, TBI)?

Objective: to identify a comprehensive outcome set of mobility, and develop preliminary banks of items of mobility among individuals with acquired brain injury (stroke, TBI), using Natural Language Processing.

8.2   Integration of manuscripts 3 and 4

It is essential to understand mobility in a holistic way in order to select a suitable outcome measure to accurately characterize and monitor changes in mobility during rehabilitation interventions for individuals with acquired brain injury (ABI) [1]. There is a need to evaluate the interplay between the determinants that influence mobility (i.e. cognitive, physical, psychosocial, environmental, and financial) to better understand what influences each patient's mobility. The International Classification of Functioning, Disability and Health Framework (ICF) [2] is useful in understanding the myriad of individual and environmental factors while evaluating mobility among individuals with ABI, and in promoting patients' engagement in rehabilitation. Also, the ICF will provide researchers and health professionals with the information needed to select the best outcome measure(s) [2-5].

A synthesis of evidence through an umbrella review of published systematic reviews on mobility measures among individuals with ABI was conducted to provide a comprehensive review of measures of mobility among individuals with ABI (Manuscript 1). Furthermore, the results of the focus groups discussions facilitate the

identification of mobility measures used in clinical practice and the factors that influence mobility among individuals with ABI (Manuscript 2). Additionally, the perspectives of clinicians, individuals with ABI, and their caregivers on their experiences about services provisions (considered as environmental factors at the societal level) could improve measuring mobility in different rehabilitation settings from the acute level of care to community re-integration among individuals with ABI.

Identified mobility domains and items among individuals with ABI, from the literature (Manuscript 1) and the focus group discussions (Manuscripts 2 & 3) will help create a comprehensive outcome set and develop preliminary banks of items for mobility specifically for individuals with ABI (stroke and TBI). Furthermore, a Core Outcome Set of mobility domains selected by researchers, clinicians, and patients allows interventions to be evaluated by using an agreed-upon set of outcomes that can be compared across studies, and clinical care programs and settings. Improved outcome measures can substantially improve clinical research and make the research process more efficient.

The process of selecting the items to evaluate Core Outcome Set takes a long time as it is requires improving items, and qualitative judgements always leave room for future improvements. Compared to traditional manual consensus, utilizing machine learning helps researchers to develop a comprehensive outcome set of mobility more efficiently and synthesize the literature which when performed manually requires a tremendous amount of time and resources. Using Natural Language Processing to classify mobility domains into clusters is needed, especially when dealing with large databases.

Properly classifying content from mobility measures is a crucial feature for efficiently selecting appropriate measures. Often, this process relies on pre-defined static vocabularies that describe mobility domains and items. The initial system vocabularies should evolve in an automatic way to reflect knowledge evolution in order to provide a correct and timely reflection of our understanding of mobility. In Manuscript 4, we developed a comprehensive outcome set and preliminary banks of items of mobility by extracting relevant information on mobility (i.e. domains and items) from the umbrella review (Manuscript 1) and the focus group discussions (Manuscripts 2 & 3) which was then used in a Natural Language Processing analysis. Structuring the data based on the Natural Language Processing will create clusters of items of mobility (i.e., sentence embedding) and enhance the development of the mobility concept and items classification (i.e., ontology), consequently.

8.3 References

1.   Murphy, M.A., et al. An overview of systematic reviews on upper extremity outcome measures after stroke. *BMC Neurology.* 2015;15(1):29.

2.   World Health Organization. *International Classification of Functioning, Disability and Health: ICF*. Geneva; 2001.

3.   Cieza, A., et al. Refinements of the ICF linking rules to strengthen their potential for establishing comparability of health information. *Disability and Rehabilitation.* 2019;41(5):574-583.

4.   Geyh, S., et al. ICF Core Sets for stroke. *Journal of Rehabilitation Medicine.* 2004;36(0):135-141.

5.   Stucki, G., T. Ewert, and A. Cieza. Value and application of the ICF in rehabilitation medicine. *Disability and Rehabilitation.* 2003;25(11-12):628-634.

Title: Informing the Development of an Outcome Set and Banks of Items to Measure Mobility among

Individuals with Acquired Brain Injury using Natural Language Processing

Rehab Alhasani,[1,4,9] Mathieu Godbout,[3] Audrey Durand,[3,10] Claudine Auger,[2,4,7] Anouk Lamontagne,[1,4,8] Sara

Ahmed.[1,4,5,6]

This manuscript has been submitted to BMC Neurology

Authors' affiliation

[1]School of Physical and Occupation Therapy, Faculty of Medicine, McGill University, Montréal, Canada

[2]School of Rehabilitation, Faculty of Medicine, Université de Montréal, Montréal, Canada

[3]Université Laval, Laval, Canada

[4]Centre for Interdisciplinary Research in Rehabilitation of Greater Montreal, Montréal, Canada

[5] McGill University Health Center Research Institute, Clinical Epidemiology, Center for Outcome Research and Evaluation, Montréal, Canada

[6] Constance Lethbridge Rehabilitation Center, CIUSSS Centre- Ouest de l'Île de Montréal, Montréal, Canada

[7]Institut universitaire sur la réadaptation en déficience physique de Montréal, CIUSSS du Centre-Sud-de-l'Île -de-Montréal, Montréal, Canada

[8] Jewish Rehabilitation Hospital, CISSS de Laval, Laval, Canada

[9]Department of Rehabilitation Sciences, College of Health and Rehabilitation Sciences, Princess Nourah Bint Abdulrahman University, Riyadh, Saudi Arabia

[10]Mila - Quebec Artificial Intelligent Institute, Montréal, Canada

Corresponding author

Sara Ahmed, PhD.
School of Physical and Occupation Therapy, Faculty of Medicine, McGill University
3655 Sir William-Osler
Montreal, QC, Canada, H3G 1Y6
Tel.: 514-398-4400 ext. 00531
E-mail: sara.ahmed@mcgill.ca

9.1   Abstract

Objective: To identify a comprehensive outcome set and develop preliminary banks of items of mobility among individuals with acquired brain injury using Natural Language Processing (NLP).

Methods: An umbrella review of 47 reviews evaluating the content of mobility measures among individuals with ABI was conducted. A search was performed on 5 electronic databases between 2000 and 2020. Two independent reviewers retrieved copies of the measures and extracted mobility domains and items. A pre-trained BERT model (state-of-the-art model for NLP) provided vector representations for each sentence. Using the International Classification of Functioning, Disability, and Health Framework (ICF) terms as a guide for clustering, a *k*-means algorithm was used to retrieve clusters of similar sentences from their embeddings. The resulting embedding clusters were evaluated using the Silhouette score and fine-tuned according to expert input.

Results: The study identified 246 mobility measures including 474 domains and 2109 items. Encoding the clusters using the ICF ontology and expert knowledge helped in regrouping the items in a way that is more closely related to mobility terminology. Our best results identified 24 preliminary banks of items of mobility. These banks of items were used to create a comprehensive outcome set of mobility including Upper Extremity Mobility, Emotional Functions, Balance, Motor Control, Self-care, Social Life and Relationship, Cognition, Walking, Postural Transition, Recreation and Leisure Activities, Domestic Life, Physical Functioning, Communication, Work/Study, Climbing, Sensory Functions, General Health, Fatigue, Functional Independence, Pain, Alcohol and Drugs Use, Transportation, Sleeping, and Finances.

Conclusion: The comprehensive banks of items of mobility domains represent a first step toward establishing a comprehensive outcome set and a common language of mobility to develop the ontology. It enables researchers and healthcare professionals to begin exposing the content of mobility measures as away to assess mobility comprehensively among individuals with ABI. Some limitations were related to the automatic evaluation of the yielded clusters, as the Silhouette score used is only based on distances between sentence embeddings and therefore the process of improving clusters is inevitably related to experts' judgments.

Keywords: Acquired brain injury, Mobility, Natural Language Processing, Machine Learning, Core Outcome Set, Item banks

9.2 Introduction

Acquired Brain Injury (ABI), including traumatic brain injury (TBI) and stroke, is most prevalent cause of disability globally [1-3]. According to the World Health Organization, the global incidence of all-severity TBI is estimated at 69 million people, while 15 million people suffer a stroke worldwide each year [4-6]. Among the 1.5 million Canadians with ABI that go through the care continuum annually; over 60% report ongoing restrictions in mobility and participation in societal roles [5]. Long-term follow-ups of individuals with ABI show that impairments in mobility appear to undergo little change, even 10 years after the initial injury [7-9]. Thus, the effect on individuals, health care systems, and society suggest a greater need to focus attention on the long-term consequences, management, and rehabilitation of people with ABI [10].

Mobility is a multidimensional construct defined through both theoretical and empirical approaches. From a theoretical point of view, mobility has frequently been defined in terms of life-space frameworks as the ability to move oneself within environments that expand from one's home to the neighbourhood and regions beyond [11-17]. Mobility is influenced by five vital inter-related determinants, including physical, environmental, cognitive, psychosocial and financial influences [14], and this is reflected in the International Classification, Functioning, Disability, and Health framework (ICF) core set [18]. Empirical studies have also focused on the effects of the built environment on community mobility [19, 20].

Selection of a suitable outcome measure is critical to accurately characterize and monitor changes in mobility during rehabilitation interventions for adults with ABI [21]. However, selection can pose a challenge to both researchers and clinicians as the range of outcome measures available in the clinical research literature is vast, and distinctions between them are often not clear [22, 23]. Researchers and clinicians also need to consider the content of measures and whether the domains evaluated match research and clinical objectives. Multifaceted assessments of mobility among individuals with ABI can assist in the development of individualized rehabilitation treatment plans that could enhance patients' global health status and allow the evaluation of the long-term effectiveness of interventions [24, 25].

Mobility is commonly assessed through performance-based measures (e.g., walking tests) or clinician-reported outcomes (e.g., Disability Rating Scale) [26, 27]. Although these measures capture some aspects of functional capacity, they are not comprehensive enough to evaluate patients' perspective on their function, nor the effects of their limitations on everyday life. In the last 20 years, advances in measurements have brought to the

research and clinical practice the assessment of quality of life through patient-reported outcome (PRO) measures [28, 29]. Mainly, the National Institutes of Health's Patient-Reported Outcomes Measurement Information System (PROMIS), the Quality of Life in Neurologic Disorders (Neuro-QoL) and the Traumatic Brain Injury Quality of Life (TBI-QOL) initiatives have pioneered the development of PRO measures [28-31]. These initiatives have resulted in the development of measures that allow comparison across conditions over time, testing of all levels of function with one measure, reduce the administration of irrelevant items to a given individual, and minimize testing time by reducing the overall number of items administered through short forms [25, 30, 31]. Although these initiatives have made great advances in general population and neurological population assessment, neither measurement system alone can capture the multi-dimensionality of mobility among individuals with ABI.

Core Outcome Sets developed by researchers and patients allow interventions to be evaluated by using an agreed-upon standardized set of outcomes that can be compared across studies, and clinical care programs and settings. A Core Outcome Set includes measures, tools, and endpoints to assess a minimum list of impacts and demonstrate changes. The PROMIS (www.nihpromis.org) is charged with developing improved PROs applicable to all areas of chronic illness and involving several domains such as physical functioning and disability. PROMIS is the most ambitious approach yet to these issues [32-34]. In simplest terms, PROMIS seeks to employ the best items in the best ways [32-34] with a focus on items that are most relevant to study endpoints in clinical trials and observational studies. Optimal instrument development requires item improvement, yet systematic approaches to the advancement of improved items need to ensure items have full coverage of the construct of interest, and adjust item banks; if data supports that a given item is problematic, it is removed or revised to increase its relevance and clarity.

Compared to traditional manual consensus, utilizing machine learning (ML) helps researchers to develop item banks more efficiently and synthesize literature that manually is nearly impossible. ML is a subset of Artificial Intelligence that enables computers to learn without being explicitly programmed with predefined rules [35]. In the rehabilitation sciences, building computer programs that can extract and process knowledge from text documents at a level that is usable by experts in the domain requires several elements that can generally be associated with intelligence [35, 36]. ML focuses on the development of computer programs that can teach themselves to grow and change when exposed to new data [35]. This predictive ability enables ML to handle massive datasets with efficiency and accuracy. ML algorithms are categorized into supervised learning, unsupervised learning, and reinforcement learning [37]. Natural language processing (NLP) is unsupervised ML that focuses particularly on

natural language data [38]. The ultimate objective of NLP is to read, decipher, understand, and make sense of the human languages in a manner that is valuable [38]. For example, a key feature of NLP is to generate embeddings for extents of text [39]. Text embeddings can be used to ease learning in downstream tasks and naturally encode similarity whether it is on the word-level or sentence-level [40].

Properly classifying content from mobility measures is needed to identify relevant texts. Often, this process relies on pre-defined static vocabularies that describe the mobility domains. To understand knowledge evolution, the initial system vocabularies should evolve in an automatic way in order to correctly reflect and evolve our understanding about mobility. Our goals for this work were to identify optimal domains by extracting and classifying items from published research of mobility measures. We did this using NLP technique to create sentence embeddings to inform the mobility ontology. NLP was selected as an approach robust enough to develop preliminary banks of items of mobility that used to evaluate each domain in a comprehensive outcome set of mobility among individuals with ABI.

9.3   Objective

While using NLP, we aimed to: (1) identify a comprehensive outcome set of mobility, and (2) develop preliminary banks of items of mobility among individuals with ABI.

9.4   Methods and data analysis

Step 1: Item selection process

To develop preliminary banks of items of mobility among individuals with ABI, we conducted a comprehensive umbrella review of mobility measures among individuals with ABI following the 10 steps of the Consensus-based Standards for the Selection of Health Measurement Instrument (COSMIN) guideline for systematic reviews [41] (under review; submitted to Quality of Life Journal). Subsequently, we conducted focus group discussions among clinicians and individuals with ABI and their caregivers to identify factors influencing mobility that need to be considered when evaluating mobility (under review; submitted to Annals of Medicine Journal).

1.1. Search strategy: a comprehensive search of the literature was performed using electronic databases of Ovid MEDLINE, CINHAL, Cochrane Library and EMBASE from 2000 to March 2020.

1.2. Select abstracts and full text articles: inclusion of articles was based on the agreement between two independent reviewers. Disagreements were resolved by discussion and consensus. If required, a third

reviewer was consulted. The reference list of the articles included for the full text screening was also hand-searched for additional identification of relevant articles. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram [42] was used to guide the selection process.

1.3. Eligibility criteria: inclusion criteria for the umbrella review were reviews published in peer-reviewed journals, including individuals with ABI (Stroke, traumatic brain injury) over 18 years old. They report a clear objective of identifying measures of mobility. They include either multiple or single measure(s) of mobility including different sources of information (i.e. clinicians, patients, and technology). The exclusion criteria were reviews investigating effectiveness of interventions or treatments, monitoring recovery, focusing on diagnostic screening or prognosis, clinical commentaries, case reports, non-human studies, and grey literature.

1.4. Data extraction: two independent reviewers extracted the measures from the reviews, retrieved copies of measures from the literature, and included the non-covered measures identified from the focus groups. They extracted measures' domains and items manually, to avoid missing relevant information. Also, they added mobility domains (i.e. factors) identified from the focus groups.

Step 2: Data cleaning

The data cleaning process ensures that the domains and items are consistent and accurate. The following steps were applied to the processed terms using Microsoft office Excel 2010 (Appendix 1 presents the functionalities that used in this process):

2.1. Export to .CSV file and create a backup copy of the original data in a separate spreadsheet.

2.2. Remove duplicate rows: we filtered for unique values first to confirm that the results were what we wanted before removing duplicate rows.

2.3. Correct spelling mistakes: lexical matching requires correction of spelling mistakes. For example, behaviour becomes behavior; practise becomes practice; neighbour becomes neighbor, and so on.

2.4. Changing the case: all the uppercase letters were converted to lowercases letters.

2.5. Extend acronyms and abbreviations to their full form: because they caused mismatches in the string-matching process, acronyms and abbreviations were removed, such as 6MWT becomes six-minute walking test, BI becomes brain injury, and so on.

2.6. Fixing numbers and number signs.

2.7. Remove white spaces, non-printing characters, typos, punctuations from the sentence, and use underscore (_) instead of dash (-).

Step 3: The proposed model

Figure 1 presents an overview of the proposed model that was used to analyze the data using the NLP technique. Python 3.0 Release was used to analyse the data. All the process details are described below:

3.1. For each mobility item, we first applied a word filtering that was hypothesized to remove noise from the word groups. The different filters considered were: the absence of filter; filtering all words with fewer than 4 letters; filtering words contained in a public stop-words dictionary; and filtering words based on their occurrence, where words seen too often in the dataset were removed from their group.

3.2. Generate database on neural network processing of 15 million articles on mobility and ABI using Medical Subject Headings (MeSH) terms from Pubmed to train our Fast-Text embeddings.

3.3. Using the pre-trained Bidirectional Encoder Representations from Transformers (BERT) model (state-of-the-art model for NLP) [43], we created sentence embeddings, in which the collected sentences (items) were mapped to vectorial representations, i.e. vectors of real numbers (https://www.sbert.net/index.html).

3.4. Vectorial representations generated from Sentence-BERT model included 768 dimensions. These dimensions are inefficient for distance-based clustering, as the usual distance metrics suffer from the curse of dimensionality and sentence clustering becomes very difficult [44]. To ease computation, we applied Principal Component Analysis (PCA) decomposition [45, 46] from the scikit-learn library (https://scikit-learn.org/stable/about.html#citing-scikit-learn) [47] to reduce the sentence embeddings' dimensions.

3.5. The ICF terms, extracted from the ICF ontology (https://bioportal.bioontology.org/ontologies/ICF), were used to focus the embedding clustering on mobility and mobility determinants. The ICF terms went through the same pipeline of word filtering, Sentence-BERT, and dimensionality reduction.

3.6. The *k*-means algorithm [48] was applied to all collected sentence embeddings to retrieve clusters of similar sentences.

3.7. To evaluate the quality of the resulting clusters, a Silhouette score [49, 50] was used. A Silhouette score is a clustering metric ranging between -1 to 1, and based on inter- and intra-cluster distances. A high Silhouette score means that sentences in a given cluster are similar and that different clusters are distinct. A Silhouette score can be used in our case, but evaluating the quality of the model was limited in terms of

sentence embeddings, as the vectorial distance between sentences in one cluster were not well fitted to mobility-related proximity. Therefore, we evaluated the quality of the resulting clusters based on the sentences themselves instead of using their embeddings.

3.8. The above steps resulted in sentence clustering that was then analyzed by 4 experts (RA, CA, AL, SA), who reviewed the top 30 sentences (items) in each cluster following agreed-upon criteria, including: remove ambiguous, vague and parallel items; clarify items by adding or removing needed words; and label each item to an agreed-upon domain. The expert annotations were then used to fine-tune the Sentence-BERT model towards more meaningful mobility-related sentence embeddings. The final clustering respected expert annotations of 80 % F1-Score [51, 52].

Step 4: Preliminary banks of items selection process

The most critical part of our proposed model is the sentence embedding process. The pre-trained Sentence-BERT model was used to produce semantically accurate embeddings (Figure 2). To ensure the quality of evidence, the following was done:

4.1. First iteration: a small subset of mobility items was analyzed by the Sentence-BERT model using the ICF terms from the ontology as a guide. According to the Silhouette score only, the best subset was retained and sent to the expert for analysis. The analysis yielded sentences that were correctly and incorrectly clustered. This information was used by the experts to create relations for sentence pairs that should or should not be clustered together.

4.2. Second iteration: the relation for sentence pairs that were extracted from the first iteration was used as a training example to fine-tune the sentence-BERT model. The resulted clusters from the second iteration were analyzed again by the experts who grouped hundreds of items by labelling them to an agreed-upon domain.

4.3. Third iteration: final results were obtained by fine-tuning the sentence-BERT model again with the newly expert knowledge, resulting in 26 unified clusters of items.

9.5   Results

9.5.1   Search results

The search strategy yielded a total of 47 reviews that met the eligibility criteria and were included [26, 53-98]. 246 copies of mobility measures were retrieved, and from these 474 mobility domains and 2109 mobility items

were extracted. Figure 3 presents the PRISMA flow diagram, including the selection process and the reasons for exclusion.

9.5.2   Identification of mobility outcome set and preliminary banks of items

Initially, our best grouping according to Silhouette score and expert knowledge resulted in 26 clusters. The experts reviewed each cluster of items and only included relevant and clear items. Duplicates (n=267), ambiguous parallel items (n=97), and fewer than 2 words items (n=134) were removed, resulting in 1611 out of 2109 items. In addition, among the 1611 items, 245 (15%) items were considered as outliers, as they did not fit well enough within their cluster. Also, seven clusters were identified as outliers, as they included items labelled to more than one domain. Results from the 26 clusters showed that ten clusters had no outliers; six clusters contained 5% to10% outliers; and ten clusters contained > 10% outliers.

After extensive discussion, experts decided not to eliminate outliers not filtered by the algorithm, clusters labelled to more than one domain, and to manually resign them to the fitted clusters. Additionally, five new clusters were generated from outliers not filtered by the algorithm. Overall, 602 (37%) of the items were reassigned in the fine-tuning process resulting in 24 preliminary comprehensive outcome set of mobility, namely: Upper Extremity Mobility, Emotional Functions, Balance, Motor Control, Self-care, Social Life and Relationship, Cognition, Walking, Postural Transition, Recreation and Leisure Activities, Domestic Life, Physical Functioning, Communication, Work/Study, Climbing, Sensory Functions, General Health, Fatigue, Functional Independence, Pain, Alcohol and Drugs Use, Transportation, Sleeping, and Finances (Figure 4 and Table 1; For more information about the mobility banks of items, please refer to Appendix 2). Also, we define the comprehensive outcome set of mobility conceptually based on the ICF and Webber's frameworks in Table 2.

9.6   Discussion

In this study, we identified a comprehensive outcome set of mobility and developed preliminary banks of items of mobility, for use in evaluating mobility among individuals with ABI, using NLP. We supported that it is possible to use a variety of existing instruments of mobility to build preliminary banks of items with promising properties using NLP. Although the PROMIS physical functioning item bank was found to be unidimensional, it was constructed to represent sub-domains of physical functioning to use among individuals with chronic illnesses [28, 29, 99]. This study identified 24 preliminary banks of items of mobility, which need to be used to evaluate each domain in a comprehensive outcome set of mobility among individuals with ABI.

Improved outcome measures can substantially enhance clinical research and make the research process more efficient. Clinical trials may require fewer subjects, and greater assurances may be given that the perspectives of the patient are included. The goal of this work was to construct comprehensive mobility tools. Previous studies have shown that better items obtained from large item banks for relevant and clear items that can be understood and are considered important to patients, with less floor and ceiling effects, standardized time frames, content, and response options to improve item structure and wording [25, 30, 31]. The identified banks of items are required for researchers and health care professionals to compile and compare common mobility outcomes and items from centre to centre or client to client, directly influencing the identification and implementation of best practices [100].

An understanding of the nature and severity of mobility among individuals with ABI is needed, in order to develop effective individualized treatment plans and to compare different interventions. This requires a comprehensive assessment of impairments, activity limitations, and participation restrictions. The intervention plan varies depending on the patients' personal context, goals, and the complex interplay of the factors that influence mobility [14, 101]. This work provided a preliminary comprehensive outcome set of mobility from all possible sources, and mapped the constructs measured to the ICF. Results of this study will be used in future as part of an agreed-upon consensus of mobility Core Outcome Set, and the Delphi approach will be administered to achieve expert consensus (i.e., clinicians and individuals with ABI and their caregivers), to examine mobility Core Outcome Set, to assess experts' views on importance, clarity, and relevance of the domains and items of mobility, to unify the language of measuring mobility among individuals with ABI, and standardize measures used across clinical sites and studies.

In the rehabilitation sciences, developing NLP algorithms that can extract and process knowledge from text documents at a level that is usable by experts in the domain requires several elements that can generally be associated with intelligence [35, 36]. Throughout the experiments, it became clear that expert knowledge was the key factor in obtaining more accurate clustering. In the beginning, no expert knowledge was used and the best architecture artificially incorporated expert knowledge by requiring adding the ICF terms and to filter words in a sentence. The resulting clusters were also hard to evaluate automatically due to the poor quality of the pre-trained sentence-BERT embeddings for mobility-related tasks. The incorporation of expert knowledge gradually improved the quality of the resulting clusters. At the same time, the more information used allowed the sentence-BERT model to be further fine-tuned, gradually reducing the need to insert artificial knowledge in the procedure. Namely, on the

final iteration, the best performing architecture did not filter words and did not require ICF terms. This shows that with iterations and fine-tuning of sentence embeddings, models improve in capturing the added expert knowledge.

The use of item response theory (IRT) and computerised adaptive testing (CAT) is important in our next steps to provide item hierarchy and calibrate the items on a linear scale, respectively [102, 103]. IRT models incorporate both the characteristics of items and characteristics of individuals and calculate the probability of a positive response, to classify items for each person [33, 104, 105]. CAT is a specific kind of computer-based testing that asks questions extracted from larger pools of items covering a wider range of items difficulty to provide a more precise way to decrease questionnaire burden [33, 104, 105]. Moreover, IRT can quantitatively estimate the properties of each item and eliminate poor items to optimise the matching of items for each patient using CAT applications.

9.6.1   Lessons learned

"*Shared language is important in leading adaptive change. When people begin to use the same words with the same meaning, they communicate more effectively, minimize misunderstandings, and gain the sense of being on the same page, even while grappling with significant differences on the issues* [106]" One of the barriers to implement a Core Outcome Set of mobility to use among individuals with ABI has been the lack of a comprehensive common language describing domains of mobility in the healthcare professions. This gap of a common language prevented the development of a classification system of representative knowledge (i.e. ontology) that would allow the experts to make decisions related to tailored intervention plans among individuals with ABI. We therefore began this robust methodology using NLP with the goal of establishing preliminary banks of items of mobility that could be mapped within the continuum of care.

Lessons learned from this work include: First, NLP techniques require human annotations to thrive, as the work clearly indicated that expert knowledge was the key factor in obtaining more accurate clustering. Second, some measures included irrelevant and ambiguous items and we were able to examine and eliminate them. Third, the provided banks of items of mobility considered other item banks not identified in the literature search such as PROMIS. Toward that end, final consensus on a Core Outcome Set and banks of items of mobility needs to incorporate input from all stakeholders. Such item banks will provide a solid foundation to develop a commonly used ontology to inform selection of mobility outcomes and classification of mobility terms in digital health solutions and electronic medical records.

9.7   Study limitations

During the process of retrieving copies of measures, we faced some challenges related to some of technology-based and performance/clinicians measures. These challenges include: the difficulty of retrieving some technology-based measures such as actical, actigraph, motionlogger, goniometers, caltrac accelerometer, gyroscopes, magnetometer and sensewear pro 3 armband; the domains and items for some technology-based measures (such as Global Positioning System (GPS)); and for some performance/clinicians measures (such as gait speed, six minute walking test, timed up and go test, and manual functional test) were hard to extract.

While our methodology improved overall performance of the model, we note the following limitations in relation to the automatic NLP evaluation: traditional clustering metrics like the Silhouette score are only barely useful when comparing two different groupings produced by our model due to the difficulty of interpreting sentence embeddings produced by neural networks. Also, the Silhouette score is not an accurate estimate to calibrate the items in the identified banks of items. Thus, the quality of our banks of items needs to be validated by expert knowledge to ensure that the emerged list of items covered the construct of mobility based on the ICF categories. Finally, regarding the items, we have not accounted for the time frame and response options while analysing the clusters, as we only accounted for the content of the item.

9.8   Conclusion

The comprehensive banks of items of mobility presented in this study has multiple uses: First, it represents a first step toward establishing a comprehensive Core Outcome Set and a common language of mobility among individuals with ABI to develop the ontology. Second, it enables researchers and healthcare professionals to begin exposing the content of mobility measures as a way to assess mobility comprehensively among individuals with ABI. Ultimately, using shared assessment items of mobility it may be possible to adapt these items across the continuum of care. Our banks of items of mobility will soon be used to develop the ontology, allowing the stakeholders to make decisions about tailored individualized treatment plans. This study provides a road map for using NLP in other health outcome areas.

DISCLOSURES OF INTEREST

Ethics Approval: Not applicable

Consent for publication: Not applicable

Availability of data and materials: The findings of the detailed preliminary banks of items are available upon request.

Conflicts of interest: None

Funding: None

Authors' contributions: All authors contributed to the design of this study, provided critical insights, and contributed to the final written manuscript.

9.9   References

1.   Maas, A.I., N. Stocchetti, and R. Bullock Moderate and severe traumatic brain injury in adults. *The Lancet Neurology.* 2008;7(8):728-741.

2.   Patil, M., et al. Cognitive and functional outcomes following inpatient rehabilitation in patients with acquired brain injury: a prospective follow-up study. *Journal of Neurosciences in Rural Practice.* 2017; 8(3):357.

3.   Prabhakaran, V. Non-communicable diseases in India: Transitions, burden of disease and risk factors-A short story. *India Health Beat.* 2012;6(1).

4.   Dewan, M.C., et al. Estimating the global incidence of traumatic brain injury. *Journal of Neurosurgery.* 2018;130(4):1080-1097.

5.   Chambers-Richards, T.L.-T.A. Risk factors, trends, health care and general life satisfaction for select neurological conditions among an aging population in Canada. 2020.

6.   Thrift, A.G., et al. Global stroke statistics. *International Journal of Stroke.* 2017;12(1):13-32.

7.   King, B., et al. Department of Rehabilitation. *Journal of Neurotrauma.* 2013;31(1).

8.   Scholten, A.C., et al. Health-related quality of life after mild, moderate and severe traumatic brain injury: patterns and predictors of suboptimal functioning during the first year after injury. *Injury.* 2015;46(4):616-624.

9.   Yin, S., et al. Summarizing health-related quality of life (HRQOL): development and testing of a one-factor model. *Population Health Metrics.* 2016;14(1):22.

10.   Feigin, V.L., et al. Global and regional burden of stroke during 1990–2010: findings from the Global Burden of Disease Study 2010. *The Lancet.* 2014;383(9913):245-255.

11.   Peel, C., et al. Assessing mobility in older adults: the UAB Study of Aging Life-Space Assessment. *Physical Therapy.* 2005;85(10):1008-1019.

12.   Shumway-Cook, A., et al. Environmental demands associated with community mobility in older adults with and without mobility disabilities. *Physical Therapy.* 2002;82(7):670-681.

13.   Tsai, L.-T. Walking, physical activity and life-space mobility among older people. *Studies in Sport, Physical Education and Health.* 2017;(254).

14.   Webber, S.C., M.M. Porter, and V.H. Menec. Mobility in older adults: a comprehensive framework. *The Gerontologist.* 2010;50(4):443-450.

15.   Baker, P.S., E.V. Bodner, and R.M. Allman. Measuring life-space mobility in community-dwelling older adults. *Journal of the American Geriatrics Society.* 200;51(11):1610-1614.

16.   May, D., U. Nayak, and B. Isaacs. The life-space diary: a measure of mobility in old people at home. *International Rehabilitation Medicine.* 1985;7(4):182-186.

17.   Stalvey, B.T., et al., The Life Space Questionnaire: A measure of the extent of mobility of older adults. *Journal of Applied Gerontology.* 1999;18(4):460-478.

18.   World Health Organization. *International Classification of Functioning, Disability and Health: ICF*. Geneva; 2001.

19.   Clarke, P., et al. Mobility disability and the urban built environment. *American Journal of Epidemiology.* 2008;168(5):506-513.

20.   Nagel, C.L., et al. The relation between neighborhood built environment and walking activity among older adults. *American Journal of Epidemiology.* 2008;168(4):461-468.

21.   Murphy, M.A., et al. An overview of systematic reviews on upper extremity outcome measures after stroke. *BMC Neurology.* 2015;15(1):29.

22.   Miller, E.L., et al. Comprehensive overview of nursing and interdisciplinary rehabilitation care of the stroke patient: a scientific statement from the American Heart Association. *Stroke.* 2010;41(10):2402-2448.

23.   Party, I.S.W. National clinical guideline for stroke. London: Royal College of Physicians. 2012.

24.   Tsyben, A., et al. Spectrum of outcomes following traumatic brain injury-relationship between functional impairment and health-related quality of life. *Acta Neurochirurgica.* 2018;160(1):107-115.

.25.   Quatrano, L.A. and T.H. Cruz, Future of outcomes measurement: impact on research in medical rehabilitation and neurologic populations. *Archives of Physical Medicine and Rehabilitation.* 2011;92(10): S7-S11.

26.   McCulloch, K.L., et al. Outcome measures for persons with moderate to severe traumatic brain injury: recommendations from the American Physical Therapy Association Academy of Neurologic Physical Therapy TBI EDGE Task Force. *Journal of Neurologic Physical Therapy.* 2016;40(4):269-280.

27. Horton, L., J. Rhodes, and L. Wilson. Randomized controlled trials in adult traumatic brain injury: a systematic review on the use and reporting of clinical outcome assessments. *Journal of Neurotrauma.* 2018;35(17):2005-2014.

28. Cella, D., et al. The Patient-Reported Outcomes Measurement Information System (PROMIS) developed and tested its first wave of adult self-reported health outcome item banks: 2005–2008. *Journal of Clinical Epidemiology.* 2010;63(11):1179-1194.

29. Hays, R.D., et al. Upper-extremity and mobility subdomains from the Patient-Reported Outcomes Measurement Information System (PROMIS) adult physical functioning item bank. *Archives of Physical Medicine and Rehabilitation.* 2013;94(11):2291-2296.

30. Cella, D., et al. Neuro-QOL: brief measures of health-related quality of life for clinical research in neurology. *Neurology.* 2012;78(23):1860-1867.

31. Tulsky, D.S. and P.A. Kisala. An overview of the traumatic brain injury–quality of life (TBI-QOL) measurement system. *The Journal of Head Trauma Rehabilitation.* 2019;34(5):281-288.

32. Ware, J.E., J.B. Bjorner, and M. Kosinski. Practical implications of item response theory and computerized adaptive testing: a brief summary of ongoing studies of widely used headache impact scales. *Medical Care.* 2000;38(9):II73-II82.

33. Cella, D. and C.-H. Chang. A discussion of item response theory and its applications in health status assessment. *Medical Care.* 2000;38(9):II66-II72.

34. Chang, W.-C., et al. Evaluating the FONE FIM: Part II. Concurrent validity & influencing factors. *Journal of Outcome Measurement.* 1997;1(4):259-285.

35. Larsen, K.R., et al. Behavior change interventions: the potential of ontologies for advancing science and practice. *Journal of Behavioral Medicine.* 2017;40(1):6-22.

36. Okhmatovskaia, A., et al. Addressing the challenge of encoding causal epidemiological knowledge in formal ontologies: a practical perspective. *MIE.* 2014.

37. Andrich, D., Rasch models for measurement *.Sage.* 1988;(68).

38. Locoro, A., V. Mascardi, and A.M. Scapolla. NLP and Ontology Matching-A Successful Combination for Trialogical Learning. *ICAART.* 2010;(1).

39.   Velupillai, S., et al. Using clinical Natural Language Processing for health outcomes research: Overview and actionable suggestions for future advances. *Journal of Biomedical Informatics.* 2018;88:11-19.

40.   Le, Q. and T. Mikolov. Distributed representations of sentences and documents. in International conference on machine learning. *PMLR.* 2014.

41.   Mokkink, L.B., et al., COSMIN methodology for systematic reviews of patient-reported outcome measures (PROMs). User manual. 2018;(78):1.

42.   Mark Vrabel, M. Preferred reporting items for systematic reviews and meta-analyses. in Oncology nursing forum. *Oncology Nursing Society.* 2015.

43.   Reimers, N. and I. Gurevych. Sentence-bert: Sentence embeddings using siamese bert-networks. *arXiv.* 2019.

44.   Har-Peled, S., P. Indyk, and R. Motwani. Approximate nearest neighbor: Towards removing the curse of dimensionality. *Theory of Computing.* 2012;8(1):321-350.

45.   Syms, C. Principal Components Analysis. 2019.

46.   McInnes, L., J. Healy, and J. Melville, Umap: Uniform manifold approximation and projection for dimension reduction. *arXiv.* 2018.

47.   Pedregosa, F., et al. Scikit-learn: Machine learning in Python. *The Journal of Machine Learning Research.* 2011;12:2825-2830.

48.   Lloyd, S. Least squares quantization in PCM. *IEEE Transactions on Information Theory.* 1982;28(2):129-137.

49.   Lee, J.A. and M. Verleysen. Nonlinear dimensionality reduction. *Springer Science & Business Media.* 2007.

50.   Rousseeuw, P.J. Silhouettes: a graphical aid to the interpretation and validation of cluster analysis. *Journal of Computational and Applied Mathematics.* 1987;20:53-65.

51.   Goutte, C. and E. Gaussier. A probabilistic interpretation of precision, recall and F-score, with implication for evaluation. in European conference on information retrieval. *Springer.* 2005.

52.   Uzuner, Ö., et al. A challenge on concepts, assertions, and relations in clinical text. *Journal of the American Medical Informatics Association.* 2011;18(5):552-556.

53. Ashford, S., S. Brown, and L. Turner-Stokes. Systematic review of patient-reported outcome measures for functional performance in the lower limb. *Journal of Rehabilitation Medicine.* 2015;47(1):9-17.

54. Ashford, S., et al. Evaluation of functional outcome measures for the hemiparetic upper limb: a systematic review. *Journal of rehabilitation Medicine.* 2008;40(10):787-795.

55. Baker, K., S.J. Cano, and E.D. Playford. Outcome measurement in stroke: a scale selection strategy. *Stroke.* 2011;42(6):787-1794.

56. Barak, S. and P.W. Duncan. Issues in selecting outcome measures to assess functional recovery after stroke. *NeuroRx.* 2006;3(4):505-524.

57. Connell, L.A. and S.F. Tyson. Clinical reality of measuring upper-limb ability in neurologic conditions: a systematic review. *Archives of Physical Medicine and Rehabilitation.* 2012;93(2):221-228.

58. Croarkin, E., J. Danoff, and C. Barnes. Evidence-based rating of upper-extremity motor function tests used for people following a stroke. *Physical Therapy.* 2004;84(1):62-74.

59. Fini, N.A., et al. How is physical activity monitored in people following stroke? *Disability and Rehabilitation.* 2015;37(19):1717-1731.

60. Gebruers, N., et al. Monitoring of physical activity after stroke: a systematic review of accelerometry-based measures. *Archives of Physical Medicine and Rehabilitation.* 2010;91(2):288-297.

61. Geroin, C., et al. Systematic review of outcome measures of walking training using electromechanical and robotic devices in patients with stroke. *Journal of Rehabilitation Medicine.* 2013;45(10):987-996.

62. Geyh, S., et al. Identifying the concepts contained in outcome measures of clinical trials on stroke using the International Classification of Functioning, Disability and Health as a reference. *Journal of Rehabilitation Medicine.* 2004;36(0):56-62.

63. Gor-García-Fogeda, M.D., et al. Scales to assess gross motor function in stroke patients: a systematic review. *Archives of Physical Medicine and Rehabilitation.* 2014;95(6):1174-1183.

64. Hong, I. and H.S. Bonilha. Psychometric properties of upper extremity outcome measures validated by Rasch analysis: a systematic review. *International Journal of Rehabilitation Research*. 2017;40(1):1-10.

65. Lemmens, R.J., et al. Valid and reliable instruments for arm-hand assessment at ICF activity level in persons with hemiplegia: a systematic review. *BMC Neurology.* 2012;12(1):21.

66.   Lord, S.E. and L. Rochester. Measurement of community ambulation after stroke: current status and future developments. *Stroke.* 2005;36(7):1457-1461.

67.   Martins, J.C., et al. Measurement properties of self-report physical activity assessment tools for patients with stroke: a systematic review. *Brazilian Journal of Physical Therapy.* 2019;23(6):476-490.

68.   McCabe, P., et al. Community reintegration following acquired brain injury. *Brain Injury.* 2007;21(2):231-257.

69.   Mudge, S. and N.S. Stott. Outcome measures to assess walking ability following stroke: a systematic review of the literature. *Physiotherapy.* 2007;93(3):189-200.

70.   Nichol, A.D., et al. Measuring functional and quality of life outcomes following major head injury: common scales and checklists. *Injury.* 2011;42(3):281-287.

71.   Oczkowski, C. and M. O'Donnell. Reliability of proxy respondents for patients with stroke: a systematic review. *Journal of Stroke and Cerebrovascular Diseases.* 2010;19(5):410-416.

72.   Pearson, O.R., et al. Quantification of walking mobility in neurological disorders. *QJM.* 2004;97(8):463-475.

73.   Pollock, C., J. Eng, and S. Garland Clinical measurement of walking balance in people post stroke: a systematic review. *Clinical Rehabilitation.* 2011;25(8):693-708.

74.   Rowland, T.J. and L. Gustafsson. Assessments of upper limb ability following stroke: a review. *British Journal of Occupational Therapy.* 2008;71(10):427-437.

75.   Salbach, N.M., et al. Considerations for the selection of time-limited walk tests poststroke: a systematic review of test protocols and measurement properties. *Journal of Neurologic Physical Therapy.* 2017;41(1): 3-17.

76.   Salter, K., et al. Issues for selection of outcome measures in stroke rehabilitation: ICF Body Functions. *Disability and Rehabilitation.* 2005;27(4):191-207.

77.   Salter, K., et al., Issues for selection of outcome measures in stroke rehabilitation: ICF Participation. *Disability and Rehabilitation.* 2005;27(9):507-528.

78.   Salter, K., et al. Issues for selection of outcome measures in stroke rehabilitation: ICF activity. *Disability and Rehabilitation.* 2005;27(6):315-340.

79.   Scrivener, K., C. Sherrington, and K. Schurr. A systematic review of the responsiveness of lower limb physical performance measures in inpatient care after stroke. *BMC Neurology.* 2013;13(1):4.

80.   Silva, P.F., et al. Measurement properties and feasibility of clinical tests to assess sit-to-stand/stand-to-sit tasks in subjects with neurological disease: a systematic review. *Brazilian Journal of Physical Therapy.* 2014;18(2):99-110.

81.   Simpson, L.A. and J.J. Eng. Functional recovery following stroke: capturing changes in upper-extremity function. *Neurorehabilitation and Neural Repair.* 2013;27(3):240-250.

82.   Sivan, M., et al. Systematic review of outcome measures used in the evaluation of robot-assisted upper limb exercise in stroke. *Journal of Rehabilitation Medicine.* 2011;43(3):181-189.

83.   Sorrentino G., S.P., Solaro C., Rabini A., Cerri C., Ferriero G. Clinical measurement tools to assess trunk performance after stroke: a systematic review. *European Journal of Physical and Rehabilitation Medicine.* 2018.

84.   Steins, D., et al. Wearable accelerometry-based technology capable of assessing functional activities in neurological populations in community settings: a systematic review. *Journal of Neuroengineering and Rehabilitation.* 2014;11(1):1-13.

85.   Stevens, P.M. Clinimetric properties of timed walking events among patient populations commonly encountered in orthotic and prosthetic rehabilitation. *Journal of Prosthetics and Orthotics.* 2010;22(1):62-74.

86.   Teale, E.A. and J.B. Young. A review of stroke outcome measures valid and reliable for administration by postal survey. *Reviews in Clinical Gerontology.* 2010;20(4):338-353.

87.   Tse, T., et al. Measuring participation after stroke: a review of frequently used tools. *Archives of Physical Medicine and Rehabilitation.* 2013;94(1):177-192.

88.   Tyson, S. and L. Connell. The psychometric properties and clinical utility of measures of walking and mobility in neurological conditions: a systematic review. *Clinical Rehabilitation.* 2009;23(11):1018-1033.

89.   van Bloemendaal, M., A.T. van de Water, and I.G. van de Port. Walking tests for stroke survivors: a systematic review of their measurement properties. *Disability and Rehabilitation.* 2012;34(26):2207-2221.

90.   Van Peppen, R.P., et al. The development of a clinical practice stroke guideline for physiotherapists in The Netherlands: a systematic review of available evidence. *Disability and Rehabilitation.* 2007;29(10):767-783.

91.   Velstra, I.-M., C.S. Ballert, and A. Cieza. A systematic literature review of outcome measures for upper extremity function using the international classification of functioning, disability, and health as reference. *PM&R.* 2011;3(9):846-860.

92.   Verceles, A.C. and E.R. Hager. Use of accelerometry to monitor physical activity in critically ill subjects: a systematic review. *Respiratory Care.* 2015;60(9):1330-1336.

93.   Verheyden, G., et al. Clinical tools to measure trunk performance after stroke: a systematic review of the literature. *Clinical Rehabilitation.* 2007;21(5):387-394.

94.   Wang, Q., et al. Interactive wearable systems for upper body rehabilitation: a systematic review. *Journal of Neuroengineering and Rehabilitation.* 2017;14(1):1-21.

95.   Wang, S., et al. Evaluation of performance-based outcome measures for the upper limb: a comprehensive narrative review. *PM&R.* 2018;10(9):951-962.

96.   Wilde, E.A., et al. Recommendations for the use of common outcome measures in traumatic brain injury research. *Archives of Physical Medicine and Rehabilitation.* 2010;91(11):1650-1660.

97.   Williams, G., V. Robertson, and K. Greenwood. Measuring high-level mobility after traumatic brain injury. *American Journal of Physical Medicine & Rehabilitation.* 2004;83(12):910-920.

98.   Zheng, H., N.D. Black, and N.D. Harris. Position-sensing technologies for movement analysis in stroke rehabilitation. *Medical and Biological Engineering and Computing.* 2005;43(4):413-420.

99.   Rose, M., et al. Evaluation of a preliminary physical function item bank supported the expected advantages of the Patient-Reported Outcomes Measurement Information System (PROMIS). *Journal of Clinical Epidemiology.* 2008;61(1):17-33.

100.   Al Zoubi, F., et al. Applying modern measurement approaches to constructs relevant to evidence-based practice among Canadian physical and occupational therapists. *Implementation Science.* 2018;13(1):1-21.

101.   Tsekleves, E., et al. Personalised stroke rehabilitation intervention using open source 3D software and the Wii Remote Plus. in Proc. 9th Intl Conf. Disabil. Virtual Real. Assoc. Technol., Laval, France. 2012.

102.   Fries, J. and D. Ramey. Platonic outcomes. *The Journal of Rheumatology.* 1993;20(3):415-417.

103. Ware Jr, J., M. Kosinski, and J. Bjorner. Item banking and the improvement of health status measures. *Quality of Life.* 2004;2:2-5.

104. Ware Jr, J.E., et al. Applications of computerized adaptive testing (CAT) to the assessment of headache impact. *Quality of Life Research.* 2003;12(8):935-952.

105. Cella, D. and J. Lai. Core item banking program: Past, present and future. *Quality of Life Research.* 2004; 13:6-11.

106. Heifetz, R.A., et al. The practice of adaptive leadership: Tools and tactics for changing your organization and the world. *Harvard Business Press.* 2009.

Table 1. Overview of the final banks of items identification from Clustering 3

Cluster number and name	Initial size	Outliers Removed (%)	Outliers reassigned (%)	Final size
1: Upper Extremity Mobility	126	0 (0)	82 (39)	**208**
2: Emotional Functions	119	37 (31)	93 (53)	**175**
3: Balance	125	32 (26)	57 (38)	**150**
4: Motor Control	131	31 (24)	10 (9)	**110**
5: Self-care	89	5 (6)	24 (22)	**108**
6: Social Life and Relationship	91	0 (0)	12 (12)	**103**
7: Cognition	55	3 (5)	40 (43)	**92**
8: Walking *(New)*	0	0 (0)	92 (100)	**92**
9: Postural Transition	107	32 (30)	15 (17)	**90**
10: Recreation and Leisure Activities	85	7 (8)	7 (8)	**85**
11: Domestic Life	64	4 (6)	15 (20)	**75**
12: Physical Functioning	55	6 (11)	18 (27)	**67**
13: Communication	27	0 (0)	25 (48)	**52**
14: Work/Study	22	0 (0)	8 (27)	**30**
15: Climbing *(New)*	0	0 (0)	28 (100)	**28**
16: Sensory Functions *(New)*	0	0 (0)	22 (100)	**22**
17: General Health *(New)*	0	0 (0)	20 (100)	**20**
18: Fatigue	13	0 (0)	6 (32)	**19**
19: Functional Independence	19	12 (63)	11 (61)	**18**
20: Pain	20	4 (20)	0 (0)	**16**
21: Alcohol and Drugs Use	14	0 (0)	0 (0)	**14**
22: Transportation	10	0 (0)	3 (23)	**13**
23: Sleeping *(New)*	0	0 (0)	13 (100)	**13**
24: Finances	10	0 (0)	1 (9)	**11**
Entirely Reassigned to cluster 2, 7 and 13	127	39 (31)	0 (0)	**0**
Entirely Reassigned to cluster 8 and 15	121	10 (8)	0 (0)	**0**
Entirely Reassigned to cluster 1 and 5	69	9 (13)	0 (0)	**0**
Entirely Reassigned to cluster 3	34	3 (9)	0 (0)	**0**
Entirely Reassigned to cluster 16 and 17	21	0 (0)	0 (0)	**0**
Entirely Reassigned to cluster 2	41	11 (27)	0 (0)	**0**
Entirely Reassigned to cluster 2	16	0 (0)	0 (0)	**0**

Table 2. The comprehensive outcome set of mobility defined conceptually based on the International Classification of Functioning, Disability, and Health, and Webber's frameworks

Cluster number and name	Definition
1. Upper Extremity Mobility	Defined as the ability to reach or rise up an object from one place to another, and perform the coordinated actions of handling, picking up, manipulating and releasing objects using one's hand, fingers and thumb.
2. Emotional Functions	Defined as mental functions related to the feeling including depression, anxiety, and anger.
3.Balance	Defined as the ability to maintain the body position within the base of support with minimal postural sway.
4. Motor Functions	Defined as functions associated with motor control and coordination of voluntary movements.
5. Self-care	Defined as the ability to caring for oneself, washing and drying oneself, dressing, eating, and drinking, and looking after one's health.
6. Social life and Relationship	Defined as the ability to carrying out the actions and tasks required for basic and complex interactions with people in a contextually and socially appropriate manner to engage in organized social life in community, social and civic areas of life.
7. Cognition	Defined as specific functions of the brain including memory and executive functions.
8. Walking	Defined as the ability to move along from point A to point B including, walking short or long distances; walking on different surfaces; and walking around and over obstacles.
9. Postural Transition	Defined as the ability to move from one surface to another without changing body position such as moving from a bed to a chair.
10. Recreation and Leisure Activities	Defined as the ability to engage in any form of play such as going to art galleries, museums, or cinemas for pleasure.
11. Domestic Life	Defined as the ability to carrying out everyday actions and tasks including caring for one's belongings and space, acquiring food, clothing and other necessities, household cleaning and repairing, caring for personal and other household objects, and assisting others.
12. Physical Functioning	Defined as the ability to do various activities that require increasing degrees of strength and endurance.
13. Communication	Defined as specific features of communicating by speaking or carrying on conversations, comprehending and comprehension.
14. Work/Study	Defined as the ability to engage in all aspects of work including seeking employment and getting a job, doing the required tasks or studies to get the job.
15. Climbing	Defined as the ability to move upwards or downwards over different surfaces such as climbing stairs.
16. Sensory Functions	Defined as functions of sense including vision, auditory, smell, touch, and taste.
17. General Health	Defined as the status of complete physical, mental, and social well-being.
18. Fatigue	Defined as functions related to respiratory and cardiovascular capacity for enduring physical exertion.
19. Functional Independence	Defined as the ability to perform an activity with no or little help from others.
20. Pain	Defined as an unpleasant feeling that indicates potential or actual damage to some body structure.
21. Alcohol and Drug use	Defined as substances that are harmful use for the mental.
22. Transportation	Defined as using transportation to move around such as being driven in a car.
23. Sleeping	Defined as a characteristic physiological change accompanied by general mental functions of intermittent, reversible, and selective physical and mental disengagement from one's immediate environment.
24. Finances	Defined as products, such as money which serve as an exchange for labour, goods, and services.

Figure 1. An overview of the proposed model

Sentence Embedding Process

Embeddings Clustering
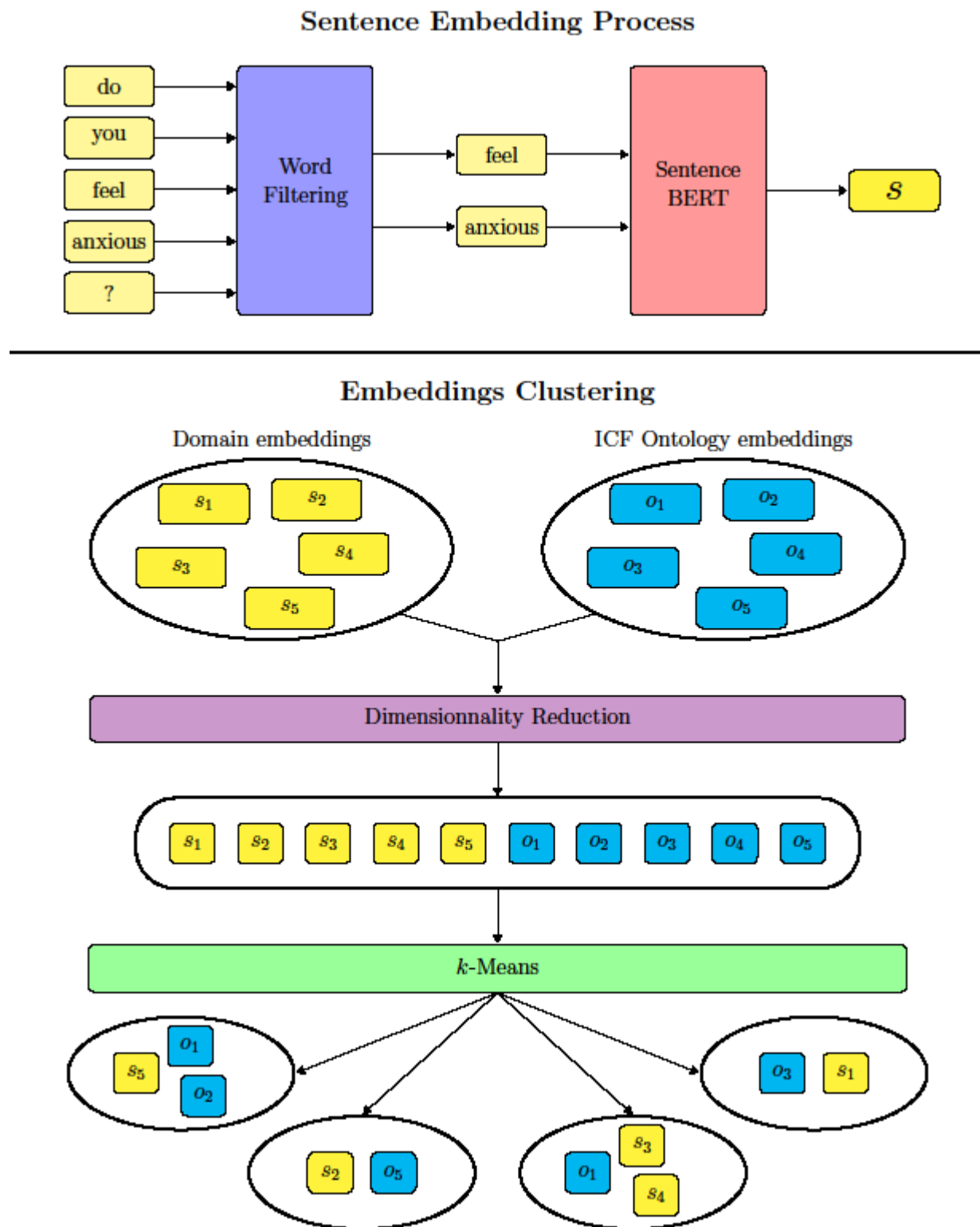
Figure 2. The iterative improvement process for preliminary banks of items process
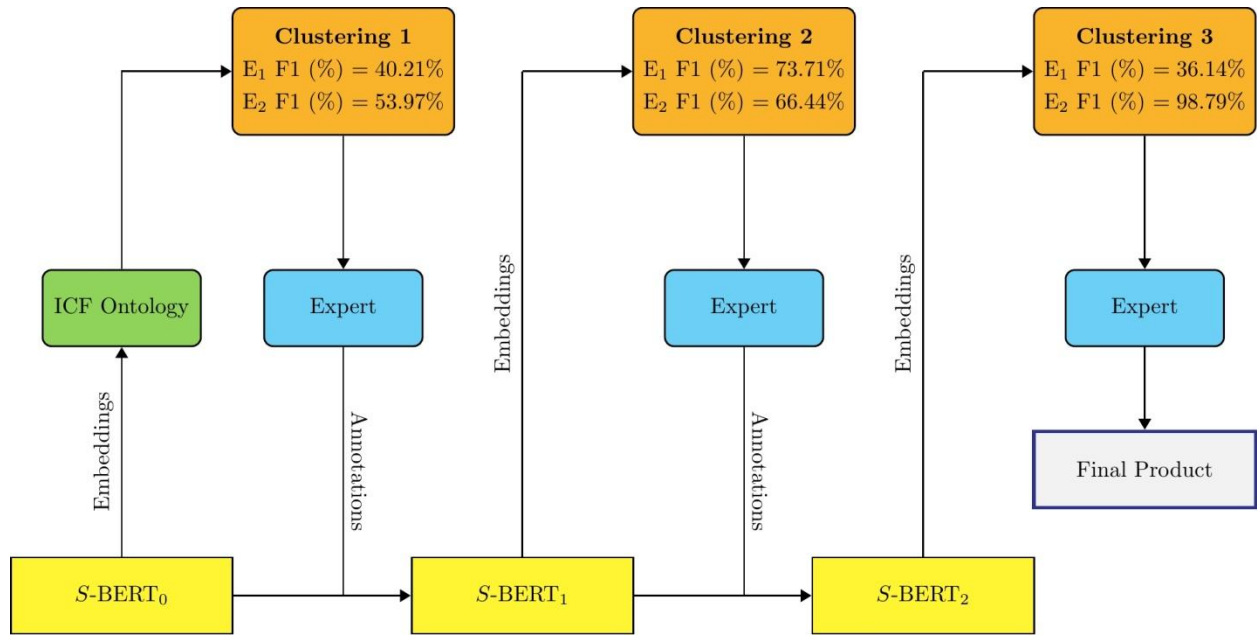
F1 score was reported for each clustering with respect to the first and second expert annotations, respectively named E1 and E2. Here, E2 is the most reliable metric, as it associates items with adequate labels, while E1 associates item pairs with whether or not they belong together. By nature, E1 penalizes having a large number of clusters, as seen on the third clustering's score. Noting that both E1 and E2 are not exact metrics, as, for instance, the third clustering still required heavy fine-tuning by experts to yield a satisfying Core Outcome Set despite the near-perfect E2 score.

Figure 3. PRISMA flowchart of the study selection

Identification

Potentially relevant systematic reviews identified
through database searching
n= 1290

Screening

Systematic reviews duplicated
(n = 175)

Systematic reviews screened
(n = 1115)

Systematic reviews excluded
(n = 1115)

Reasons:
- Not ABI: (n=326)
- Interventions: (n=306)
- Not mobility measures: (n=158)
- Not SR: (n=42)
- Not related to the aim of the study:
(n=204)

Eligibility

Full-text systematic reviews assessed
for eligibility
(n = 79)

Full-text systematic reviews excluded
with reasons
(n = 32)

Reasons:
-Not mobility measures: (n=7)
-non-structured reviews: (n=8)
-ABI <50%, mixed with orthopedic
conditions: (n=6)
-Protocol: (n=1)
-Not measurement study (n=10)

Included

Systematic reviews included in the
umbrella reviews
(n = 47)

Number of mobility measures n=246

Number of mobility domains
(n=474)
Number of mobility items (n=2109)

Figure 4. Identification of mobility outcome set and preliminary banks of items from the third final Clustering
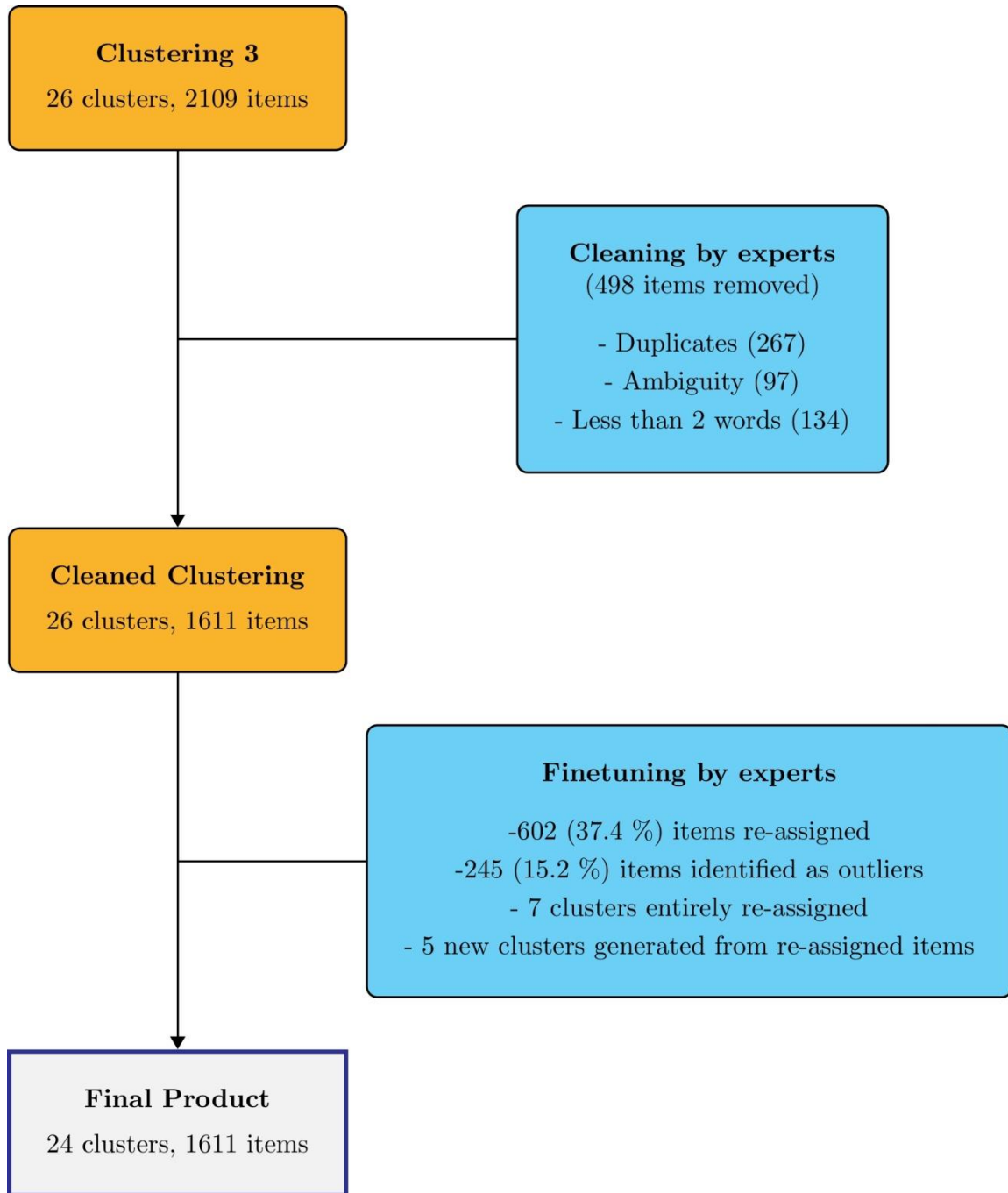
In the fine-tuning step, items were considered outliers when they did not match well enough with the cluster they were in (clustering inaccuracy). Re-assigned items are items that changed cluster between the Cleaned Clustering and the Final Product. Re-assigned items include outliers but also items that were part of a large cluster that was split to make smaller and more precise clusters.

CHAPTER 10 OVERALL CONCLUSION

The overall objective of this PhD thesis was to provide a common language and taxonomy of mobility to help compare and select mobility measures for clinical care and research among individuals with ABI (stroke and TBI). All studies in the thesis defined mobility comprehensively as the ability to move oneself within environments that expand from one's home to the neighbourhood and regions beyond. This comprehensive definition accounts for five "key" interrelated determinants of mobility, including cognitive, psychosocial, physical, environmental, and financial influences [1]. The multi-dimensionality and complexity of all domains that encompass mobility are also reflected in the International Classification, Functioning, Disability, and Health Framework (ICF) core set [2]. In this PhD thesis, we achieved the first step for defining the ontology by using traditional means, that is synthesising the scope of the ontology for mobility from the literature (Manuscript 1), and from the perspective of patients/caregivers, and clinicians (Manuscripts 2 & 3), and supplemented this with a machine learning informed synthesis of the literature (Manuscript 4). Figure 1 presents a comprehensive illustration for the PhD thesis.

10.1   Summary of the main findings from all manuscripts

The *First Manuscript* aimed to synthesize the measurement properties, the interpretability, and the feasibility of mobility measures, from various sources of information (patients, clinicians, technology), through an umbrella review of published systematic reviews among individuals with ABI (Stroke, TBI). A synthesis of evidence through an umbrella review of published systematic reviews on clinician, patient, and technology-reported mobility measures among individuals with ABI was required to provide a comprehensive review of appropriate measures of mobility for research and clinical practice. In this review, 85% of 147 mobility measures among 35 systematic reviews were mapped mainly to the ICF component of Activity and Participation. We used the JBI guidelines to direct the methodology for conducting the umbrella review [3], and the COSMIN guidelines for the systematic reviews of outcome measures [4]. Findings from this review showed that the systematic reviews' methodological quality using the JBI critical appraisal tool was relatively low, as 83% of systematic reviews did not apply COSMIN Risk of Bias checklist.

Although content validity is considered the most important measurement property [4], only 11% of measures were rated as "adequate" based on the definition provided by COSMIN guidelines accounting for relevance, comprehensiveness and comprehensibility of the measurement tool [4]. According to COSMIN guidelines [4], there is limited evidence of "High" quality of evidence for reliability, construct validity, and

responsiveness of the included measures, as the majority of systematic reviews included studies with a sample size ≤50 or did not report it. There was limited information reported in the systematic reviews on the interpretability and feasibility of mobility measures, as only 30% of mobility measures contained this information. Less information was provided in terms of scoring interpretability and floor and ceiling effects.

Results identified the mobility measures that were rated as "sufficient" for most measurement properties as well as interpretability and feasibility, including the Rivermead Mobility Index (RMI), 6-Minute Waking Test (6MWT), 10-Meter Walking Test (10MWT), Barthel Index (BI), Berg Balance Scale (BBS), Frenchay Activities Index (FAI), and Stroke Impact Scale (SIS) among individuals with stroke; and RMI and 6MWT among individuals with TBI. RMI and 6MWT have been used across the continuum of care, SIS and 10MWT were used in both sub-acute and chronic care settings, and FAI, BI and BBS were used in both acute and chronic care settings. These widely used measures, however, have limitations in that they cannot be used in certain contexts; for example, a patient with cognitive impairment or unable to change body position. Also, these measures did not consider real-life mobility, including both capacity and actual performance of mobility within one's home and community [1, 5]. Real-life mobility includes in-home mobility as part of domestic activities, and out-of-home mobility, such as purchasing daily necessities, recreation activities, and keeping up social relations. Also, mobility in real-life includes the use of assistive devices (e.g. wheelchair) and using transportation, such as trains and cars [6, 7]. The extent to which someone is mobile does not only depend on their physical ability to be mobile [8], since mobility is a complex, multi-dimensional construct influenced by many factors such as psychosocial [9]. Thus, decisions for selection of mobility measure(s) needs to consider applicability to all patients and different contexts.

To complement the literature review, focus groups were conducted to identify what mobility outcomes are important to stakeholders; facilitate understanding of why some mobility outcomes may be more important than others; determine the scope of mobility outcomes; and identify appropriate language for use in a future Delphi survey to create a Core Outcome Set for mobility.

The *Second Manuscript* aimed to identify factors influencing mobility that need to be considered while evaluating mobility, and incorporating patients' needs and preferences into individualized care management plans among individuals with ABI, as perceived by clinicians, individuals with ABI, and their caregivers. Through an in-depth inductive thematic analysis, four main themes emerged: (1) considering mobility holistically and individual needs, preferences, and unique experiences; (2) assessment and intervention guidelines; (3) having a caregiver,

healthcare, and social support network; and (4) uncertainty about symptoms and recovery. Also, through a deductive thematic analysis, using the 10-rule ICF linking process [10], identified domains within each theme were categorized into Body Functions, Activity and Participation, and Environmental Factors.

All participants defined mobility as a multi-dimensional construct and underscored the importance of considering bio-psychosocial factors when evaluating and treating mobility. In the sample of individuals with ABI, 80% of the participants indicated at least one mobility-related limitation post-ABI. Although mobility was their most significant concern, emphasis on factors hindering mobility was different between the groups. While discussing factors hindering mobility, most post-stroke survivors mentioned cognition and fatigue, whereas post-TBI survivors mentioned headache, nausea, fear, and dizziness. The clinicians were mostly concerned with individuals' safety and wanted to prevent falls. Participants with ABI discussed that cognitive impairments and sensitivity to stimulation have a considerable impact on their daily activities, resulting in developing psychological and emotional factors that would lead to self-isolation. Individuals with ABI experience a process of reconstitution of self in response to the burden of living with a deficit or disability. Restoring a sense of control and self-identity is essential for persons with ABI to be able to move and integrate into their community.

Overall, clinicians appeared to regard standardized measures used to evaluate mobility among ABI survivors as necessary, but acknowledged the complexity and challenges associated with measuring community mobility in ABI survivors. One challenge identified by participating clinicians was the lack of specific tools for measuring mobility, compelling clinicians to rely on a range of measures that infer mobility, such as tools to assess balance and walking. Even then, clinicians were not consistent as to which measures they believed should be used. Clinicians expressed the need to standardize the measurement of mobility to facilitate shared decision-making between clinician and patient about rehabilitation goals; facilitate evaluation of changes over time in a person's mobility; and to make comparisons between patient sub-groups. There is a need to consider measuring mobility at the endpoint of any given treatment decision or pathway. Also, there is a need to use an appropriate combination of instruments suitable for the clinical context, including patients, clinicians, and technology-based tools.

Individuals with ABI and the caregiver in this study preferred to be actively involved in the rehabilitation process, instead of only allowing clinicians to make judgments and decision on their behalf based merely on functional assessments. Clinicians tend to integrate the proficiency and judgment that they acquire through clinical practice in deciding on what tool and when to assess mobility using a standardized tool. Ideally, clinicians expressed

the need to consider patient preferences while evaluating mobility to tailor interventions and increase patient

engagement in carrying out the rehabilitation plan [11]. They should be encouraged to explore how treatment

preference matches patient goals, as well as the individuals' understanding of associated pros and cons. Treatment

preferences adapted to patients' goals should be seen as a process of shared decision making. Patients and clinicians

are expected to collaborate and make decisions together that are informed by the best available evidence and

genuinely aligned with patient preferences [12]. Thus, healthcare professionals must engage patients during all

stages of rehabilitation care by reviewing changes in their mobility and adjusting together the rehabilitation

treatment plan.

One way to address this problem could be by incorporating an oriented interdisciplinary teamwork

approach to incorporate patient-centred needs in care planning. Patient perspectives could also contribute to guiding

the development of patient-centred care and the selection of outcome measures and educational programs. Our

results showed that in the absence of a support network, patients may be less likely to participate when they feel

their emotional needs are not considered, resulting in a decreased sense of self-perception in conjunction with a

decreased sense of belonging [13, 14]. Thus, healthcare providers should communicate their understanding of a

patients' emotional response by actively listening and acknowledging patients' needs and preferences.

Given that the care process emerged when we explored factors influencing mobility evaluation with

clinicians and patients/caregiver, the *Third Manuscript* aimed to explore the care experiences and service design

related to rehabilitation for mobility and participation in the community among individuals with ABI, as perceived

by clinicians, individuals with ABI, and their caregivers. Through an in-depth inductive thematic analysis, five main

themes emerged from the perceptions of clinicians, individuals with ABI, and their caregivers. All themes align with

the patient-centred care concept, including (1) Enabling continuity of care; (2) System design; (3) Accessibility and

services in the community; (4) Transportation services; (5) Uncertainty about the provided services. Also, through a

deductive thematic analysis using the ten-rule ICF linking process [10], most of the identified domains within each

theme were mapped to the ICF Environmental Factors, perhaps because of the focus of this study related to explain

in-depth the available services that needed to improve mobility. Identifying environmental factors at societal level,

as a potential determinant that influences mobility, is crucial for maintaining independent mobility, and fully

integrates the patient's perspectives, experiences, and needs into every phase of medical consultation, evaluation,

treatment, and follow-up. For example, participation of individuals with disabilities in society is dependent on the use of accessible designs to remove physical environmental barriers in public and private facilities.

Results of this study showed that individuals with ABI experienced limited access to information related to recovery prognosis and to care planning following discharge from the acute setting. They felt they had insufficient information about waiting times when they were discharged from acute care and transitioning to outpatient rehabilitation. Patients also expressed that they had limited information about the available support services and resources in the community. Not getting the needed information can lead to fear, depression, and anxiety, which hinders mobility among individuals with ABI.

Additionally, limited information services can hinder engaging the patient into their care as well as information exchange between patients and clinicians [15]. Lack of knowledge and information can have a huge influence on recovery progress and impact patients' rehabilitation outcomes. Access to rehabilitation services was an important concern among individuals with ABI and their caregiver. They reported that access to rehabilitation services decreased as they progressed across the continuum of care. It was difficult to gain access to specialized rehabilitation services once discharged from acute care settings and (unfortunately) into non-existent care in community setting. While access to specialised ABI acute care was feasible, families needed to make substantial efforts to get rehabilitation services when they were re-integrating into the community. Participants with ABI explained that it was difficult to access rehabilitation services when they do not have a mobility disability. Evidence in the literature showed that most rehabilitation services offered to individuals with ABI concerned mobility limitations; however, fewer rehabilitation services were offered to individuals with cognitive, speech, or visual impairments [16]. It is essential that patients with ongoing impairments and functional limitations that remain after rehabilitation and which impact mobility continue to benefit from rehabilitation services in the community to ensure their safe re-integration into the community. Thus, raising awareness among the stakeholders about invisible disabilities and patients' needs would result in better accessibility to rehabilitation services among individuals with ABI.

There is a need to implement community education groups to better promote equitable rehabilitation services in the community. The community education groups may create new social networks, and participate in learning, educational, and therapeutic opportunities among individuals with ABI [17]. Community-based therapy [18], such as group exercise [19] or aphasia therapy [19, 20] would benefit from the development of coping

strategies and resilience and understanding physical limitations as well as emotional cues. Thus, collaboration between stakeholders would create a better therapeutic relationship between individuals with ABI, caregivers, and clinicians and could support empowerment of families of a person with ABI once she/he returns home.

A structured follow-up process, initiated at discharge, could improve access to healthcare services and help individuals with ABI search for services to address their needs. The problem of unequal access to follow-up care was brought to light in this, especially when patients experienced problems discovered at a later stage (e.g., cognitive impairments) indicating the need for long-term follow-up. In this study, clinicians in the rehabilitation setting felt that current follow-up services were sufficient; however, the follow-up only covered the first six months and did not provide continuity for longer-term support in the community. There is a lack of longer-term services that include holistic and coordinated support beyond the first six months [11].

One solution to providing long-term care and follow-up outside the hospital to individuals with ABI and their caregivers is using technology such as tele-rehabilitation and digital health to provide the needed care, education, and support. Tele-rehabilitation allows long-term follow up and more efficient and timely access to care, particularly for individuals with ABI who may have difficulty with transportation, or are isolated by their disability or live in rural areas. Thus, tele-rehabilitation is one strategy that allows clinicians to assess and treat patients in different environments, especially in the community, exchanging the needed information and providing guidance to their clients, while identifying problems early that may lead to further deterioration in health if not addressed [21].

Identified mobility measures and determinants among individuals with ABI, from literature (Manuscript 1), and as perceived from clinicians, individuals with ABI, and their caregivers (Manuscript 2 &3), will help inform the development of a comprehensive outcome set and the creation of preliminary banks of items for mobility among individuals with ABI (stroke and TBI). Given the myriad of domains of mobility and determinants that are needed in order to properly evaluate the impact of ABI on a person's mobility, we examined the potential value of machine learning to facilitate classification of mobility items.

The *Fourth Manuscript* aimed to identify a comprehensive outcome set of mobility, and develop preliminary banks of items of mobility among individuals with ABI using Natural Language Processing (NLP). It was established that it is possible to use a variety of existing instruments of mobility to build a preliminary banks of items with promising properties using unsupervised machine learning. This study identified 24 preliminary banks of items of mobility. These banks of items were reviewed by the experts and used to inform a preliminary

comprehensive outcome set of mobility among individuals with ABI including Upper Extremity Mobility,

Emotional Functions, Balance, Motor Control, Self-Care, Social Life and Relationship, Cognition, Walking,

Postural Transition, Recreation and Leisure Activities, Domestic Life, Physical Functioning, Communication,

Work/Study, Climbing, Sensory Functions, General Health, Fatigue, Functional Independence, Pain, Alcohol and

Drugs Use, Transportation, Sleeping, and Finances. The identified comprehensive outcome set of mobility includes

domain of mobility which covered all factors that are represented by Webber's framework, and most domains that

are identified in the comprehensive ICF core set for TBI and stroke, which need to be used to evaluate mobility

among individuals with ABI.

10.2   Main contributions

10.2.1   Creating mobility item banks

The National Institutes of Health's Patient-Reported Outcomes Measurement Information System

(PROMIS), the Quality of Life in Neurologic Disorders (Neuro-QoL) and The Traumatic Brain Injury Quality of

Life (TBI-QOL) initiatives have pioneered the development of PRO measures through developing item banks [22-

25]. These initiatives include mobility as a sub-domain. In PROMIS, mobility is a sub-domain for physical

functioning [26], while in TBI-QoL and Neuro-QoL mobility is considered as a sub-domain of physical health [24,

25]. These initiatives limited the conceptualisation of mobility to lower extremity function, despite the fact that

mobility is a multi-dimensional concept.

Typically, item banks created through extensive qualitative judgments take a long time as it requires

improving items as they are applied in different clinical and research contexts. As highlighted in Manuscript 4, the

use of NLP algorithms can accelerate the development of banks of items and synthesizes literature more efficiently

than if manually completed. As we iteratively improved the NLP algorithm, it became clear that expert knowledge

was the key factor in obtaining more accurate clustering. The development of NLP algorithms that extract and

process knowledge from text documents at a level that is usable by experts specifically tailored to mobility and ABI

population text led to successful deployments of NLP solutions for handling massive and complex data to create a

preliminary banks of items for mobility.

10.2.2   The role of NLP in developing the mobility ontology

NLP was used as a first appropriate step to develop the ontology for mobility, as it aimed at exploiting rich

knowledge resources (i.e. mobility measures (Manuscript 1), and its determinants (Manuscript 2 &3)) with the goal

of understanding, extracting, and retrieving from unstructured text to create a list of phrases or nouns of mobility. Knowledge resources that have been used for these purposes include the entire range of terminologies that define the construct of mobility among individuals with ABI.

While the literature (Manuscript 1) and text identified from the focus group discussions (Manuscript 2 &3) are major mechanisms for reporting new knowledge about the construct of mobility, the NLP methods have been developed and evaluated on words or sentences (from domains names and items) related to mobility that serve as important knowledge-rich resources for ontology learning [27]. Thus, an important consideration for the NLP method is to complete the mobility ontology using the natural-language terms.

10.2.3   Creating a mobility ontology

Developing an ontology for mobility in rehabilitation science is challenging, as it requires many steps that necessitate an agreed-upon consensus among stakeholders to provide standardized terminology for mobility among individuals with ABI. As we discussed in Chapter 1, ontologies, in information science, are data structures that define classes and the relations between those classes [28]. Developing the mobility ontology is an iterative process, and includes the following steps:

Step 1: The process of defining the scope of the ontology is often consensus-based and iterative. We started investigating the scope of mobility ontology by synthesizing mobility measures that were used to evaluate individuals with ABI through an umbrella review (Manuscripts 1). Then, we identified determinants that influence mobility through focus group discussions among clinicians, individuals with ABI, and their caregivers (Manuscripts 2 and 3). Once we defined all mobility measures and determinants of mobility, we mapped each identified domain to the ICF to standardize the language of mobility. As a prior step to develop the agreed-upon consensus Core Outcome Set, we used the NLP methodology as a rigorous method to inform the creation of a comprehensive outcome set and develop preliminary banks of items of mobility (Manuscript 4). We were then able to synthesize all the terminologies related to mobility to identify a common language that defines the construct of mobility. In this way, a Core Outcome Set can be developed through continuous agreed-upon consensus among stakeholders (future step). Also, clinicians and researchers can pick mobility items from the larger identified banks of items of mobility when needed (Manuscript 4).

Step 2: in the development of the mobility ontology, a controlled vocabulary need to be identified. Several complementary ongoing efforts focused on developing controlled vocabularies related to rehabilitation, including

the ICD 11 and the ICF ontologies. When developing a controlled vocabulary, an important step is to define synonymous and antonymous classes carefully and, ideally, to build on previous controlled vocabularies/ontologies whenever possible [29, 30]. The existing controlled vocabulary (and hierarchical structure, discussed next) from the ICF ontology will be adopted for the mobility ontology.

Step 3: is the creation of the hierarchical structure for the controlled vocabularies. For the mobility ontology, ICF's classes of "D: Activities and Participation" and (to a lesser degree) "E: Environmental Factors" will be used. A part of the draft ontology is shown in Figure 2. The numbering scheme follows ICF, and additions to ICF are shown with a period followed by lower-case letters (for example, d4201.a. health care use).

Step 4: is the establishment of relevant inter-relationships between key classes. In the mobility ontology, three types of non-hierarchical relationships will be specified: (1) Reverse_of which addresses cases from different parts of the hierarchy, where two domains are opposites. For example, "d469.a physical activity" is coded as the reverse_of "d5701.b resting." (2) Action_links includes domains that could be considered synonyms in certain circumstances and often exist in different parts of the hierarchy. For example, "d110.a watching tv" and "d469.b sedentary activity"; (3) Dimension_of, represents the domains that might be indistinguishable from a higher-class domain to a casual observer. For example, "d166. reading" is essential for some researchers as it leads to thinking and learning. For others, the material being read is important, such as reading religious/spiritual text for religious scholars, "d910.b reading spiritual text."

Step 5: includes codification of the ontology into a computer-readable format such as Web Ontology Language (OWL). This last step then enables the deployment of the mobility ontology. To date, no ontologies directly relevant to mobility evaluations or interventions have been encoded in OWL.

The purpose of developing the mobility ontology includes improving interoperability [31], improving information gathering [32], aiding medical education [33], administrative support [34], and improving clinical decision making [35]. Evolving the mobility ontology for rehabilitation science will help in influencing the decision making in choosing the proper evaluation and intervention among individuals with ABI. Furthermore, developing a mobility ontology with a focus on supporting multidisciplinary integrated care of individuals with ABI is required. Our ontological approach will recognize the quality of electronic health records (EHRs) influenced by the data, knowledge modeling, system architecture, implementation protocols, training and support, and associated knowledge management and information governance processes. Thus, the mobility ontology can potentially support

several categories of integration including: (1) data integration from different clinical data sources within and across EHRs; (2) knowledge integration from varied health and social professionals' knowledge; (3) clinical integration through linking clinical concepts; and (4) interdisciplinary integration by bringing multiple disciplines together to support multidisciplinary coordinated care and information exchange over the patient's journey through a complex network of clinical and bio-psychosocial factors and contexts.

We believe that using the mobility ontology for information extraction based on NLP is important in the sense that it does not only represent concepts with their semantic groups for clinical knowledge domains, but also has a structure for patient clinical data stored in the EHR system, which makes the patients' data more valuable and can be used to assist in the decision-making process. Furthermore, the mapping of the mobility ontology with the EHR databases ensures a step forward to convert unstructured data to structured data, accessible in the EHR databases, and thus can further be reasoned by decision support systems. Thus, using the mobility ontology to develop decision support systems inside the EHRs is needed.

10.2.4 Electronic health records and digital communication

In treating patients, clinicians are faced with questions such as "What is the patient's diagnosis?" and "When did symptoms start?" They are also faced with more complex questions related to reasoning such as "Why was a particular intervention given over another?" or "What were the other evaluations considered?" The data structures currently used within EHRs do not lend themselves readily to identifying answers to questions regarding clinical reasoning. Therefore, developing the mobility ontology based on NLP within EHR systems will allow us to categorize and organize the data, and forms the basis for a more sophisticated system that utilizes prior patient-specific clinician reasoning. In this way, data generated from EHRs can be used to compare interventions and evaluate outcomes to improve patient care.

The use of technology in improving data collection has seen a rise over the past few years, particularly in acquiring usable outcomes data from multiple sources such as patients, clinicians, and technology. The adoption of technological solutions has taken greater importance due to the COVID-19 pandemic; clinicians and patients alike are more likely to utilize technological means to communicate, and this also applies to communications between researchers and clinicians. Maximizing the use of data in technological solutions with agreed-upon terminologies and data coding for mobility are needed.

10.2.5　Data availability and interoperability

One possible technological avenue of health data enrichment consists of adopting some principles of crowd sourcing in order to acquire larger datasets. Free access to online data sources, including social media such as PatientsLikeMe [36], and recruitment of users who donate their social media and sensor data for research (e.g. OurDataHelps [37]) would greatly contribute to enlarging the datasets, as well as facilitate the capture of novel aspects of the data such as personalized models, timely predictions, and model interoperability. When combined with EHR data, this in turn could advance the rehabilitation field considerably, especially in light of better communication between stakeholders (researcher, data collectors, study participants, etc.), as well as facilitating keeping the patients' goals and values at the forefront of intervention design.

Interoperability standards would need to be developed in order to ensure that all parties involved (suppliers, patient-facing application developers, etc.) understands and share clear expectations for the content, context, and meaning of the data, and how the data are represented and shared. Since multiple applications and devices are used to maintain the integrity of data exchange across all platforms, these standards are essential.

Most solution attempts for interoperability to date have only focused on technical exchange of data in common formats. In developing interoperability standards, two major perspectives are in play: (1) reliable, consistent and seamless data exchange should be underpinned by a clear definition of the technical information exchange structure for instance, the use of the mobility ontology within the EHRs is an important element in the overall design of e-Health information systems; and (2) common underlying models and codification of the collected data elements using ontologies in digital environments should reflect the semantic structure for outcomes, for example, linking mobility measures and clinical terminologies to existing ontology (such as ICF). Items such as data dictionaries, classification systems, terminologies and ontologies [38] would be essential in enabling near real-time patient data collection and storage, and in bypassing the need for manual processing of data, ensuring that data are complete, consistent, conformant, and accurate. This would also remove the need for creating complex workarounds for data mapping. Another requirement for achieving data interoperability is the representation and interpretation of longitudinal data, which then becomes a communication between stakeholders in direct care systems. The digital communication would deliver significant benefits to EHR as long as it is incorporated into care and well-being strategies [39] in terms of standards for collecting, aggregating, analyzing, presenting, and visualizing data for the use of healthcare professionals.

10.2.6 The Biomedical Research and Informatics Living Laboratory for Innovative Advances of New Technologies in Community Mobility Rehabilitation (BRILLIANT) research program

There is a direct application of this PhD thesis to the BRILLIANT research program. The first objective of BRILLIANT is to identify factors limiting or enhancing mobility in real-world community environments (public spaces including the RehabMaLL, home, outdoors), and understand their complex interplay in individuals of all ages with ABI. The second objective of BRILLIANT is to customize community environment mobility training by continuously identifying the specific rehabilitation strategies and interventions that patient subgroups benefit from most. The thesis work will inform the optimal mobility outcome measures to include in the BRILLIANT health informatics solutions to collect relevant mobility outcome measures, using various sources of information (patient, clinicians and technology), in clinical practice and research. Moreover, these measures will be used to develop predictive algorithms that will inform which interventions work best for different individuals across various environments. Eventually, these predictive algorithms will be used within a mobility clinical decision support system that will provide patients and health professionals with evidence-based recommendations for mobility retraining. This work will contribute to the literature and scientific community a common vocabulary of the construct of mobility and their interrelationships (i.e. sharing a common understanding of mobility).

10.3 Implication of results

Sharing a common language and understanding of mobility through developing an ontology for mobility will help stakeholders to share and exchange knowledge, and make decisions about evaluating and treating mobility, as well as providing the needed services to support direct rehabilitation care for individuals with ABI.

10.3.1 Patient level

Improved mobility outcome measures can substantially improve standardised selection of clinical outcomes among individuals with ABI. Mobility outcome measures are important to use in rehabilitation in the hospital setting, home environment, and community to inform the clinical process, both at the individual level and at the service level to inform resource allocation. Optimal mobility measures could improve the quality of care, empower patients to take care of their own deficits and disabilities, and improve patients' outcomes in the community.

10.3.2 Clinician level

Identifying preliminary items banks for mobility may over time facilitate the process of selecting items that can evaluate all levels of mobility precisely. To develop effective individualized treatment plans and to compare

interventions, an understanding of the nature and severity of mobility challenges among individuals with ABI is needed, which requires a comprehensive assessment of impairments, activity limitations, and participation restrictions. The intervention plan varies depending on the patients' personal context, goals, and the complex interplay of the factors that influence mobility [1, 40]. Beyond mobility determinants, effective rehabilitation for mobility among individuals with ABI requires an oriented interdisciplinary teamwork approach across the continuum of care to facilitate information exchange; understand patient's needs; facilitate the task of engaging patients in their care; support the implementation of care in the community; and incorporate patient-centred needs supporting the optimal care planning for mobility for individuals with ABI.

10.3.3   Decision-maker level

Many individuals with ABI were unable to access rehabilitation services to continue improving their mobility due to limited organizational policies. There were also inequities in access to services reported by clinicians, patients, and caregivers, which contributed to a disempowering rehabilitation process and placed barriers on consistent, supported rehabilitation and recovery across the continuum of care. Standardized and comprehensive evaluations of mobility can help monitor rehabilitation programs that improve patients' outcomes. In turn, decisions can be made on how to modify services to better meet the needs of patients and prepare them to return to the community.

10.4   Strengths and limitations

10.4.1   Strengths

The main strength of this PhD thesis is that we have applied the ICF framework across all the manuscripts to unify the common language of measuring mobility. Also, we captured most mobility measures, as we included systematic reviews reporting (or not) measurement properties as well as mobility used in clinical practice. In Manuscript 1, COSMIN guidelines were used to evaluate the measurement properties, the methodological quality, and the interpretability and the feasibility for mobility measures used among individuals with ABI. Applying COSMIN guidelines standardized author's terminology in term of measurement properties. In Manuscripts 2 and 3, we analyzed the data using an inductive and a deductive thematic analysis of utterances. Combining these approaches allowed the development of patterns from the unknown parts that may fall outside the predictive codes of deductive reasoning and allowed for a more complete analysis. Also, using online platforms and virtual communication tools in conducting research activities are promising strategies for future research, especially in the

current pandemic crisis (COVID-19). In Manuscript 4, accounting for existing mobility measures identified from the literature as well as factors identified by clinicians, patients, and their caregivers in the focus group discussions results in creating preliminary banks of items for mobility using NLP. Using the rigorous NLP methodology to identify preliminary banks of items allowed us to test this approach as a more efficient tool to synthesize the literature that manually is nearly impossible.

10.4.2 Limitations

The main limitation that interferes with quality of evidence in Manuscripts 2 and 3 was related to sample size for participants with ABI and their caregivers, as they were recruited from one rehabilitation site. Because of the current pandemic (COVID19), rehabilitation sites became inaccessible due to global shutdowns, which made recruitment difficult. This forced us to continue the study virtually from patients' homes. Also, some participants with TBI faced challenges in using technology. Access to and ability and skill to proficiently and effectively make use of the technology was much lower in older individuals with TBI as compared to younger populations. In addition, some participants were living alone and experienced vision and cognitive impairments that affect their use of the technology. Last, some participants could not handle the 90-minute virtual meeting, as they were sensitive to stimulations. All the above factors limited our ability to recruit more individuals with ABI. Given the sample size issue and the inability to recruit more participants with ABI from all three rehabilitation centres, identifying mobility factors and services provision in different settings and among different conditions was limited, which in turn affects generalization of the results. Therefore, we were unable to reach saturation in the findings, and results should be interpreted cautiously. In Manuscript 4, while NLP approaches automate textual tasks, the automation quality is only as good as the knowledge it is based on. Thus, the quality of our results needs to be validated by the expert knowledge.

10.5 Future directions

Identified preliminary comprehensive outcome set and preliminary banks of items of mobility taxonomies among individuals with ABI needs further analysis to reach an agreed-upon consensus of mobility Core Outcome Set. Thus, a Delphi approach will be utilized to achieve expert consensus to examine mobility constructs, and assess patient views on importance, clarity, and relevance of the domains and items of mobility. The Core Outcome Set for mobility is needed in order to unify the language of measuring mobility among individuals with ABI, and standardise measures used across clinical sites and studies. A Core Outcome Set developed by researchers and

patients allows interventions to be evaluated by using an agreed-upon set of outcomes that can be compared across studies, and clinical care programs and settings. A defined Core Outcome Set of mobility domains to measure consistently can substantially improve clinical research and make the research process more efficient.

Second, developing an ontology for mobility in rehabilitation science is important in order to provide standardized terminology for mobility measures. Also, this development is akin to defining a set of data and their structure for other programs to use. For example, evolving the ontology for mobility for rehabilitation science will help in analyzing an inventory list of mobility domains and suggest which domain can be expanded to choose the best source of information (patient, clinician, technology) to evaluate mobility. Another application from the mobility ontology will be in influencing the decision making in choosing the proper intervention among individuals with ABI. Also, a mobility ontology could help in clinical reasoning to reach decisions regarding a patient [41]. In treating patients, clinicians are faced with complex questions related to reasoning such as "Which intervention should be delivered?" or "What were the other diagnoses considered?" The data structures currently used within the EHRs are not ready for identifying answers to questions regarding clinical reasoning. Therefore, developing a mobility ontology will allow us to categorize and organize the data, and forms the basis for a more sophisticated system that utilizes prior patient-specific clinician reasoning.

10.6   References

1.   Webber, S.C., M.M. Porter, and V.H. Menec. Mobility in older adults: a comprehensive framework. *The Gerontologist.* 2010;50(4):443-450.

2.   World Health Organization. *International Classification of Functioning, Disability and Health: ICF*. Geneva; 2001.

3.   Aromataris, E., et al. Summarizing systematic reviews: methodological development, conduct and reporting of an umbrella review approach. *International Journal of Evidence-based Healthcare.* 2015; 13(3):132-140.

4.   Prinsen, C., et al. COSMIN guideline for systematic reviews of patient-reported outcome measures. *Quality of Life Research.* 2018;27(5):1147-1157.

5.   Frank, J.S. and A.E. Patla. Balance and mobility challenges in older adults: implications for preserving community mobility. *American Journal of Preventive Medicine.* 2003;25(3):157-163.

6.   Amireault, S., G. Godin, and L.-A. Vézina-Im. Determinants of physical activity maintenance: a systematic review and meta-analyses. *Health Psychology Review.* 2013;7(1):55-91.

7.   Rantakokko, M., et al. Associations between environmental characteristics and life-space mobility in community-dwelling older people. *Journal of Aging and Health.* 2015;27(4):606-621.

8.   Giannouli, E., et al. Mobility in old age: capacity is not performance. *BioMed Research International.* 2016.

9.   Thompson, D., et al. Multidimensional physical activity: an opportunity not a problem. *Exercise and Sport Sciences Reviews.* 2015;43(2):67.

10.   Cieza, A., et al. Refinements of the ICF linking rules to strengthen their potential for establishing comparability of health information. *Disability and Rehabilitation.* 2019;41(5):574-583.

11.   Kjörk, E.K., et al. Experiences, needs, and preferences for follow-up after stroke perceived by people with stroke and healthcare professionals: A focus group study. *PloS One.* 2019;14(10):e0223338.

12.   Krishnan, S., et al. Patient-centered mobility outcome preferences according to individuals with stroke and caregivers: a qualitative analysis. *Disability and Rehabilitation.* 2018;40(12):1401-1409.

13.   Hole, E., et al. The patient's experience of the psychosocial process that influences identity following stroke rehabilitation: a metaethnography. *The Scientific World Journal.* 2014.

14.   Epstein, R.M. and R.L. Street. The values and value of patient-centered care. *Annals Family Medicine*. 2011.

15.   Clarke, S., et al. Defining elements of patient-centered care for therapeutic relationships: A literature review of common themes. *European Journal for Person Centered Healthcare*. 2017;5(3):362-372.

16.   Vincent, C., et al. Provision of rehabilitation services in Québec following stroke: a comparative survey conducted by postal questionnaire. *Canadian Journal on Aging*. 2010;29(2):193-203.

17.   Hou, S.-I. Health education: theoretical concepts, effective strategies and core competencies. *Health Promotion Practice.* 2014;15(5):619-621.

18.   Graven, C., et al. Stroke survivor and carer perspectives of the concept of recovery: a qualitative study. *Disability and Rehabilitation.* 2013;35(7):578-585.

19.   Mayo, N.E., et al. Getting on with the rest of your life following stroke: a randomized trial of a complex intervention aimed at enhancing life participation post stroke. *Clinical Rehabilitation.* 2015;29(12):1198-1211.

20.   Gallacher, K., et al. Uncovering treatment burden as a key concept for stroke care: a systematic review of qualitative research. *PLoS Medicine.* 2013;10(6):e1001473.

21.   Parmanto, B. and A. Saptono. Telerehabilitation: State-of-the-art from an informatics perspective. *International Journal of Telerehabilitation.* 2009;1(1):73.

22.   Cella, D., et al. The Patient-Reported Outcomes Measurement Information System (PROMIS) developed and tested its first wave of adult self-reported health outcome item banks: 2005–2008. *Journal of Clinical Epidemiology.* 2010;63(11):1179-1194.

23.   Hays, R.D., et al. Upper-extremity and mobility subdomains from the Patient-Reported Outcomes Measurement Information System (PROMIS) adult physical functioning item bank. *Archives of Physical Medicine and Rehabilitation.* 2013;94(11):2291-2296.

24.   Cella, D., et al. Neuro-QOL: brief measures of health-related quality of life for clinical research in neurology. *Neurology.* 2012;78(23):1860-1867.

25.   Tulsky, D.S. and P.A. Kisala. An overview of the traumatic brain injury–quality of life (TBI-QOL) measurement system. *The Journal of Head Trauma Rehabilitation.* 2019;34(5):281-288.

26. Rose, M., et al. Evaluation of a preliminary physical function item bank supported the expected advantages of the Patient-Reported Outcomes Measurement Information System (PROMIS). *Journal of Clinical Epidemiology.* 2008;61(1):17-33.

27. Liu, K., W.R. Hogan, and R.S. Crowley. Natural language processing methods and systems for biomedical ontology learning. *Journal of Biomedical Informatics.* 2011;44(1):163-179.

28. Arp, R., B. Smith, and A.D. Spear. Building ontologies with basic formal ontology. *Mit Press.* 2015.

29. McMurry, J.A., et al. Identifiers for the 21st century: How to design, provision, and reuse persistent identifiers to maximize utility and impact of life science data. *PLoS Biology.* 2017;15(6):e2001414.

30. Smith, B., W. Kusnierczyk, and W. Ceusters. Towards a reference terminology for ontology research and development in the biomedical domain. 2006.

31. Diaz, M.A.C., L. Antonelli, and L.E. Sanchez. Health ontology and information systems: a systematic review. *IEEE Latin America Transactions.* 2017;15(1):103-120.

32. Sadki, F., et al. Semantically Structured Web Form and Data Storage: A Generic Ontology-Driven Approach Applied to Breast Cancer. *EFMI-STC.* 2018.

33. Budovec, J.J., C.A. Lam, and C.E. Kahn Jr. Informatics in radiology: radiology gamuts ontology: differential diagnosis for the Semantic Web. *Radiographics.* 2014;34(1):254-264.

34. Wilk, S., et al. Using semantic components to represent dynamics of an interdisciplinary healthcare team in a multi-agent decision support system. *Journal of Medical Systems.* 2016;40(2):1-12.

35. Mohammed, O. and R. Benlamri. Developing a semantic web model for medical differential diagnosis recommendation. *Journal of Medical Systems.* 2014;38(10):1-18.

36. Bellika, J., et al. Text Mining of Web-based Medical Content. Walter de Gruyter GmbH & Co KG. 2014;(1).

37. Sun, W., A. Rumshisky, and O. Uzuner. Evaluating temporal relations in clinical text: 2012 i2b2 Challenge. *Journal of the American Medical Informatics Association.* 2013;20(5):806-813.

38. Eccher, C., et al. An ontology of cancer therapies supporting interoperability and data consistency in EPRs. *Computers in Biology and Medicine.* 2013;43(7):822-832.

39. Gann, B. Digital inclusion in health and care in Wales. Caerphilly: Wales Co-operative Centre with Carnegie UK Trust. 2018.

40.   Tsekleves, E., et al. Personalised stroke rehabilitation intervention using open source 3D software and the Wii Remote Plus. in Proc. 9th Intl Conf. Disabil. Virtual Real. Assoc. Technol., Laval, France. 2012.

41.   Dissanayake, P.I., T.K. Colicchio, and J.J. Cimino. Using clinical reasoning ontologies to make smarter clinical decision support systems: a systematic review and data synthesis. *Journal of the American Medical Informatics Association.* 2020;27(1):159-174.

Figure 1. A comprehensive illustration for the PhD thesis
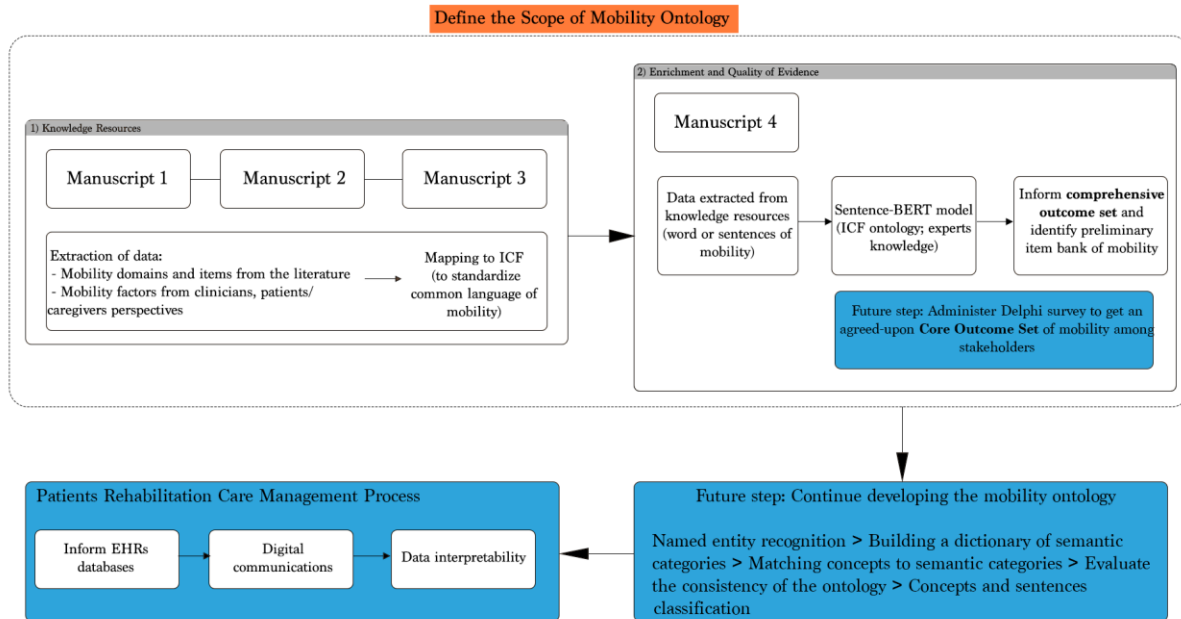
Figure 2. The creation of the hierarchical structure for the controlled vocabularies in the ICF ontology (partial view)
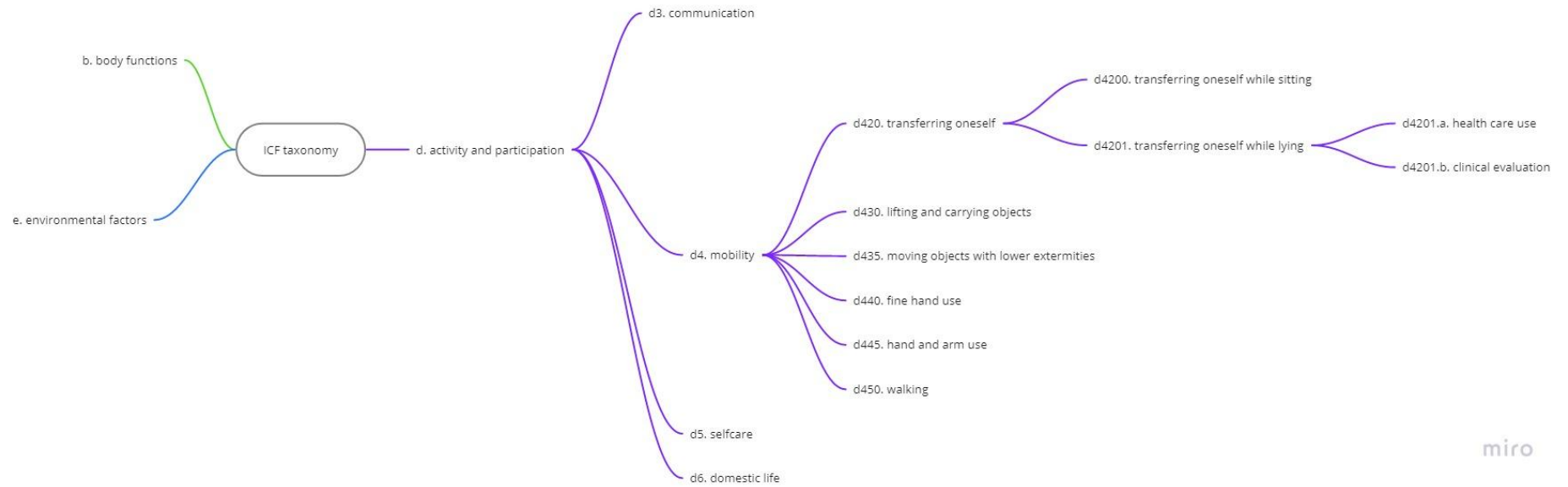
APPENDICES

Appendices of Chapter 3

Appendix 1. Ovid Medline search strategy

#	Searches	Results
1	Brain Injuries/ or Acquired brain injury.mp.	50721
2	stroke.mp. or exp Stroke/	270322
3	traumatic brain injury.mp. or exp Brain Injuries, Traumatic/	35483
4	Brain Injuries/ or non-traumatic brain injury.mp.	50222
5	Brain Injuries/ or non traumatic brain injury.mp.	50222
6	1 or 2 or 3 or 4 or 5	334129
7	performance based outcome*.mp.	74
8	performance-based outcome.mp.	38
9	"Process Assessment (Health Care)"/ or process assessment*.mp.	29528
10	process measure*.mp. or "Outcome and Process Assessment (Health Care)"/	26774
11	"Outcome Assessment (Health Care)"/ or clinician report outcome*.mp.	63956
12	clinician report measure*.mp.	13
13	"Surveys and Questionnaires"/ or Patient report measure*.mp.	400844
14	"Surveys and Questionnaires"/ or patient report measure*.mp.	400844
15	"Surveys and Questionnaires"/ or Self-report measure*.mp.	407827
16	"Outcome Assessment (Health Care)"/ or Self-report outcome*.mp. or "Surveys and Questionnaires"/	458479
17	"Outcome Assessment (Health Care)"/ or technology based measure*.mp.	63961
18	technology-based measure*.mp.	5
19	"Outcome Assessment (Health Care)"/ or technology based outcome*.mp.	63957
20	Accelerometry/ or Acceleromet*.mp. or Monitoring, Ambulatory/	19895
21	Monitoring, Ambulatory/ or Pedometer.mp. or Monitoring, Physiologic/	59907
22	Monitoring, Ambulatory/ or Gyroscope wearable system.mp. or Biofeedback, Psychology/	14272
23	Activity monitor.mp.	1257
24	"Outcome Assessment (Health Care)"/ or Physical science technique*.mp.	63960
25	Clinimetry.mp.	9
26	Observational technique*.mp.	130
27	"Surveys and Questionnaires"/ or Diaries.mp.	407596
28	"Surveys and Questionnaires"/ or Questionnaire*.mp.	633534
29	Physiological technique*.mp.	258
30	Actigraphy.mp. or Actigraphy/	4714
31	Monitoring, Physiologic/ or Ambulatory activity monitor*.mp.	51290
32	Accelerometry/ or Monitoring, Physiologic/ or Activity monitor*.mp. or Monitoring, Ambulatory/	63895
33	Patient Outcome Assessment/ or Patient outcome assessment*.mp.	4033
34	Patient Reported Outcome Measures/ or "Outcome Assessment (Health Care)"/ or "Surveys and Questionnaires"/ or Patient report outcome measure*.mp.	459542
35	Telemedicine/ or telemonitoring.mp. or Monitoring, Ambulatory/ or Monitoring, Physiologic/	75213
36	Telemedicine/ or tele-monitoring.mp. or Monitoring, Ambulatory/	24415
37	Monitoring, Ambulatory/ or Home monitoring.mp.	8746
38	Digital monitoring.mp.	45
39	Monitoring, Ambulatory/ or Web based monitoring.mp.	7460
40	Web-based monitoring.mp. or Monitoring, Ambulatory/	7460

#	Searches	Results
41	Internet based monitoring.mp.	29
42	mobility.mp.	146819
43	mobilit*.mp.	151687
44	activity.mp.	2551450
45	gait.mp. or Gait/	51056
46	walk*.mp. or Walking/	109205
47	lower limb.mp. or Lower Extremity/	39175
48	Lower limb activity.mp. or Lower Extremity/	14998
49	Movement/ or sit to stand.mp.	70042
50	Climb* stair*.mp.	761
51	Wheelchair.mp. or Wheelchairs/	7195
52	performance based measure*.mp.	688
53	Movement/ or movement.mp.	365518
54	7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 52	826617
55	balance.mp. or POSTURAL BALANCE/	223878
56	Walking/ or community ambulation.mp.	28610
57	42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 55 or 56	3276423
58	STROKE REHABILITATION/ or rehabilitation.mp. or NEUROLOGICAL REHABILITATION/ or REHABILITATION/	286767
59	instrumentation.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	631636
60	methods.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	6625341
61	Validation Studies.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	96216
62	Comparative Study.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	1829711
63	psychometrics.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	68799
64	(psychometr* or clinimetr* or clinometr*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	85815
65	(outcome assessment health care or outcome assessment or outcome measure*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	259515
66	(observer variation or observer variation or Health Status Indicators or reproducibility of results or reproducib* or discriminant analysis or reliab* or unreliab* or valid* or coefficient or homogeneity or homogeneous or internal consistency).mp. [mp=title, abstract, original title, name of substance	1540652

#	Searches	Results
	word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	
67	(cronbach* alpha or alphas or item correlation* or selection* or reduction* or agreement or precision or imprecision or precise values or test-retest or test retest).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	1938724
68	(reliab* test or retest or stability or interrater or inter-rater or intrarater or intra-rater or intertester or inter-tester or intratester or intra-tester or interobserver or inter-observer or intraobserver or intraobserver or intertechnician or inter-technician or intratechnician or intra-technician).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	461820
69	(interexaminer or inter-examiner or intraexaminer or intra-examiner or interassay or inter-assay or intraassay or intra-assay or interindividual or inter- individual or intraindividual or intra-individual).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub- heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	41687
70	(interparticipant or inter-participant or intraparticipant or intra-participant or kappa or kappas or repeatab).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	132266
71	(replicab or repeated measure or measures or findings or result or results or test or tests or generaliza*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	10418234
72	(generalisa* or concordance or intraclass correlation* or discriminative or known group or factor analysis or factor analyses).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	127347
73	(dimension* or subscale* or multitrait scaling analysis or analyses or item discriminant).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	1308767
74	(interscale correlation* or error or errors or individual variability or variability analysis or values or uncertainty measurement or measuring).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	1622787
75	(standard error of measurement or sensitiv* or responsive* or minimal or minimally or clinical).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	5294004
76	(clinically important or significant or detectable change or difference or small*real or detectable change).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	3430257
77	(difference or meaningful change or ceiling effect or floor effect or Item response model).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol	952375

#	Searches	Results
	supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	
78	(IRT or Rasch or Differential item functioning or DIF or computer adaptive testing or item bank or cross-cultural equivalence).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	8655
79	58 or 59 or 60 or 61 or 62 or 63 or 64 or 65 or 66 or 67 or 68 or 69 or 70 or 71 or 72 or 73 or 74 or 75 or 76 or 77 or 78	16827007
80	(instrumentation or Validation Studiies or reproducibility of results or reproducib* or psychometrics).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	1081784
81	(psychometr* or clinimetr* or clinometr* or observer variation or observer variation or discriminant analysis).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	143788
82	(reliab* or valid* or coefficient or internal consistency or cronbach* alpha or alphas or item correlation or item correlations).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	1106012
83	(item selection or item selections or item reduction or item reductions or agreement or precision or imprecision).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	359742
84	(precise values or test-retest or test retest or reliabtest or retest or stability or interrater or inter-rater).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	436899
85	(intrarater or intra-rater or intertester or inter-tester or intratester or intra-tester or interobserver or inter-observer).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	25824
86	(intraobserver or intra-observer or intertechnician or intertechnician or intratechnician or intra-technician or interexaminer or inter-examiner or intraexaminer).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	11004
87	(intra-examiner or interassay or inter-assay or intraassay or intra-assay or interindividual or inter-individual or intraindividual or intra-individual).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	40346
88	(interparticipant or inter-participant or intraparticipant or intra-participant or kappa or kappas or coefficient of variation).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	152787
89	(repeatab* or replicab* or repeated measure or measures or findings or result or results or test or tests).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	10414057
	(generaliza* or generalisa* or concordance or intraclass correlation* or discriminative or known	

#	Searches	Results
90	group or factor analysis).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	159663
91	(factor analyses or factor structure or factor structures or dimensionality or subscale* or multitrait scaling analysis).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	58747
92	(multitrait scaling analyses or item discriminant or interscale correlation or interscale correlations).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	282
93	(error or errors measure* or correlat* or evaluat* or accuracy or accurate or precision or mean).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	5943737
94	(individual variability or interval variability or rate variability or variability analysis or uncertainty measurement or measuring).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	274144
95	(standard error of measurement or sensitiv* or responsive* or limit detection or minimal detectable concentration).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	1698114
96	(interpretab* or small* real or detectable change or difference).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	959743
97	(meaningful change or minimal important change or minimal important difference or minimally important change).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	1215
98	(minimally important difference or minimal detectable change or minimal detectable difference).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	1171
99	(minimally detectable change or minimally detectable difference or minimal real change).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	23
100	(minimal real difference or minimally real change or minimally real difference).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	4
101	(ceiling effect or floor effect or Item response model or IRT or Rasch).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	7840
102	(Differential item functioning or DIF or computer adaptive testing or item bank or cross-cultural equivalence).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare	3589

#	Searches	Results
	disease supplementary concept word, unique identifier, synonyms]	
103	80 or 81 or 82 or 83 or 84 or 85 or 86 or 87 or 88 or 89 or 90 or 91 or 92 or 93 or 94 or 95 or 96 or 97 or 98 or 99 or 100 or 101 or 102	13729406
104	79 or 103	17444095
105	6 and 54 and 57 and 104	3139
106	limit 105 to (meta analysis or "review" or systematic reviews)	1290

Appendix 2. The characteristics of the included systematic reviews

Author (year)	Country	Objective or research question	Population	SOI	Search strategy data source/date range of included studies	Number of sub-studies	Method for conducting the systematic review	Number of identified measures	Critical appraisal	Apply the ICF framework	Recommended outcome measures
Ashford (2008) [1]	UK	To identify valid and reliable outcome measures that have been applied to assess changes following focal rehabilitation interventions in the hemiparetic upper limb in the context of stroke or brain injury, and are reflective of "real-life" function, for both active and passive tasks.	Stroke & TBI	PRO SRO	Medline, CINAHL, BIDS Science Citation Index, EMBASE, Specialized Register of Stroke Trials, National Health Service National Research, MRC Clinical Trials Directory, the Cochrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effects (DARE), Google, ProFusion and SIGLE (medical/rehabilitation grey literature). Other sources were reference lists from papers identified, conference proceedings, books and book chapters and communication with lead authors of published studies and other researchers/Inception to May 2008	84	NR	5	No	No	ABILIHAND
Ashford (2015)[2]	UK	To identify valid and reliable patient (and/or carer) reported outcome measures that have been applied to assess changes following focal rehabilitation. Interventions in the lower limb in the context of stroke or brain injury, and are reflective of 'real-life' function (activity according to the ICF for both active and passive function tasks.	Stroke & TBI	PRO SRO	Ovid MEDLINE, CINAHL, Embase, Web of Science, Pubmed, National Health Service National Research Register, MRC Clinical Trial directory, Database of Abstracts of Reviews of effect (DARE), Google Scholar, Cochrane Database of Systematic Reviews/NR	22	PRISMA	7	Yes /COSMIN	Yes	Rivermead Mobility Index
Baker (2011) [3]	UK	To present a scale selection strategy for evidence-based scale selection in stroke research.	Stroke	ClinRO PerfO PRO SRO	Medline, Embase (Excerpta Medica), CINAHL, and PsycINFO/from 1966 to 2011	NR	NR	5	No	Yes	Chedoke Arm and Hand Inventory Stroke Rehabilitation Assessment of Movement upper limb section

Author (year)	Country	Objective or research question	Population	SOI	Search strategy data source/date range of included studies	Number of sub-studies	Method for conducting the systematic review	Number of identified measures	Critical appraisal	Apply the ICF framework	Recommended outcome measures
											ABILHAND
Barak (2006) [4]	USA	To provide a comprehensive overview of the issues in selecting stroke outcome measures and to characterize existing measures relative to these issues.	Stroke	ClinRO PerfO PRO SRO	NR/NR	NR	NR	27	No	Yes	NR
Connel (2012) [5]	UK	To review the psychometric properties and clinical utility of upper limb impairment and activity in people with neurologic conditions.	Stroke & TBI	ClinRO PerfO PRO SRO	MEDLINE, CINAHL, EMBASE, PEDro, AMED/ inception to September 2009	NR	Standardized accepted guidelines from previous published	10	No	Yes	Box and Block test Action Research Arm test
Croarkin (2004) [6]	USA	To review all available literature relative to upper extremity motor function tests used for people during rehabilitation following a stroke; to develop and use criteria to select tests and relevant literature; to rate tests relative to available psychometric evidence that supports the use of upper extremity motor function testing following a stroke.	Stroke	ClinRO PerfO	Pubmed, CINAHL/from 1983 to December 1999	13	NR	9	No	No	Box and Block Test Jebsen Hand Function Test
Fini (2015) [7]	Australia	To describe how physical activity is monitored following stroke, including identification of methods and devices used across the stroke pathway (from acute care to community). The secondary aim was to describe the reported psychometric properties (reliability and validity) of these measurements.	Stroke	TechO	MEDLINE, CINAHL, EMBASE, Cochrane Library, PEDro/Inception to February 2014	91	NR	14	No	No	NR
Gebruers (2010) [8]	Belgium	To assess the clinometric properties and clinical applicability of different accelerometer-based measurement techniques in persons with stroke.	Stroke	TechO	PubMed, EMBASE, CINAHL, Cochrane Library of Clinical Trials/Inception to September 2008	25	NR	14	No	No	NR
Geroin (2013)	Italy	To identify appropriate selection criteria of clinical scales for	Stroke	ClinRO PerfO	MEDLINE, EMBASE, CINALH, Pub-Med,	27	Standardized accepted	6	No	Yes	10-meter walking test

Author (year)	Country	Objective or research question	Population	SOI	Search strategy data source/date range of included studies	Number of sub-studies	Method for conducting the systematic review	Number of identified measures	Critical appraisal	Apply the ICF framework	Recommended outcome measures
[9]		future trials, starting from those most commonly used in the literature, according to their psychometric properties and ICF domains		PRO SRO	PsychINFO and Scopus databases/ from January 2000 to January 2012		guidelines from previous published				Motricity index 6-meter walking test Berg Balance Scale Rivermead Mobility Index Functional Ambulation Category
Gor-Garcı́a-Fogeda (2014) [10]	Spain	To compile all scales available in the scientific literature that assess gross motor function in stroke; to establish which specific aspects of gross motor function they assess; to study their psychometric properties.	Stroke	ClinRO PerfO PRO SRO	MEDLINE, PEDro, ISI Web of Knowledge, and Cumulative Index to Nursing and Allied Health (CINAHL)/ from March 2011 to January 2014	19	NR	7	No	No	Stroke rehabilitation assessment of movement Fugl-Meyer Assessment
Hong (2016) [11]	USA	To provide the psychometric properties of upper extremity outcome measures validated by the Rasch model and assess the extent to which their measurement areas cover the domains of the International Classification of Functioning, Disability and Health model.	Stroke & neurological conditions	ClinRO PerfO PRO SRO	PubMed, CINAHL, Scopus, PsycINFO, Ovid/MEDLINE, ERIC, and Cochrane library/ from January 1966 to March 2014	22	NR	15	No	Yes	NR
Lemmens (2012) [12]	Netherland	To identify and evaluate the available instruments to assess arm-hand skilled performance in patients with stroke; to categorize the available instruments into the category's capacity, perceived performance, and actual performance. Instruments for which no data about the validity and reliability was available were not included in this study.	Stroke	ClinRO PerfO	PubMed, CINAHL, EMBASE, Cochrane, PsychINFO, IEEE and Scopus/Inception to November 2010	747	NR	21	No	Yes	NR
Martins (2019) [13]	Brazil	To summarize both the measurement properties and clinical utility of self-report measures of physical activity levels of subjects with stroke and to evaluate both the methodological quality of the studies on measurement	Stroke	PRO SRO	MEDLINE, EMBASE, PEDro, LILACS, and SCIELO/Inception to December 2018	19	PRISMA	6	Yes /COSMIN	No	NR

Author (year)	Country	Objective or research question	Population	SOI	Search strategy data source/date range of included studies	Number of sub-studies	Method for conducting the systematic review	Number of identified measures	Critical appraisal	Apply the ICF framework	Recommended outcome measures
		properties and the quality of the measurement properties.									
Oczkowski (2010) [14]	Canada	To identify all studies that evaluated the reliability of proxy respondents for patients with stroke.	Stroke	PRO SRO	MEDLINE, Google, and the Cochrane Library/ from 1969 to June 2008	14	NR	8	No	No	NR
Pearson (2004) [15]	UK	To review some current methods of assessing mobility in terms of reliability, validity, responsiveness and whether they can inform objectively on performance.	Stroke & neurological conditions	ClinRO PerfO PRO SRO TechO	NR/NR	NR	NR	5	No	Yes	NR
Pollock (2011) [16]	Canada	To identify and evaluate walking balance measures that have been established for use with people post stroke at the level of community walking. Outcome measures will be evaluated for content validity in the context of current physiotherapy practice. Construct validity, reliability and aspects of clinical interpretability will be explored with recommendations for clinical use of the outcome measure.	Stroke	ClinRO PerfO	MEDLINE, Embase, AMED/Inception to April 2010	24	NR	9	No	No	NR
Rowland (2008) [17]	Australia	To review the literature of upper limb ability assessments following stroke; to analyze the assessments against criteria that will assist clinicians to determine the utility of the tools; to rate the assessment's psychometric properties.	Stroke	ClinRO PerfO	MEDLINE, CINAHL, Cochrane Library/ from 1965 to 2008	NR	NR	7	No	No	NR
Salbach (2017) [18]	Canada	To appraise and synthesize the research literature describing: reliability, measurement error, construct validity, and sensitivity to change; the effect of walk test protocol elements on test performance for time-limited walk tests in adult's post stroke; to identify gaps in the evaluation	Stroke	ClinRO PerfO	MEDLINE, EMBASE, PubMed, CINAHL, Scopus, PEDro, Cochrane Library/Inception to July 2013	43	PRISMA	5	Yes/COSMIN	Yes	6-minute walking test

Author (year)	Country	Objective or research question	Population	SOI	Search strategy data source/date range of included studies	Number of sub-studies	Method for conducting the systematic review	Number of identified measures	Critical appraisal	Apply the ICF framework	Recommended outcome measures
		of measurement properties of time-limited walk tests; to identify considerations for the administration and interpretation of performance on time-limited walk tests post-stroke to enhance acceptance, utility, and value for practicing clinicians.									
Salter (2005) [19]	Canada	To evaluate the psychometric and administrative properties of outcome measures assigned to the ICF Body Functions category, and commonly used in stroke rehabilitation research.	Stroke	ClinRO PerfO PRO SRO	NR/NR	NR	NR	5	No	Yes	NR
Salter (2005) [20]	Canada	To evaluate the psychometric and administrative properties of outcome measures in the ICF Participation category, which are used in stroke rehabilitation research and reported in the published literature.	Stroke	PRO SRO	NR/NR	NR	NR	6	No	Yes	NR
Salter (2005) [21]	Canada	To evaluate the psychometric and administrative properties of outcome measures in the ICF Activity category used in stroke rehabilitation research and reported in the published literature.	Stroke	ClinRO PerfO PRO SRO	NR/NR	NR	NR	9	No	Yes	NR
Scrivener (2013) [22]	Australia	How responsive are measurement tools that measure any aspect of lower limb physical performance in stroke survivors when the use of the measure commences in inpatient care that is early after stroke.	Stroke	ClinRO PerfO PRO SRO TechO	Medline, CINAHL and EMBASE and CINAHL/Inception to April 2012	21	PRISMA	19	Yes /COSMIN	No	Berg Balance Scale 5-metre walk test 2, 6- and 12-meter walking tests Functional Ambulation Category Rivermead Mobility Index
Silva (2014) [23]	Brazil	To determine the measurement properties and feasibility previously investigated for clinical tests that evaluate sit-to-stand and stand-to-sit in subjects	Stroke	ClinRO PerfO	MEDLINE, SCIELO, LILACS and PEDro/Inception to December 2012	11	PRISMA	1	Yes/COSMIN	No	Five times sit to stand test

Author (year)	Country	Objective or research question	Population	SOI	Search strategy data source/date range of included studies	Number of sub-studies	Method for conducting the systematic review	Number of identified measures	Critical appraisal	Apply the ICF framework	Recommended outcome measures
		with neurological disease.									
Simpson (2013) [24]	Canada	To synthesize and critically review the research evidence that captures responsiveness as defined by three types of change (observed, important, and detectable). This systematic review provides an understanding of the responsiveness of outcome measures used in stroke research, specifically within the context of upper extremity functional recovery.	Stroke	ClinRO PerfO PRO SRO	MEDLINE, EMBASE, CINAHL, PsycINFO, Cochrance CENTRAL/Inception to March 2012	68	NR	4	No	No	Action Research Arm Test Motor Activity Log Wolf Motor Function test Stroke Impact Scale
Sivan (2011) [25]	UK	To identify the outcome measures and classify them using the ICF and report on their psychometric properties.	Stroke	ClinRO PerfO PRO SRO	MEDLINE, EMBASE, CINAHL, PubMed, PsychINFO/NR	28	NR	20	No	Yes	Fugl-Mayer kinematic measures Action Action Research Arm Test Wolf Motor Function Test Functional independence measure ABILHAND
Sorrentino (2018)[26]	Italy	To conduct an updated systematic literature review in order to identify psychometrically sound clinical measurement scales for assessing trunk control in stroke and to analyze the strength of their psychometric characteristics to obtain accurate and meaningful indicators of the treatment outcome, thus improving decision-making in clinical practice.	Stroke	ClinRO PerfO	NR/January 2006 to April 2017	19	PRISMA	10	No	No	NR
Stevens (2010) [27]	USA	To enable the orthotics and prosthetics practitioners to better use established timed ambulatory outcome measures.	Stroke, TBI and neurological conditions	ClinRO PerfO	PubMed/Inception to April 2009	NR	NR	4	No	No	NR

Author (year)	Country	Objective or research question	Population	SOI	Search strategy data source/date range of included studies	Number of sub-studies	Method for conducting the systematic review	Number of identified measures	Critical appraisal	Apply the ICF framework	Recommended outcome measures
Teale (2010) [28]	UK	To identify outcome measures that has been demonstrated as valid and reliable for postal administration and acceptable to patients with stroke and their careers across a spectrum of domains and impairments.	Stroke	PRO SRO	Cochrane Controlled Trials Register, MEDLINE, EMBASE, CINAHL psychINFO, AMED and British Nursing Index/Inception to January 2009	60	NR	5	No	No	Frenchay Activities Index Subjective Index of Physical and Social Outcome European Quality of life test
Tse (2013) [29]	Australia	To identify and critique the tools frequently used to measure participation in clinical stroke studies and to identify the ICF Activities and Participation domains sampled within these most frequently used participation measures.	Stroke	PRO SRO	Medline, CINAHL, ProQuest Central Database/from January 2001 to April 2012	119	NR	5	No	Yes	Stroke Impact Scale London Handicap Scale Assessment of Life Habits Frenchay Activities Index Activity Card Sort
Tyson (2009) [30]	UK	To identify and recommend the best measures to use with neurological and stroke patients in the clinical setting.	Stroke, TBI and neurological conditions	ClinRO PerfO PRO SRO TechO	MEDLINE, CINAHL, EMBASE, PEDro, and AMED/Inception to October 2008	NR	Standardized accepted guidelines from previous published	15	No	Yes	5-meter walking test 10-meter walking test 6-minute walk test High Level Mobility Assessment Tool Rivermead Mobility Index
Van Bloemen daal (2012) [31]	Netherlan d	To provide an overview of walking tests used in stroke survivors including information about the tests' measurement properties in terms of reliability, validity, and responsiveness.	Stroke	ClinRO PerfO TechO	PubMed, CINAHL, EMBASE and Cochrane Controlled Trial Register/from 1966 to January 2011	32	NR	15	Yes /COSMIN	Yes	NR
Van Peppen (2007) [32]	Netherlan d	To describe the available evidence to guide the clinical decision-making process of physiotherapists dealing with the rehabilitation of patients with stroke regarding: the best determinants of the ultimate functional recovery of patients diagnosed with stroke; the effectiveness of applicable physiotherapy interventions; and the core set of reliable, valid, and responsive outcome measures to assess patients' progress in	Stroke	ClinRO PerfO PRO SRO	MEDLINE, CINAHL and EMBASE databases, Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, DocOnline (Database of the Dutch Institute of Allied Health Care)/Inception to January 2004	32	NR	7	No	Yes	Motricity index trunk control test Berg Balance scale Functional Ambulation Category 10-meter walking test Frenchay Arm test Barthel Index

Author (year)	Country	Objective or research question	Population	SOI	Search strategy data source/date range of included studies	Number of sub-studies	Method for conducting the systematic review	Number of identified measures	Critical appraisal	Apply the ICF framework	Recommended outcome measures
		functional health at fixed moments after stroke.									
Velstra (2011) [33]	Swizerla nd	To identify outcome measures that address functioning and disability in studies that involve persons with impairments in upper extremity function; to compare the content of the identified outcome measures with the ICF as a reference; to report the reliability and responsiveness data of the identified outcome measures when these data are available.	Stroke & neurological conditions	ClinRO PerfO PRO SRO	MEDLINE, CINAHL, PsycINFO, and EMBASE/from July 1997 to July 2010	44	NR	13	No	Yes	Modified Ashworth Scale Action Research Arm Test Motor Activity Log Functional Independence Measure Fugl-Meyer Assessment Short Form 36 Health Survey Questionnaire
Verheyde n (2007) [34]	Belgium	To give a systematic review of clinical tools designed to evaluate trunk performance after stroke.	Stroke	ClinRO PerfO	CINAHL, Cochrane, Pedro, and PubMed/Inception to January 2006	32	NR	3	No	No	Trunk control test Trunk impairment scales
Wilde (2010) [35]	USA	To summarize the selection of outcome measures by the interchangeably TBI outcomes workgroup to address primary clinical research objectives including documentation of the natural course of recovery from TBI, prediction of later outcome, measurement of treatment effects, and comparison of outcomes across studies.	TBI	ClinRO PerfO PRO SRO	NR/NR	NR	NR	6	No	No	NR

ClinRO: Clinician-reported outcome, COSMIN: COnsensus-based Standards for the Selection of Health Measurement Instrument, ICF: International Classification of Functioning, Health and Disability framework, PerfO: Performance-reported outcome, PRO: Patient-reported outcome, PRISMA: Preferred Reporting Items for Systematic reviews and Meta-Analyse, SRO: Self-reported outcome, TechO: Technology-reported outcome; TBI: Traumatic Brain Injury, NR: not reported, SOI: source of information.

Appendix 3. Methodological quality of the included systematic reviews using the Joanna Briggs Institute (JBI) critical appraisal checklist for systematic reviews and research syntheses

JBI items	Ashford (2008) [1]	Ashford (2015) [2]	Baker (2011) [3]	Barak (2006) [4]	Connel (2012) [5]	Croarkin (2004) [6]	Fini (2015) [7]	Gebruers (2010) [8]	Geroin (2013) [9]	Gor-Garcı´a-Fogeda (2014) [10]	Hong (2016) [11]	Lemmens (2012)[12]
1. Is the review question clearly and explicitly stated?	√	√	√	√	√	√	√	√	√	√	√	√
2. Were the inclusion criteria appropriate for the review question?	√	√	√	√	√	√	√	√	√	√	√	√
3. Was the search strategy appropriate?	√	√	√	-	√	√	√	√	√	√	√	√
4. Were the sources of studies adequate?	√	√	√	-	√	?	√	?	√	√	√	?
5. Were the criteria for appraising studies appropriate?	-	√	-	-	-	-	-	-	-	-	-	-
6. Was critical appraisal conducted by two or more reviewers independently?	-	√	-	-	-	-	-	-	-	-	-	-
7. Were there methods to minimize errors in data extraction?	√	√	√	-	√	?	√	?	√	√	√	?
8. Were the methods used to combine studies appropriate?	√	√	√	√	√	√	√	√	√	√	√	√
9. Was the likelihood of publication bias assessed?	-	-	-	-	-	-	-	-	-	-	-	-
10. Were recommendations for policy and/or practice supported by the reported data?	√	√	√	-	√	√	-	-	√	√	-	-
11. Were the specific directives for new research appropriate?	√	√	√	-	√	√	-	-	√	√	-	-
JBI items	Martins (2019) [13]	Oczkowski (2010) [14]	Pearson (2004) [15]	Pollock (2011) [16]	Rowland (2008) [17]	Salbach (2017) [18]	Salter (2005) [19]	Salter (2005) [20]	Salter (2005) [21]	Scrivener (2013) [22]	Silva (2014)[23]	Simpson (2013) [24]
1. Is the review question clearly and explicitly stated?	√	√	√	√	√	√	√	√	√	√	√	√
2. Were the inclusion criteria appropriate for the review question?	√	√	√	√	√	√	√	√	√	√	√	√
3. Was the search strategy appropriate?	√	√	-	√	√	√	-	-	-	√	√	√
4. Were the sources of studies adequate?	√	√	-	√	√	√	-	-	-	√	√	-
5. Were the criteria for appraising studies appropriate?	√	-	-	-	-	√	-	-	-	√	√	-
6. Was critical appraisal conducted by two or more	√	-	-	-	-	√	-	-	-	√	√	-

reviewers independently?												
7. Were there methods to minimize errors in data extraction?	√	√	-	√	√	√	-	-	-	√	√	-
8. Were the methods used to combine studies appropriate?	√	√	√	√	√	√	√	√	√	√	√	√
9. Was the likelihood of publication bias assessed?	-	-	-	-	-	-	-	-	-	-	-	-
10. Were recommendations for policy and/or practice supported by the reported data?	-	-	-	-	-	√	-	-	-	√	√	√
11. Were the specific directives for new research appropriate?	-	-	-	-	-	√	-	-	-	√	√	√

JBI items	Sivan (2011) [25]	Sorrentino (2018)[26]	Stevens (2010) [27]	Teale (2010) [28]	Tse (2013) [29]	Tyson (2009) [30]	Van Bloemendaal (2012) [31]	Van Peppen (2007) [32]	Velstra (2011) [33]	Verheyden (2007) [34]	Wilde (2010)[35]	
1. Is the review question clearly and explicitly stated?	√	√	√	√	√	√	√	√	√	√	√	
2. Were the inclusion criteria appropriate for the review question?	√	√	√	√	√	√	√	√	√	√	√	
3. Was the search strategy appropriate?	√	-	√	√	√	√	√	√	√	√	-	
4. Were the sources of studies adequate?	√	-	√	√	-	√	√	√	?	√	-	
5. Were the criteria for appraising studies appropriate?	-	-	-	-	-	-	√	-	-	-	-	
6. Was critical appraisal conducted by two or more reviewers independently?	-	-	-	-	-	-	√	-	-	-	-	
7. Were there methods to minimize errors in data extraction?	√	-	√	√	-	√	√	√	?	√	-	
8. Were the methods used to combine studies appropriate?	√	√	√	√	√	√	√	√	√	√	√	
9. Was the likelihood of publication bias assessed?	-	-	-	-	-	-	-	-	-	-	-	
10. Were recommendations for policy and/or practice supported by the reported data?	√	-	-	√	√	√	-	√	√	√	-	
11. Were the specific directives for new research appropriate?	√	-	-	√	√	√	-	√	√	√	-	

Appendix 4: Assessment of methodological quality using 4-point COSMIN Risk of Bias rating scale

Name of measure	Population	Setting	SOI	Content validity**	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
ABILHAND [1, 3, 5, 11, 12, 17, 24, 25]	Stroke	Chronic	PRO	Very good	Very good	Adequate	Adequate	Inadequate	Inadequate	Very good	Very good
Accelerometer (ActiGraph) [8]	Stroke	Sub-acute	TechO	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Actical [7]	Stroke	Chronic	TechO	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate
Action Research arm test (ARAT) [3, 5, 6, 11, 12, 17, 24, 25, 33]	Stroke	Chronic	ClinRO	Very good	Very good	Very good	Very good	Inadequate	Inadequate	Very good	Very good
Activities of Daily Living scale [12]	Stroke	Chronic	ObserO	Inadequate	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Adequate	Inadequate
Activity Cart Sort (ACS) [13, 29]	Stroke	Chronic	PRO	Adequate	Very good	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Actiwatch [8]	Stroke	Acute, Chronic	TechO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Actual Amount of Use Test (AAUT) [12]	Stroke	Chronic	ClinRO	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Ambulatory Monitoring (AM Accelerometer) [8, 31]	Stroke	Acute, Chronic	TechO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Arm Motor Ability Test (AMAT) [11, 12, 17, 25]	Stroke	Sub-acute, Chronic	PerfO	Adequate	Very good	Very good	Very good	Inadequate	Inadequate	Adequate	Very good
Assessment of Life Habits (LIFE-H) [14, 29]	Stroke	Chronic	PerfO	Adequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Assessment of Motor and Process Skills (AMPS) [12]	Stroke	Chronic	PerfO	Inadequate	Inadequate	Adequate	Adequate	Inadequate	Inadequate	Adequate	Inadequate
Balance	Stroke	Chronic	ClinRO	Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate	Adequate	Adequate

Name of measure	Population	Setting	SOI	Content validity**	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Assessment in Sitting and Standing Position (BASSP) [26]											
Balance Evaluation System test (BESTest) [16]	Stroke	Chronic	PerfO	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Very good
Barthel Index (BI) [4, 9, 21, 22, 32]	Stroke	Chronic, Acute	PerfO	Inadequate	Very good	Very good	Adequate	Adequate	Inadequate	Adequate	Very good
Beck Depression Inventory (BDI) [4, 19]	Stroke	Chronic, Acute	PRO	Inadequate	Very good	Very good	Inadequate	Inadequate	Inadequate	Very good	Very good
Berg Balance Scale (BBS) [4, 9, 21, 22, 32]	Stroke	Acute, Sub-acute, Chronic	PerfO	Inadequate	Very good	Very good	Very good	Inadequate	Inadequate	Very good	Very good
Berg Balance Scale three point (BBS-3P) [22]	Stroke	Acute	PerfO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Very good
Biaxial accelerometer [8]	Stroke	Chronic	TechO	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Box and Block test [5, 25]	Stroke	Chronic	ClinRO	Inadequate	Inadequate	Very good	Very good	Very good	Inadequate	Very good	Inadequate
Brain injury community rehabilitation outcome scale (BICRO) [2]	BI		PRO	Inadequate	Very good	Adequate	Adequate	Inadequate	Inadequate	Adequate	Inadequate
Brunel Balance Assessment [16]	Stroke	Chronic	ClinRO	Adequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Caltrac accelerometer [7, 8]	Stroke	Chronic	TechO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate
Canadian Occupational Performance Measure (COPM) [12]	Stroke	Chronic	PRO	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Very good

Name of measure	Population	Setting	SOI	Content validity**	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Centre for Epidemiological Studies Depression [4]	Stroke	Chronic	PRO	Inadequate	Adequate	Adequate	Adequate	Inadequate	Inadequate	Adequate	Adequate
Chedoke Arm and Hand Inventory (CAHAI) [3, 12, 17, 25]	Stroke	Chronic	PerfO	Adequate	Very good	Very good	Adequate	Inadequate	Inadequate	Adequate	Very good
Chedoke McMaster Stroke assessment scale (CMSA) [4, 6, 21, 25]	Stroke	Chronic	ClinRO	Inadequate	Very good	Very good	Very good	Adequate	Inadequate	Very good	Very good
Climbing stairs questionnaire (CSQ) [2]	Stroke	Chronic	ClinRO	Inadequate	Very good	Adequate	Adequate	Inadequate	Inadequate	Adequate	Inadequate
Coded activity diary [13]	Stroke	Chronic	PRO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Community balance and mobility scale (CB&M) [16, 30]	Stroke, TBI	Chronic	PRO	Inadequate	Inadequate	Inadequate	Adequate	Adequate	Inadequate	Adequate	Very good
Computer Science and Applications Inc. Model 7164 activity monitors x 4 [7]	Stroke	Chronic		Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Dimensional gait analysis (3-DGA) [8]	Stroke	Chronic	TechO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Disabilities of the Arm, Shoulder and Hand (DASH) [11]	Stroke	Chronic	TechO	Inadequate	Very good	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Duruoz Hand Index (DHI) [12]	Stroke	Chronic	SRO	Inadequate	Very good	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate

Name of measure	Population	Setting	SOI	Content validity**	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Dynamic Gait Index (DGI) [16, 30, 31]	Stroke	Sub-acute, Chronic	SRO	Inadequate	Inadequate	Adequate	Adequate	Adequate	Inadequate	Adequate	Inadequate
European Quality of life scale (EQ5D) [4, 14, 20, 25, 28, 35]	Stroke, TBI	Acute, Chronic	PerfO	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Very good
Fitbit Ulta [7]	Stroke	Chronic	PRO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Very good
Fitts Reaching test [5]	Stroke	Chronic	TechO	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Very good	Inadequate
Five-meter walking test (5MWT) [18, 30, 31]	Stroke	Chronic	PerfO	Inadequate	Inadequate	Adequate	Adequate	Adequate	Adequate	Adequate	Inadequate
Five times Sit to Stand test [23]	Stroke	Chronic	PerfO	Inadequate	Inadequate	Very good	Very good	Very good	Adequate	Adequate	Very good
Footswitches [8, 31]	Stroke	Sub-acute, Chronic	PerfO	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Adequate	Adequate	Inadequate
Four metre Comfortable Walk Test (4mCWT) [31]	Stroke	Chronic	TechO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Four Square Step [16]	Stroke	Chronic	PerfO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Very good
Frenchay Activities Index (FAI) [13, 14, 21, 29, 32]	Stroke	Acute, Chronic	ClinRO	Adequate	Very good	Adequate	Adequate	Inadequate	Inadequate	Adequate	Very good
Frenchay Arm Test (FAT) [4, 12, 25]	Stroke	Chronic	SRO	Inadequate	Inadequate	Adequate	Adequate	Inadequate	Inadequate	Very good	Inadequate
Fugl-Meyer Assessment (FMA) [4, 10, 19, 25, 33]	Stroke	Acute, Chronic	ClinRO	Inadequate	Very good	Very good	Very good	Inadequate	Inadequate	Very good	Very good
Fugl-Meyer Assessment-Upper extremity [11]	Stroke	Chronic	ClinRO	Very good	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate

Name of measure	Population	Setting	SOI	Content validity**	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Fugl-Meyer test-Balance subscale (FM-B) [22]	Stroke	Acute	ClinRO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Very good
Function in Sitting Test (FIST) [26]	Stroke	Acute	ClinRO	Inadequate	Very good	Inadequate	Inadequate	Inadequate	Adequate	Adequate	Inadequate
Functional Ambulation Category (FAC) [9, 22, 30-32]	Stroke	Acute, Sub-acute, Chronic	PerfO	Inadequate	Inadequate	Adequate	Adequate	Adequate	Inadequate	Adequate	Very good
Functional Ambulation Classification Hospital (FACHS) [31]	Stroke	Chronic	ClinRO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Functional Arm Activity Behavioral Observation System (FAABOS) [12]	ABI		ObseRO	Inadequate	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Inadequate
Functional Gait Assessment (FGA) [31]	Stroke	Chronic		Inadequate	Inadequate	Inadequate	Adequate	Adequate	Adequate	Inadequate	Inadequate
Functional Independence measure (FIM) [4, 14, 15, 21, 25, 33, 35]	Stroke, TBI	Acute, Chronic	PerfO	Inadequate Adequate (TBI)	Very good	Very good	Very good	Inadequate	Inadequate	Very good	Very good
Functional Test for the Hemiplegic Upper Extremity (FTHUE) [12]	Stroke	Chronic	ClinRO	Inadequate	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Inadequate
Geriatric Depression scale-long form (GDS) [4]	Stroke	Chronic	ClinRO	Inadequate	Very good	Very good	Inadequate	Inadequate	Inadequate	Adequate	Very good

Name of measure	Population	Setting	SOI	Content validity**	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Grasp-Release test [33]	Stroke	Chronic	PRO	Inadequate	Very good	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Inadequate
Grip strength [25]	Stroke	Chronic	PerfO	Inadequate	Inadequate	Adequate	Adequate	Inadequate	Inadequate	Inadequate	Inadequate
Grooved Pegboard Test (GPT) [35]	TBI		ClinRO	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate
Hand Function Survey (HFS) [12]	Stroke	Chronic		Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
High Level Mobility Assessment (HiMAT) [30]	TBI		PerfO	Inadequate	Inadequate	Inadequate	Adequate	Adequate	Inadequate	Adequate	Inadequate
Human activity profile (HAP) [2, 13]	Stroke	Chronic		Inadequate	Very good	Adequate	Adequate	Inadequate	Inadequate	Adequate	Inadequate
Intelligent Device for Energy Expenditure and Activity (IDEEA) [7, 8]	Stroke	Chronic	PRO	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate
International classification of functioning, health, and disability-Activity measure (ICF-AM) [11]	Stroke	Chronic	TechO	Inadequate	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Adequate	Inadequate
Jebsen Hand Function Test [12, 33]	Stroke	Chronic	SRO	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Very good
Kinematics [25]	Stroke	Chronic	PerfO	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Inadequate	Very good
London Handicap scale (LHS) [28, 29]	Stroke	Acute, Chronic	PRO	Adequate	Very good	Adequate	Adequate	Inadequate	Inadequate	Adequate	Inadequate

Name of measure	Population	Setting	SOI	Content validity**	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Manual Function Test (MFT) [12]	Stroke	Acute	PRO	Inadequate	Very good	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Mayo-Portland Adaptability Inventory (MPAI-4) [35]	TBI	PRO	ClinRO	Very good	Very good	Inadequate	Very good	Inadequate	Inadequate	Very good	Inadequate
Medical Outcomes Study 36-Item Short Form Health Survey (SF-36) [4, 14, 15, 20, 33, 35]	Stroke, TBI	Chronic		Inadequate	Very good	Adequate	Adequate	Inadequate	Inadequate	Very good	Very good
Mini Mental State Examination (MMSE) [4, 19]	Stroke	Acute, Chronic	PRO	Inadequate	Very good	Adequate	Adequate	Adequate	Inadequate	Adequate	Inadequate
Modified Ashworth Scale (AS) [4, 19, 25, 33]	Stroke	Acute	ClinRO	Inadequate	Inadequate	Inadequate	Adequate	Adequate	Inadequate	Adequate	Inadequate
Modified Emory Functional Ambulation Profile (M-EFAM) [16, 22, 30]	Stroke	Acute, Chronic	ClinRO	Inadequate	Inadequate	Adequate	Inadequate	Adequate	Inadequate	Adequate	Very good
Modified Functional Reach test (MFRT) [22]	Stroke	Chronic	ClinRO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Very good
Modified Rankin Handicap scale [4, 21]	Stroke	Acute, Chronic	PerfO	Inadequate	Inadequate	Very good	Adequate	Inadequate	Inadequate	Adequate	Very good
Motor activity log (MAL-14) [1, 5, 12, 17, 33]	Stroke	Chronic	PRO	Inadequate	Very good	Very good	Inadequate	Inadequate	Inadequate	Very good	Very good
Motor Activity Log-28 items [1]	Stroke	Sub-acute	SRO	Inadequate	Very good	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate

Name of measure	Population	Setting	SOI	Content validity**	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Motor Assessment Scale (MAS) [4, 6, 10, 22, 25]	Stroke	Acute, Chronic	SRO	Inadequate	Inadequate	Very good	Very good	Inadequate	Inadequate	Very good	Very good
Motor Evaluation Scale for Upper Extremity in Stroke Patients (MESUPES) [11, 12]	Stroke	Chronic	ClinRO	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Motor Free Visual Perception Test (MVPT) [4, 19]	Stroke	Chronic	ClinRO	Inadequate	Very good	Very good	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Motor status scale (MSS) [5, 25]	Stroke	Acute	ClinRO	Inadequate	Inadequate	Adequate	Adequate	Inadequate	Inadequate	Very good	Inadequate
Motricity index (MI) [4, 6, 9, 10, 32]	Stroke	Chronic	ClinRO	Inadequate	Very good	Adequate	Very good	Inadequate	Inadequate	Very good	Very good
Multimedia activity recall for children and adults (MARCA) [13]	Stroke	Chronic	ClinRO	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
National institute for health Stroke scale (NIHSS) [4]	Stroke	Chronic	SRO	Inadequate	Inadequate	Very good	Inadequate	Inadequate	Inadequate	Very good	Inadequate
Neurobehavioral Cognition Status Exam (NCSE) [4]	Stroke	Chronic	ClinRO	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Very good
Nike+Fuelband [7]	Stroke	Chronic	ClinRO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Very good
Nine-Hole Peg test (NHPT) [5, 6, 25]	Stroke	Chronic	TechO	Inadequate	Inadequate	Very good	Adequate	Inadequate	Inadequate	Very good	Inadequate
Nottingham Extended	Stroke	Chronic	ClinRO	Inadequate	Very good	Adequate	Adequate	Inadequate	Inadequate	Adequate	Very good

Name of measure	Population	Setting	SOI	Content validity**	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
ADL index (N-ADL) [2]											
Nottingham leisure activity (NLA) [13, 20]	Stroke	Chronic	PRO	Inadequate	Very good	Adequate	Adequate	Inadequate	Inadequate	Adequate	Inadequate
OMRON HJ-113-E Piezoelectric Pedometers [7]	Stroke	Chronic	PRO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate		Very good
Ottawa Sitting Scale (OSS) [26]	Stroke	Chronic	TechO	Inadequate	Inadequate	Inadequate	Adequate	Adequate	Inadequate	Inadequate	Inadequate
Outpatient Physical Therapy Improvement in Movement Assessment Log (OPTIMAL) [11]	Stroke	Chronic	ClinRO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
PAL2 (Gorman ProMed Pty. Ltd) [7]	Stroke	Chronic	PRO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Pedometers [7, 8, 31]	Stroke	Chronic	TechO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Very good
Pens taped to feet [30]	TBI		TechO	Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate	Adequate	Inadequate
Physical Ability Scale (PAS) [26]	Stroke	Sub-acute		Inadequate	Inadequate	Inadequate	Adequate	Adequate	Inadequate	Inadequate	Inadequate
Postural Assessment Scale for Stroke Patients (PASS) [22]	Stroke	Chronic	PRO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Very good
Postural Assessment Scale for Stroke Patients Trunk Control	Stroke	Chronic	PerfO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Very good

Name of measure	Population	Setting	SOI	Content validity**	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
(PASS-TC) [22]											
Postural Control and Balance for Stroke (PCBS) [22]	Stroke	Acute	PerfO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Very good
Quadriplegia Index of Function [33]	Stroke	Chronic	PerfO	Inadequate	Inadequate	Very good	Inadequate	Inadequate	Inadequate	Inadequate	Very good
Reintegration to normal living index (RNLI) [28]	Stroke	Chronic	ClinRO	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Rivermead mobility Index (RMI) [2, 9, 10, 15, 21, 22, 30]	Stroke, TBI	Acute, Sub-acute, Chronic	SRO	Inadequate	Very good	Very good	Very good	Inadequate	Inadequate	Very good	Very good
Rivermead mobility Assessment (RMA) [4-6, 10, 11, 21, 25]	Stroke	Acute, Chronic	PerfO	Inadequate	Very good	Adequate	Inadequate	Inadequate	Adequate	Very good	Inadequate
Satisfaction with Life Scale (SWLS) [35]	TBI	PRO	SRO	Inadequate	Inadequate	Very good	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate
Sensewear Pro 3 Armband [7]	Stroke	Chronic		Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Very good
Short Form Berg Balance Scale (SFBBS) [22]	Stroke	Acute	TechO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Very good
Short Form Postural Assessment Scale for Stroke Patients-6 items (6 SFPASS) [22]	Stroke	Acute	PerfO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Very good
Sickness Impact profile (SIP) [2, 4,	Stroke, TBI	Chronic	PerfO	Inadequate	Very good	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Very good

Name of measure	Population	Setting	SOI	Content validity**	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
14, 20]											
Sitting Rising Test (SRT) [26]	Stroke	Chronic	PRO	Inadequate	Inadequate	Adequate	Adequate	Inadequate	Inadequate	Adequate	Inadequate
Six-minute walking test (6MWT) [4, 9, 18, 22, 30, 31]	Stroke, TBI	Acute, Sub-acute, Chronic	ClinRO	Inadequate	Inadequate	Adequate	Adequate	Adequate	Adequate	Adequate	Very good
Smart Balance Master (SBM) [22]	Stroke	Acute	PerfO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Very good
SmartShoe [7]	Stroke	Chronic	TechO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Very good
Sodring motor evaluation for Stroke patients [10]	Stroke	Chronic	TechO	Inadequate	Very good	Inadequate	Very good	Inadequate	Inadequate	Very good	Very good
Sollerman hand function test [5]	Stroke	Chronic	ClinRO	Inadequate	Inadequate	Very good	Very good	Inadequate	Inadequate	Inadequate	Inadequate
Step test [16]	Stroke	Chronic	PerfO	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Very good
StepWatch Activity Monitor or Step Activity Monitor (SAM) [7, 8, 30]	Stroke	Chronic	ClinRO	Inadequate	Inadequate	Adequate	Adequate	Inadequate	Inadequate	Adequate	Very good
Stride analyzer system (SAS) [8]	Stroke	Chronic	TechO	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Stroke Arm Ladder (SAL) [11]	Stroke	Chronic	TechO	Adequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Stroke impact scale (SIS) [2, 4, 14, 20, 24, 25, 28, 29]	Stroke	Sub-acute, Chronic	ClinRO	Inadequate	Very good	Adequate	Adequate	Inadequate	Inadequate	Very good	Very good

Name of measure	Population	Setting	SOI	Content validity**	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Stroke Rehabilitation assessment of movement (STREAM) [4, 5, 10, 11]	Stroke	Chronic	PRO	Adequate	Very good	Very good	Very good	Very good	Inadequate	Very good	Very good
Stroke Specific Quality of Life Scale (SSQOL) [4, 14, 20]	Stroke	Chronic	ClinRO	Inadequate	Very good	Very good	Adequate	Inadequate	Inadequate	Adequate	Very good
Subjective index of physical and social outcome (SIPSO) [28]	Stroke	Chronic	PRO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate
Ten-meter walking test (10MWT) [4, 9, 22, 27, 30-32]	Stroke, TBI	Acute, Sub-acute, Chronic	PRO	Inadequate	Inadequate	Very good	Adequate	Adequate	Adequate	Adequate	Very good
Thirty metre Comfortable Walk Test (30mCWT) [31]	Stroke	Chronic	PerfO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Three hundred metre Walk Test in community (300mWT) [31]	Stroke	Chronic	PerfO	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Three-meter walking test (3MWT) [18]	Stroke	Sub-acute	PerfO	Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate	Adequate	Inadequate
Three Point Postural Assessment Scale for Stroke Patients (PASS-3P) [22]	Stroke	Acute	PerfO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Very good
Timed Up and Go test	Stroke, TBI	Chronic	PerfO	Inadequate	Inadequate	Very good	Adequate	Inadequate	Inadequate	Adequate	Very good

Name of measure	Population	Setting	SOI	Content validity**	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
(TUG) [4, 16, 21, 27, 30]											
Timed walk [15]	Stroke	Chronic	PerfO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Very good
Triaxial accelerometer / RT3 [7, 8]	Stroke	Chronic	PerfO	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Trunk Control Test (TCT) [26, 32, 34]	Stroke	Chronic	TechO	Inadequate	Very good	Inadequate	Inadequate	Inadequate	Inadequate	Very good	Inadequate
Trunk Impairment Scale [26, 34]	Stroke	Chronic	ClinRO	Adequate	Very good	Adequate	Very good	Very good	Adequate	Adequate	Very good
Trunk Recovery Scale (TRS) [26]	BI		ClinRO	Inadequate	Very good	Inadequate	Adequate	Inadequate	Adequate	Adequate	Inadequate
Twelve-meter walking test (12MWT) [18, 30, 31]	Stroke	Acute, Sub-acute, Chronic		Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Very good
Two-meter walking test (2MWT) [18, 22, 30, 31]	Stroke	Acute, Chronic	PerfO	Inadequate	Inadequate	Adequate	Adequate	Adequate	Adequate	Inadequate	Very good
Uniaxial accelerometer [8]	Stroke	Acute, Chronic	PerfO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Upper Body Dressing Scale (UBDS) [12]	Stroke	Chronic	TechO	Inadequate	Very good	Inadequate	Adequate	Inadequate	Inadequate	Adequate	Very good
Upper Extremity Functional Index (UEFI) [11]	Stroke	Chronic	ClinRO	Inadequate	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Adequate	Inadequate
Upper Extremity Performance Test for Elderly (Test d'Évaluation des Membres supérieurs de Personnes Âgées	Stroke	Chronic	ClinRO	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate

Name of measure	Population	Setting	SOI	Content validity**	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
(TEMPA) [12]											
Upper Limb-Motor Assessment Scale (UL-MAS) [11, 17]	Stroke	Chronic	ClinRO	Very good	Very good	Very good	Adequate	Adequate	Inadequate	Adequate	Very good
Van Lieshout Test Short Form [33]	Stroke	Chronic	ClinRO	Inadequate	Inadequate	Inadequate	Adequate	Inadequate	Inadequate	Inadequate	Very good
Wireless Triaxial Accelerometers [7]	Stroke	Chronic	ClinRO	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate	Adequate	Inadequate
Wolf Motor Function Test (WMFT) [4, 11, 12, 17, 24, 25, 33]	Stroke	Chronic	PerfO	Very good	Very good	Very good	Very good	Inadequate	Adequate	Adequate	Very good

ABI: acquired brain injury, CliInRO: clinicians-reported outcome, COSMIN: COnsensus-based Standards for the selection of health Measurement Instruments, PerfO: performance-reported outcome, PRO: patient-reported outcome, SRO: self-reported outcome, SOI: source of information, OberRO: observation-reported outcome, TechO: technology-reported outcome, TBI: traumatic brain injury

*Inadequate in all measurement properties mean that there is no calculation has been done or no information was reported in the included systematic reviews.

**Rating of Inadequate was given to content validity, because these systematic reviews did not evaluate the content validity of mobility measures based on COSMIN guidelines.

Appendix 5. Updated criteria for good measurement properties

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	test-retest	inter-rater	intra-rater	Measurement error	Construct validity	Responsiveness
Ashfod (2008) [1]											
ABILHAND	Stroke	Chronic		+	+	+	+	?	?	+	+
Motor activity log (MAL-14)	Stroke	Chronic		?	+	-	-	?	?	-	?
Motor Activity Log-28 items	Stroke	Sub-acute	222	?	+	?	?	?	?	-	?
Ashford (2015) [2]											
Brain injury community rehabilitation outcome scale (BICRO)	Brain Injury		127	+	+	+	+	?	?	+	?
Climbing stairs questionnaire (CSQ)	Stroke	Chronic	15	+	+	+	+	?	?	-	?
Human activity profile (HAP)	Stroke	Chronic		+	+	+	+	?	?	-	-
Nottingham Extended ADL index (N-ADL)	Stroke	Chronic	78	+	+	+	+	?	?	+	+
Rivermead mobility index (RMI)	Stroke	Acute	38	+	+	+	+	?	?	+	+
Sickness Impact profile (SIP)	Traumatic brain injury		25	+	+	+	?	?	?	+	+
Stroke impact scale (SIS)	Stroke	Chronic		+	+	+	+	?	?	+	-
Baker (2011) [3]											
ABILHAND	Stroke	Chronic		?	?	+	?	?	?	+	+
Action Research Arm test (ARAT)	Stroke	Chronic		+	-	?	?	?	?	-	-
Chedoke Arm and Hand Inventory (CAHAI)	Stroke	Chronic	109	+	+	+	+	?	?	+	?
Fugl-Meyer Assessment (FMA)	Stroke	Chronic		?	-	?	?	?	?	-	-
Stroke Rehabilitation assessment of movement (STREAM)	Stroke	Chronic	80	?	+	+	+	+	?	+	+
Barak (2006) [4]											
Ten Meter Walking Test	Stroke	Sub-acute		?	?	+	?	?	?	-	+
Six Minute Walking Test	Stroke	Sub-acute		?	?	+	?	?	+	+	?
Barthel Index (BI)	Stroke	Chronic	30	?	?	+	?	?	?	+	+
Beck Depression Inventory (BDI)	Stroke	Acute	202	?	?	+	?	?	?	+	-
Berg Balance Scale (BBS)	Stroke	Chronic	70	?	?	+	?	?	?	+	+
Boston diagnostic aphasia exam	Stroke	Chronic		?	?	+				?	?
Chedoke McMaster Stroke assessment scale (CMSA)	Stroke	Acute	32	?	?	+	?	?	?	+	+
European Quality of life scale (EQ5D)	Stroke	Chronic		?	?	-	?	?	?	-	+
Frenchay Arm Test (FAT)	Stroke	Chronic	38	?	?	-	?	?	?	+	-
Fugl-Meyer Assessment (FMA)	Stroke	Chronic		?	?	+	?	?	?	+	+
Functional Independence measure (FIM)	Stroke	Chronic		?	?	+	?	?	?	-	+

Geriatric Depression scale-long form (GDS)	Stroke	Chronic		?	+	+	?	?	?	+	+
Medical Outcomes Study 36-Item Short Form Health Survey (SF-36)	Stroke	Chronic		?	?	-	?	?	?	+	+
Mini Mental State Examination (MMSE)	Stroke	Acute	116	?	?	+	?	?	?	-	?
Modified Ashworth scale	Stroke	Acute		?	?	-	?	?	?	-	?
Modified Rankin Handicap scale	Stroke	Acute	1034	?	?	+	?	?	?	-	-
Motor Assessment Scale (MAS)	Stroke	Chronic		?	?	+	?	?	?	+	+
Motor Free Visual Perception Test	Stroke	Acute		?	?	+	?	?	?	-	?
Motricity index (MI)	Stroke	Chronic		?	?	-	?	?	?	+	?
National Institute of Health Stroke Scale	Stroke	Chronic	65	?	?	+	?	?	?	+	-
Neurobehavioral Cognition Status Exam (NCSE)	Stroke	Chronic		?	?	-	-	?	?	+	+
Rivermead mobility Assessment (RMA)	Stroke	Chronic		?	?	-	?	?	?	-	-
Sickness Impact profile (SIP)	Stroke	Chronic		?	?	-	?	?	?	-	?
Stroke impact scale (SIS)	Stroke	Chronic	696	?	?	-	?	?	?	+	-
Stroke Specific Quality of Life Scale (SSQOL)	Stroke	Chronic		?	+	+	?	?	?	-	+
Timed Up and Go test (TUG)	Stroke	Chronic		?	?	+	?	?	?	-	?
Wolf Motor Function Test (WMFT)	Stroke	Chronic		?	+	+	+	?	?	-	+
Connell (2012) [5]											
ABILHAND	Stroke	Chronic	103	?	?	?	?	?	?	+	?
Action Research Arm test (ARAT)	Stroke	Chronic		?	?	+	+	?	?	+	?
Box and Block test	Stroke	Chronic	15	?	?	+	+	+	?	+	?
Fitts Reaching test	Stroke	Chronic	18	?	?	+	?	?	?	+	?
Motor activity log	Stroke	Chronic	56	?	?	?	?	?	?	+	?
Motor activity log	Stroke	Chronic	20	?	?	?	?	?	?	+	?
Motor activity log	Stroke	Chronic	41	?	?	?	?	?	?	+	?
Motor activity log	Stroke	Chronic	27	?	?	+	?	?	?	?	?
Motor status score-MSS	Stroke	Acute	18	?	?	?	?	?	?	+	?
Nine-Hole Peg test (NHPT)	Stroke	Chronic	62	?	?	+	?	?	?	+	?
Rivermead mobility Assessment (RMA)	Stroke	Chronic		?	?	?	?	?	+	+	?
Sollerman hand function test	Stroke	Chronic	24	?	?	+	+	?	?	?	?
Stroke Rehabilitation assessment of movement (STREAM)	Stroke	Chronic		?	?	+	?	?	?	+	?
Croarkin (2004) [6]											
Action Research Arm test (ARAT)	Stroke	Chronic		?	?	?	+	?	?	+	?
Chedoke McMaster Stroke assessment scale (CMSA)	Stroke	Chronic		?	?	?	+	?	?	+	?
Fugl-Meyer Assessment (FMA)	Stroke	Chronic		?	?	?	+	?	?	+	?
Motor Assessment Scale (MAS)	Stroke	Chronic		?	?	?	+	?	?	+	?
Motricity index (MI)	Stroke	Chronic		?	?	?	+	?	?	+	?
Nine-Hole Peg test (NHPT)	Stroke	Chronic		?	?	+	-	?	?	+	?

Rivermead mobility Assessment (RMA)	Stroke	Chronic		?	?	?	-	?	?	+	?
Fini (2014) [7]											
Actical	Stroke	Chronic	40	?	?	+	?	?	?	?	?
Caltrac accelerometer	Stroke	Chronic	17	?	?	-	?	?	?	?	?
Computer Science and Applications Inc. Model 7164 activity monitors x 4	Stroke	Chronic	9	?	?	?	?	?	?	+	?
Fitbit Ulta	Stroke	Chronic	30	?	?	?	?	?	?	-	+
IDEEA-the Intelligent Device for Energy Expenditure and Activity	Stroke	Chronic	42	?	?	-	?	?	?	?	?
Nike+Fuelband	Stroke	Chronic	30	?	?	?	?	?	?	-	+
OMRON HJ-113-E Piezoelectric Pedometers	Stroke	Chronic	50	?	?	?	?	?	?	?	+
PAL2 (Gorman ProMed Pty. Ltd)	Stroke	Chronic	20	?	?	?	?	?	?	-	?
Pedometer (Conventional)	Stroke	Chronic	16	?	?	-	?	?	?	?	?
Pedometer (model 650 Yamasa Tokei Co., Yamax Digi Walker)	Stroke	Chronic	20	?	?	?	?	?	?	-	+
Sensewear Pro 3 Armband	Stroke	Chronic	12	?	?	?	?	?	?	-	+
SmartShoe	Stroke	Chronic	12	?	?	?	?	?	?	+	+
StepWatch Activity Monitor or Step Activity Monitor (SAM)	Stroke	Chronic	17	?	?	+	?	?	?	?	?
StepWatch Activity Monitor or Step Activity Monitor (SAM)	Stroke	Chronic	16	?	?	+	?	?	?	?	?
StepWatch Activity Monitor or Step Activity Monitor (SAM)	Stroke	Chronic	40	?	?	+	?	?	?	?	?
StepWatch Activity Monitor or Step Activity Monitor (SAM)	Stroke	Chronic	30	?	?	?	?	?	?	+	+
StepWatch Activity Monitor or Step Activity Monitor (SAM)	Stroke	Chronic	25	?	?	?	?	?	?	+	+
StepWatch Activity Monitor or Step Activity Monitor (SAM)	Stroke	Chronic	16	?	?	?	?	?	?	?	+
Triaxial accelerometer/ RT3	Stroke	Chronic	20	?	?	-	?	?	?	?	?
Wireless Triaxial Accelerometers	Stroke	Chronic	12	?	?	?	?	?	?	-	?
Gebruers (2010) [8]											
Accelerometer (ActiGraph)	Stroke	Sub-acute	20	?	?	+	?	?	?	+	?
Actiwatch	Stroke	Acute	52	?	?	?	?	?	?	+	?
Actiwatch	Stroke	Chronic	11	?	?	?	?	?	?	+	?
Ambulatory Monitoring (AM Accelerometer)	Stroke	Acute	43	?	?	?	?	?	?	+	?
Biaxial accelerometer	Stroke	Chronic	6	?	?	+	?	?	?	+	?
Caltrac accelerometer	Stroke	Chronic	27	?	?	-	?	?	?	?	?
Dimensional gait analysis (3-DGA)	Stroke	Chronic	25	?	?	?	?	?	?	+	?
Finger Tapping (uniaxial accelerometer)	Stroke	Chronic	60	?	?	?	?	?	?	+	?
Footswitches	Stroke	Chronic	25	?	?	?	?	?	?	+	?
Intelligent Device for Energy Expenditure and Activity	Stroke	Chronic	6	?	?	+	?	?	?	?	?

Measure	Population	Phase	N								
Pedometers	Stroke	Chronic	16	?	?	?	?	?	?	+	?
StepWatch Activity Monitor or Step Activity Monitor (SAM)	Stroke	Chronic	16	?	?	+	?	?	?	+	?
StepWatch Activity Monitor or Step Activity Monitor (SAM)	Stroke	Chronic	21	?	?	?	?	?	?	+	?
StepWatch Activity Monitor or Step Activity Monitor (SAM)	Stroke	Chronic	53	?	?	?	?	?	?	+	?
StepWatch Activity Monitor or Step Activity Monitor (SAM)	Stroke	Chronic	17	?	?	+	?	?	?	?	?
StepWatch Activity Monitor or Step Activity Monitor (SAM)	Stroke	Chronic	50	?	?	?	?	?	?	+	+
StepWatch Activity Monitor or Step Activity Monitor (SAM)	Stroke	Chronic	25	?	?	?	?	?	?	+	?
StepWatch Activity Monitor or Step Activity Monitor (SAM)	Stroke	Chronic	27	?	?	?	?	?	?	+	?
Stride analyzer system (SAS)	Stroke	Chronic	6	?	?	+	?	?	?	+	?
Triaxial accelerometer/ RT3	Stroke	Chronic	20	?	?	+	?	?	?	+	?
Triaxial accelerometer/ RT3	Stroke	Chronic	52	?	?	+	?	?	?	?	?
Uniaxial accelerometer	Stroke	Acute	34	?	?	?	?	?	?	+	?
Uniaxial accelerometer	Stroke	Acute	45	?	?	?	?	?	?	+	?
Geroin (2013) [9]											
Ten Meter Waling Test	Stroke	Chronic		?	?	+	+	?	?	-	+
Six Minute Walking Test	Stroke	Chronic		?	?	?	+	+	?	-	?
Berg Balance Scale (BBS)	Stroke	Sub-acute	15	?	?	+	+	?	?	-	+
Functional Ambulation Category (FAC)	Stroke	Acute		?	?	+	+	?	?	-	+
Motricity index (MI)	Stroke	Chronic		?	?	?	+	?	?	-	?
Rivermead mobility index (RMI)	Stroke	Sub-acute	73	?	+	+	+	?	?	-	+
Gor-Garcı´a-Fogeda (2014) [10]											
Fugl-Meyer Assessment (FMA)	Stroke	Acute	78	?	+	+	+	?	?	+	+
Motor Assessment Scale (MAS)	Stroke	Chronic	37	?	?	+	+	?	?	+	?
Stroke Rehabilitation assessment of movement (STREAM)	Stroke	Chronic	134	?	+	+	+	?	?	?	+
Motricity index (MI)	Stroke	Chronic	55	?	+	?	+	?	?	+	?
Rivermead mobility Assessment (RMA)	Stroke	Chronic	158	?	+	+	?	?	?	?	?
Rivermead mobility index (RMI)	Stroke	Chronic		?	+	?	?	?	?	+	?
Sodring motor evaluation for stroke patients	Stroke	Chronic	123	?	+	?	+	?	?	+	+
Hong (2017) [11]											
ABILHAND	Stroke	Chronic	103	+	?	+	?	?	?	+	?
Action Research Arm test (ARAT)	Stroke	Chronic	191	+	+	+	?	?	?	+	?
Action Research Arm test (ARAT)	Stroke	Chronic	351	+	?	?	?	?	?	+	?
Arm Motor Ability Test (AMAT)	Stroke	Chronic	36	+	?	?	?	?	?	?	?
DASH (Disabilities of the Arm, Shoulder and Hand)	Stroke	Chronic	300	?	+	+	?	?	?	+	?

Fugl-Meyer Assessment-Upper extremity	Stroke	Chronic	512	+	?	+	?	?	?	+	?
International classification of functioning, health, and disability-Activity measure (ICF-AM)	Stroke	Chronic	317	?	?	?	+	?	?	+	?
MESUPES (Motor Evaluation Scale for Upper Extremity in Stroke Patients)	Stroke	Chronic	396	+	?	+	?	?	?	+	?
OPTIMAL (Outpatient Physical Therapy Improvement in Movement Assessment Log)	Stroke	Chronic	3138	?	?	?	?	?	?	+	?
Rivermead mobility Assessment (RMA)	Stroke	Chronic		?	?	?	?	?	?	?	?
Stroke Arm Ladder (SAL)	Stroke	Chronic	942	+	?	+	?	?	?	+	?
Stroke Rehabilitation assessment of movement (STREAM)	Stroke	Chronic	351	+	?	+	?	?	?	+	?
Upper Extremity Functional Index (UEFI)	Stroke	Chronic	239	?	?	?	+	?	?	+	?
Upper Limb-Motor Assessment Scale (UL-MAS)	Stroke	Chronic	80	+	?	+	?	?	?	+	?
Wolf Motor Function Test (WMFT)	Stroke	Chronic	189	+	+	+	?	?	?	+	?
Lemmens (2012) [12]											
ABILHAND	Stroke	Chronic		+	?	?	+	?	?	?	?
Action Research Arm test (ARAT)	Stroke	Chronic		?	?	?	?	?	?	?	?
Action Research Arm test (ARAT)	Stroke	Chronic		?	?	?	?	?	?	?	?
Activities of Daily Living observation	Stroke	Chronic	81	?	?	?	+	?	?	+	?
Actual Amount of Use Test (AAUT)	Stroke	Chronic	11	?	?	+	?	?	?	+	?
Arm Motor Ability Test (AMAT)	Stroke	Chronic		?	?	?	?	?	?	?	?
Assessment of Motor and Process Skills (AMPS)	Stroke	Chronic	76	?	?	+	+	?	?	+	?
Canadian Occupational Performance Measure (COPM)	Stroke	Chronic	26	?	?	+	?	?	?	+	+
Chedoke Arm and Hand Inventory (CAHAI)	Stroke	Chronic		?	?	?	?	?	?	?	?
Duruoz Hand Index (DHI)	Stroke	Chronic	56	?	?	+	?	?	?	+	?
Frenchay Arm Test (FAT)	Stroke	Chronic	45	?	?	?	+	?	?	?	?
Functional Arm Activity Behavioral Observation System (FAABOS)	ABI		9	?	?	?	+	?	?	?	?
Functional Test for the Hemiplegic Upper Extremity (FTHUE)	Stroke	Chronic	82	?	?	?	+	?	?	?	?
Hand Function Survey (HFS)	Stroke	Chronic	45	?	?	+	?	?	?	+	?

Measure	Population	Phase	N								
Jebsen Hand Function Test	Stroke	chronic		?	?	+	?	?	?	+	+
Manual Function Test (MFT)	Stroke	Acute	51	?	+	+	?	?	?	+	?
MESUPES (Motor Evaluation Scale for Upper Extremity in Stroke Patients)	Stroke	Chronic		?	?	?	?	?	?	?	?
Motor activity log (MAL-14)	Stroke	Chronic	56	?	?	?	?	?	?	?	?
Upper Body Dressing Scale (UBDS)	Stroke	Chronic	51	?	?	?	+	?	?	+	+
Upper Extremity Performance Test for Elderly (Test d'Évaluation des Membres supérieurs de Personnes Âgées (TEMPA)	Stroke	Chronic	29	?	?	+	?	?	?	+	?
Wolf Motor Function Test (WMFT)	Stroke	Chronic		?	?	?	?	?	?	?	?
Martin (2018) [13]											
Activity Cart Sort (ACS)	Stroke	Chronic	29	?	?	?	?	?	?	+	?
Activity Cart Sort (ACS)	Stroke	Chronic	60	?	+	+	?	?	?	+	?
Coded activity diary	Stroke	chronic	16	?	?	?	?	?	?	+	?
Frenchay Activities Index (FAI)	Stroke	Chronic	36	?	?	?	+	?	?	+	?
Frenchay Activities Index (FAI)	Stroke	Chronic	238	?	?	?	?	?	?	+	?
Frenchay Activities Index (FAI)	Stroke	Chronic	52	?	?	+	?	?	?	?	?
Frenchay Activities Index (FAI)	Stroke	Chronic	127	?	+	?	?	?	?	?	?
Frenchay Activities Index (FAI)	Stroke	Chronic	70	?	?	?	?	?	?	+	+
Frenchay Activities Index (FAI)	Stroke	Chronic	163	?	?	?	?	?	?	?	+
Frenchay Activities Index (FAI)	Stroke	Chronic	45	?	?	?	+	?	?	?	?
Frenchay Activities Index (FAI)	Stroke	Chronic	22	?	?	+	?	?	?	?	?
Frenchay Activities Index (FAI)	Stroke	Chronic	68	?	?	?	+	?	?	?	?
Frenchay Activities Index (FAI)	Stroke	Chronic	188	?	+	?	?	?	?	+	?
Frenchay Activities Index (FAI)	Stroke	Chronic	14	?	?	?	+	?	?	?	?
Frenchay Activities Index (FAI)	Stroke	Chronic	581	+	?	?	?	?	?	?	?
Frenchay Activities Index (FAI)	Stroke	Chronic	935	?	?	?	?	?	?	+	?
Frenchay Activities Index (FAI)	Stroke	Chronic	383	?	?	?	?	?	?	?	+
Frenchay Activities Index (FAI)	Stroke	Chronic		?	?	+	?	?	?	+	?
Human activity profile (HAP)	Stroke	Chronic	24	?	?	?	?	?	?	+	?
Multimedia activity recall for children and adults (MARCA)	Stroke	Chronic	40	?	?	+	?	?	?	+	?
Nottingham leisure activity (NLA)	Stroke	Chronic	21	?	?	-	?	?	?	?	?
Nottingham leisure activity (NLA)	Stroke	Chronic	20	?	?	?	-	?	?	?	?
Oczkowski (2010) [14]											
Assessment of Life Habits (LIFE-H)	Stroke	Chronic	80	?	?	+	?	?	?	?	?
European Quality of life scale-EQ5D	Stroke	Chronic	15	?	?	+	?	?	?	?	?
Frenchay Activities Index (FAI)	Stroke	Chronic		?	?	-	?	?	?	?	?
Functional Independence measure (FIM)	Stroke	Chronic		?	?	+	?	?	?	?	?
Medical Outcomes Study 36-Item Short Form Health Survey (SF-36)	Stroke	Chronic	60	?	?	-	?	?	?	?	?

Measure	Population	Phase	N								
Sickness Impact profile (SIP)	Stroke	Chronic	574	?	?	+	?	?	?	-	?
Sickness impact profile (SIP)	Stroke	Chronic		?	?	+	?	?	?	?	?
Stroke impact scale (SIS)	Stroke	Chronic		?	?	-	?	?	?	?	?
Stroke Specific Quality of Life Scale (SSQOL)	Stroke	Chronic		?	?	-	?	?	?	?	?
Pearson (2004) [15]											
Barthel Index (BI)	Stroke	Chronic		?	?	+	?	+	?	+	+
Functional Independence measure (FIM)	Stroke	Chronic		?	?	?	+	+	?	+	+
Medical Outcomes Study 36-Item Short Form Health Survey (SF-36)	Stroke	Chronic		?	+	?	?	?	?	+	?
Rivermead mobility index (RMI)	Stroke	Chronic		?	?	+	?	?	?	+	?
Timed walk	Stroke	Chronic	22	+	?	?	?	+	?	+	+
Poolack (2015) [16]											
Balance Evaluation System test (BESTest)	Stroke	Chronic	115	+	?	+	?	?	?	+	+
Brunel Balance Assessment	Stroke	Chronic	92	+	?	+	?	?	?	+	?
Community balance and mobility scale (CB&M)	Stroke	Chronic	44	?	?	?	?	?	?	+	+
Dynamic Gait Index (DGI)	Stroke	Chronic		?	?	+	-	-	?	?	?
Four Square Step	Stroke	Chronic	37	-	?	?	?	?	?	+	+
Modified Emory Functional Ambulation Profile (M-EFAM)	Stroke	Chronic	26	?	?	+	?	?	?	+	+
Step test	Stroke	Chronic	41	+	?	+	?	?	?	+	+
Timed Up and Go test (TUG)	Stroke	Chronic	50	-	?	+	?	?	?	?	+
Timed Up and Go test (TUG)	Stroke	Chronic	11	?	?	+	?	?	?	?	?
Timed Up and Go test (TUG)	Stroke	Chronic	44	?	?	?	?	?	?	+	+
Rowland (2008) [17]											
ABILHAND	Stroke	Chronic		+	?	+	?	?	?	-	?
Action Research Arm test (ARAT)	Stroke	Chronic		?	+	+	+	?	?	+	+
Arm Motor Ability Test (AMAT)	Stroke	Sub-acute	32	?	+	+	-	?	?	-	+
Chedoke Arm and Hand Inventory (CAHAI)	Stroke	Chronic		+	+	+	-	?	?	+	+
Motor Activity Log	Stroke	Chronic		+	+	-	?	?	?	-	+
Upper Limb-Motor Assessment Scale (UL-MAS)	Stroke	Chronic		+	+	+	+	+	?	+	+
Wolf Motor Function Test (WMFT)	Stroke	Chronic		?	+	+	+	?	?	-	?
Salbach (2017) [18]											
Twelve Meter Walking Test	Stroke	Chronic	25	+	?	?	?	?	?	+	?
Twelve Meter Walking Test	Stroke	Sub-acute	20	+	?	?	?	+	?	+	?
Two Meter Walking Test	Stroke	Chronic	61	+	?	?	?	+	+	?	?
Two Meter Walking Test	Stroke	Chronic	12	+	?	?	?	+	+	?	?
Two Meter Walking Test	Stroke	Chronic	32	+	?	?	?	+	+	?	?
Two Meter Walking Test	Stroke	Chronic	17	+	?	?	?	+	+	?	?
Three Meter Walking Test	Stroke	Sub-	14	+	?	?	?	+	?	+	?

		acute									
Five Meter Walking Test	Stroke	Chronic	9	+	?	?	?	+	+	?	?
Five Meter Walking Test	Stroke	Chronic	20	+	?	?	?	?	?	+	?
Five Meter Walking Test	Stroke	Chronic	10	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Acute	37	+	?	?	?	+	+	?	?
Six Minute Walking Test	Stroke	Acute	24	+	?	?	?	+	+	?	?
Six Minute Walking Test	Stroke	Acute	13	+	?	?	?	+	+	?	?
Six Minute Walking Test	Stroke	Acute	41	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Acute	30	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	83	+	?	?	?	+	?	?	?
Six Minute Walking Test	Stroke	Chronic	12	+	?	?	?	+	+	?	?
Six Minute Walking Test	Stroke	Chronic	10	+	?	?	?	+	?	?	?
Six Minute Walking Test	Stroke	Chronic	50	+	?	?	?	+	+	?	?
Six Minute Walking Test	Stroke	Chronic	27	+	?	?	?	+	+	?	?
Six Minute Walking Test	Stroke	Chronic	27	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	36	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	34	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	50	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	61	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	64	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	12	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	34	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	25	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	48	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	30	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	21	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	40	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	77	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	40	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	49	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	17	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	42	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	50	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	68	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	25	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	25	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	30	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	77	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Sub-acute	50	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Sub-acute	63	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Sub-acute	48	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Sub-acute	25	+	?	?	?	?	?	+	?
Salter (2005) [21]											
Barthel Index (BI)	Stroke	Acute	22	?	+	+	+	+	?	+	+

263

Berg Balance Scale (BBS)	Stroke	Acute		?	+	+	+	?	?	+	+
Frenchay Activities Index (FAI)	stroke	Acute	35	?	+	+	+	?	?	-	?
Functional Independence measure (FIM)	Stroke	Acute	52	?	+	+	+	?	?	+	+
Modified Rankin Handicap Scale	Stroke	Chronic	63	?	?	+	-	?	?	+	+
Rivermead mobility Assessment (RMA)	Stroke	Acute	51	?	?	-	?	?	?	+	?
Rivermead mobility index (RMI)	Stroke	Acute		+	+	+	+	?	?	+	+
Timed Up and Go test (TUG)	Stroke	Chronic		?	?	+	+	?	?	-	+
Chedoke McMaster Stroke assessment scale (CMSA)	Stroke	Chronic	127	?	+	+	+	+	?	+	+
Salter (2005) [19]											
Beck Depression Inventory (BDI)	Stroke	Chronic	202	+	+	-	?	?	?	+	+
Fugl-Meyer Assessment (FMA)	Stroke	Acute		?	+	?	+	+	?	+	+
Mini-Mental State Examination (MMSE)	Stroke	Chronic	75	?	-	-	-	+	?	+	?
Modified Ashworth scale	Stroke	Acute		?	?	?	-	-	?	+	?
Motor-free Visual Perception Test (MVPT)	Stroke	Acute	30	?	-	+	?	?	?	+	?
Salter (2005) [20]											
European Quality of life scale (EQ5D)	Stroke	Chronic		?	?	-	?	?	?	+	?
Medical Outcomes Study 36-Item Short Form Health Survey (SF-36)	Stroke	Chronic		?	+	+	?	?	?	+	+
Nottingham leisure activity (NLA)	Stroke	Chronic		?	+	+	-	?	?	+	?
Sickness Impact profile (SIP)	Stroke	Chronic		?	+	?	?	?	?	+	?
Stroke Impact Scale (SIS)	Stroke	Chronic		?	+	+	?	-	?	+	+
Stroke Specific Quality of Life Scale (SSQOL)	Stroke	Chronic	71	?	+	?	-	?	?	+	+
Scrivener (2013) [22]											
10MWT	Stroke	Acute	42	?	?	?	?	?	?	?	+
10MWT	Stroke	Acute	50	?	?	?	?	?	?	?	+
12MWT	Stroke	Chronic	18	?	?	?	?	?	?	?	+
2MWT	Stroke	Acute	18	?	?	+	+	?	?	?	+
6-item Short Form Postural Assessment Scale for Stroke Patients (6 SFPASS)	Stroke	Acute	262	?	?	?	?	?	?	?	+
6MWT	Stroke	Chronic	18	?	?	?	?	?	?	?	+
Berg Balance Scale (BBS)	Stroke	Acute	50	?	?	?	?	?	?	?	+
Berg Balance Scale (BBS)	Stroke	Acute	110	?	?	?	?	?	?	?	+
Berg Balance Scale (BBS)	Stroke	Acute	93	?	?	?	?	?	?	?	+
Berg Balance Scale (BBS)	Stroke	Acute	80	?	?	?	?	?	?	?	+
Berg Balance Scale (BBS)	Stroke	Acute	93	?	?	?	?	?	?	?	+
Berg Balance Scale (BBS)	Stroke	Acute	80	?	?	?	?	?	?	?	+
Berg Balance Scale (BBS)	Stroke	Acute	60	?	?	?	?	?	?	?	+
Berg Balance Scale three point (BBS-3P)	Stroke	Acute	202	?	?	?	?	?	?	?	+
Berg Balance Scale three point	Stroke	Acute	167	?	?	?	?	?	?	?	+

(BBS-3P)											
Berg Balance Scale three point (BBS-3P)	Stroke	Acute	167	?	?	?	?	?	?	?	+
Fugl-Meyer test-Balance subscale (FM-B)	Stroke	Acute	110	?	?	?	?	?	?	?	+
Fugl-Meyer test-Balance subscale (FM-B)	Stroke	Acute	93	?	?	?	?	?	?	?	+
Fugl-Meyer test-Balance subscale (FM-B)	Stroke	Acute	80	?	?	?	?	?	?	?	+
Fugl-Meyer test-Balance subscale (FM-B)	Stroke	Acute	93	?	?	?	?	?	?	?	+
Fugl-Meyer test-Balance subscale (FM-B)	Stroke	Acute	80	?	?	?	?	?	?	?	+
Functional Ambulation Category (FAC)	Stroke	Acute	101	?	?	?	?	?	?	?	+
Functional Ambulation Category (FAC)	Stroke	Sub-acute	55	?	?	?	?	?	?	?	+
Modified Emory Functional Ambulation Profile (M-EFAM)	Stroke	Acute	40	?	?	?	?	?	?	?	+
Modified Functional Reach test (MFRT)	Stroke	Chronic	35	?	?	?	?	?	?	?	+
Motor Assessment Scale (MAS)	Stroke	Acute	61	?	?	?	?	?	?	?	+
Postural Assessment Scale for Stroke Patients (PASS)	Stroke	Acute	202	?	?	?	?	?	?	?	+
Postural Assessment Scale for Stroke Patients (PASS)	Stroke	Chronic	167	?	?	?	?	?	?	?	+
Postural Assessment Scale for Stroke Patients (PASS)	Stroke	Chronic	167	?	?	?	?	?	?	?	+
Postural Assessment Scale for Stroke Patients Trunk Control (PASS-TC)	Stroke	Acute	110	?	?	?	?	?	?	?	+
Postural Assessment Scale for Stroke Patients Trunk Control (PASS-TC)	Stroke	Chronic	93	?	?	?	?	?	?	?	+
Postural Assessment Scale for Stroke Patients Trunk Control (PASS-TC)	Stroke	Chronic	80	?	?	?	?	?	?	?	+
Postural Assessment Scale for Stroke Patients Trunk Control (PASS-TC)	Stroke	Chronic	93	?	?	?	?	?	?	?	+
Postural Assessment Scale for Stroke Patients Trunk Control (PASS-TC)	Stroke	Chronic	80	?	?	?	?	?	?	?	+
Postural Assessment Scale for Stroke Patients Trunk Control (PASS-TC)	Stroke	Acute	246	?	?	?	?	?	?	?	+
Postural Assessment Scale for Stroke Patients Trunk Control (PASS-TC)	Stroke	Chronic	203	?	?	?	?	?	?	?	+

Postural Assessment Scale for Stroke Patients Trunk Control (PASS-TC)	Stroke	Chronic	189	?	?	?	?	?	?	?	+
Postural Control and Balance for Stroke (PCBS)	Stroke	Acute	50	?	?	?	?	?	?	?	+
Rivermead mobility index (RMI)	Stroke	Chronic		?	?	?	?	?	?	?	?
Rivermead mobility index (RMI)	Stroke	Chronic		?	?	?	?	?	?	?	?
Short Form Berg Balance Scale (SFBBS)	Stroke	Acute	81	?	?	?	?	?	?	?	+
Smart Balance Master (SBM)	Stroke	Acute	40	?	?	?	?	?	?	?	+
Three Point Postural Assessment Scale for Stroke Patients (PASS-3P)	Stroke	Acute	202	?	?	?	?	?	?	?	+
Three Point Postural Assessment Scale for Stroke Patients (PASS-3P)	Stroke	Acute	167	?	?	?	?	?	?	?	+
Three Point Postural Assessment Scale for Stroke Patients (PASS-3P)	Stroke	Acute	167	?	?	?	?	?	?	?	+
Silva (2013) [23]											
Five times Sit to Stand test	Stroke	Chronic	19	+	?	+	?	?	+	?	?
Five times Sit to Stand test	Stroke	Chronic	12	+	?	+	+	+	?	+	+
Five times Sit to Stand test	Stroke	Chronic	27	+	?	?	?	?	?	+	?
Simpson (2013) [24]											
ABILHAND	Stroke	Chronic		?	?	?	?	?	?	?	+
Action Research Arm test (ARAT)	Stroke	Chronic		?	?	?	?	?	?	+	?
Stroke impact scale (SIS)	Stroke	Chronic		?	?	?	?	?	?	?	+
Wolf Motor Function Test (WMFT)	Stroke	Chronic		?	?	?	?	?	?	+	?
Sivan (2001) [25]											
ABILHAND	Stroke	Chronic		?	?	+	?	?	?	-	?
Action Research Arm test	Stroke	Chronic		?	?	+	+	?	?	+	+
Arm Motor Ability Test (AMAT)	Stroke	Chronic		?	?	+	+	?	?	?	?
Barthel Index (BI)	Stroke	Chronic	167	?	?	+	+	?	?	-	+
Box and Block test	Stroke	Chronic	37	?	?	+	?	?	?	-	-
Chedoke Arm and Hand Inventory (CAHAI)	Stroke	Chronic		?	?	?	+	?	?	?	+
Chedoke McMaster Stroke assessment scale (CMSA)	Stroke	Chronic		?	?	?	+	?	?	-	?
European Quality of life scale (EQ5D)	Stroke	Acute		?	?	+	?	?	?	-	?
Frenchay Arm Test (FAT)	Stroke	Chronic	10	?	?	+	+	?	?	?	?
Fugl-Meyer Assessment (FMA)	Stroke	Acute		?	?	+	+	?	?	-	+
Grip strength	stroke	Chronic	27	?	?	+	+	?	?	?	?
Kinematics	stroke	Chronic	8	?	?	+	?	?	?	-	+
Modified Ashworth scale	Stroke	Acute		?	?	+	+	?	?	-	?
Motor Assessment Scale (MAS)	Stroke	Chronic		?	?	+	+	?	?	-	?
Motor status score-MSS	Stroke	Acute		?	?	+	+	?	?	-	?

Nine-Hole Peg test (NHPT)	Stroke	Chronic		?	?	?	+	?	?	-	?
Rivermead mobility Assessment (RMA)	Stroke	Chronic		?	?	+	?	?	?	-	?
Stroke impact scale (SIS)	Stroke	Chronic		?	?	+	?	?	?	-	?
Wolf Motor Function Test (WMFT)	Stroke	Chronic		?	?	+	+	?	?	-	+
Functional Independence measure (FIM)	Stroke	Chronic	83	?	?	+	+	?	?	-	+
Sorrentino (2018) [26]											
Balance Assessment in Sitting and Standing Position (BASSP)	Stroke	Chronic	1193	?	?	?	?	+	?	+	+
Function in Sitting Test (FIST)	Stroke	Acute	31	+	+	?	?	?	+	+	?
Modified Functional Reach test (MFRT)	Stroke	Chronic		?	?	+	?	+	?	?	+
Ottawa Sitting Scale (OSS)	Stroke	Chronic	71	?	?	?	+	+	?	?	?
Physical Ability Scale (PAS)	Stroke	Sub-acute	10	?	?	?	-	-	?	?	?
Postural Assessment Scale for Stroke Patients (PASS)	Stroke	Chronic		?	?	?	?	?	?	?	+
Sitting Rising Test (SRT)	Stroke	Chronic	60	?	?	+	+	?	?	+	?
Trunk Control test	Stroke	Chronic		?	+	?	+	?	?	+	?
Trunk Impairment Scale	Stroke	Chronic		?	+	?	+	+	?	?	?
Trunk Impairment Scale	Stroke	Chronic		?	+	+	+	+	?	?	?
Trunk Impairment Scale (TIS)-Verheyden version	Stroke	Chronic		?	-	+	+	?	?	+	?
Trunk Impairment Scale - Fujiwara version	Stroke	Chronic		?	+	?	+	?	?	+	+
Trunk Recovery Scale (TRS)	Brain Injury		59	?	+	?	+	?	+	+	?
Stevens (2010) [27]											
Ten Meter Walking test	Stroke	Chronic		?	?	+	?	?	?	?	+
Ten Meter Walking test	Stroke	Sub-acute		?	?	+	?	?	?	?	?
Ten Meter Walking test	Traumatic brain injury		94	?	?	+	?	?	?	?	?
Five Meter Walking Test	Stroke	Chronic		?	?	+	?	?	?	?	?
Six Minute Walking Test	Stroke	chronic		?	?	+	+	?	?	?	?
Six Minute Walking Test	Traumatic brain injury		36	?	?	+	?	?	?	?	?
Timed Up and Go test (TUG)	Stroke	Chronic	343	?	?	+	?	?	?	?	?
Timed Up and Go test (TUG)	Traumatic brain injury		24	?	?	+	?	?	?	?	?
Teale (2010) [28]											
European Quality of life scale (EQ5D)	Stroke	Chronic		?	?	+	?	?	?	?	?
London handicap score-LHS	Stroke	Acute	361	+	?	+	+	?	?	+	?

Reintegration to normal living index (RNLI)	Stroke	Chronic	57	?	?	+	?	?	?	+	?
Stroke impact scale (SIS)	Stroke	Chronic		?	?	?	?	?	?	+	?
Subjective index of physical and social outcome (SIPSO)	Stroke	Chronic	260	?	?	?	?	?	?	?	?
Tse (2013) [29]											
Activity Cart Sort (ACS)	Stroke	Chronic		+	-	+	?	?	?	+	?
Assessment of Life Habits (LIFE-H)	Stroke	Chronic	84	+	?	+	?	?	?	+	?
Frenchay Activities Index (FAI)	Stroke	Chronic		+	+	?	+	?	?	+	?
London Handicap scale (LHS)	Stroke	Chronic	37	+	+	+	?	?	?	+	?
Stroke impact scale (SIS)	Stroke	Sub-acute	25	+	+	+	?	?	?	+	?
Tyson (2009) [30]											
Ten Meter Walking Test	Stroke	Acute	81	?	?	?	+	?	?	?	?
Ten Meter Walking Test	Stroke	Chronic	22	?	?	?	+	?	?	?	?
Ten Meter Walking Test	Stroke	Chronic	40	?	?	?	?	?	?	+	?
Ten Meter Walking Test	Stroke	Chronic	60	?	?	?	+	+	?	?	?
Ten Meter Walking Test	Stroke	Chronic	19	?	?	?	?	?	?	?	+
Ten Meter Walking Test	Traumatic brain injury		12	?	?	?	?	+	?	+	?
Ten Meter Walking Test	Traumatic brain injury		13	?	?	?	+	?	?	?	?
Twelve Meter Walking Test	Stroke	Acute	18	?	?	?	+	+	?	?	?
Two Meter Walking Test	Stroke	Chronic		?	?	+	+	?	?	?	?
Five Meter Walking Test	Stroke	Chronic	61	?	?	?	?	?	?	?	+
Five Meter Walking Test	Stroke	Chronic	35	?	?	?	+	+	?	+	?
Six Minute Walking Test	Stroke	Acute	18	?	?	?	+	+	?	?	?
Six Minute Walking Test	Stroke	Chronic	37	?	?	?	+	?	?	+	?
Six Minute Walking Test	Traumatic brain injury		23	?	?	?	+	?	?	?	?
Six Minute Walking Test	Traumatic brain injury		13	?	?	?	+	?	?	?	?
Community balance and mobility scale (CB&M)	Traumatic brain injury		32	?	?	?	+	+	?	+	?
Functional Ambulation Category (FAC)	Stroke	Chronic	31	?	?	?	?	+	?	+	?
Functional Ambulation Category (FAC)	Stroke	Chronic	55	?	?	?	+	+	?	+	?
Functional Ambulation Category (FAC)	Stroke	Sub-acute	20	?	?	?	?	?	?	+	?
High Level Mobility Assessment (HiMAT)	Traumatic brain injury		103	?	?	?	+	+	?	+	?

Modified Emory Functional Ambulation Profile (M-EFAM)	Stroke	Chronic	28	?	?	?	?	+	?	+	?
Modified Emory Functional Ambulation Profile (M-EFAM)	Stroke	Chronic	26	?	?	?	+	+	?	+	?
Modified Emory Functional Ambulation Profile (M-EFAM)	Stroke	Chronic	40	?	?	?	+	?	?	+	?
Pens taped to feet	Traumatic brain injury		12	?	?	?	?	+	?	+	?
Rivermead mobility index (RMI)	Stroke	Chronic	73	?	?	?	?	?	?	+	+
Rivermead mobility index (RMI)	Stroke	Chronic	38	?	?	?	?	?	?	+	?
Rivermead mobility index (RMI)	Traumatic brain injury		20	?	?	?	?	?	?	+	?
StepWatch Activity Monitor or Step Activity Monitor (SAM)	Stroke	Chronic	19	?	?	?	?	?	?	+	?
StepWatch Activity Monitor or Step Activity Monitor (SAM)	Stroke	Chronic	17	?	?	?	+	?	?	?	?
Timed Up and Go test (TUG)	Stroke	Chronic	11	?	?	?	+	?	?	+	?
Timed Up and Go test (TUG)	Stroke	Chronic	50	?	?	?	+	?	?	?	?
Van Bloemendaal (2012) [31]											
Ten Meter Walking Test	Stroke	Chronic	50	+	?	+	?	?	+	?	?
Ten Meter Walking Test	Stroke	Chronic	28	+	?	?	?	?	?	+	?
Ten Meter Walking Test	Stroke	Chronic	18	+	?	?	?	?	+	?	?
Ten Meter Walking Test	Stroke	Chronic	50	+	?	?	+	?	+	?	?
Ten Meter Walking Test	Stroke	Chronic	20	+	?	+	?	?	?	+	?
Ten Meter Walking Test	Stroke	Sub-acute	12	+	?	+	?	?	+	+	?
Ten Meter Walking Test	Stroke	Sub-acute	12	+	?	+	?	?	?	?	?
Ten Meter Walking Test	Stroke	Sub-acute	43	+	?	?	?	?	?	+	?
Twelve Meter Walking Test	Stroke	Chronic	18	+	?	?	+	+	?	?	?
Twelve Meter Walking Test	Stroke	Chronic	25	+	?	?	?	?	?	+	?
Two Meter Waling Test	Stroke	Chronic	18	+	?	?	+	+	?	?	?
Three Hundred Metre Walking Test in Community	Stroke	Chronic	28	+	?	+	?	?	?	+	?
Thirty Metre Comfortable Walking Test	Stroke	Chronic	18	+	?	?	?	?	?	+	?
Four Metre Comfortable Walking Test	Stroke	Chronic	25	+	?	?	?	?	?	+	?
Five Meter Walking Test	Stroke	Chronic	35	+	?	+	?	?	?	?	?
Six Minute Walking Test	Stroke	Chronic	15	+	?	+	?	?	+	?	?
Six Minute Walking Test	Stroke	Chronic	18	+	?	+	+	?	?	?	?
Six Minute Walking Test	Stroke	Chronic	25	+	?	?	?	?	?	+	?
Six Minute Walking Test	Stroke	Chronic	12	+	?	+	?	?	?	?	?
Six Minute Walking Test	Stroke	Sub-acute	24	+	?	+	?	?	?	+	?
Six Minute Walking Test	Stroke	Sub-	37	+	?	+	?	?	+	+	?

		acute								
Six Minute Walking Test	Stroke	Sub-acute	83	+	?	+	?	?	+	?	?
Six Minute Walking Test	Stroke	Sub-acute	45	+	?	+	+	?	+	+	?
Dynamic Gait Index (DGI)	Stroke	Chronic	25	+	?	+	+	?	?	?	?
Dynamic Gait Index (DGI)	Stroke	Sub-acute	45	+	?	+	?	?	?	+	?
Footswitches	Stroke	Sub-acute	25	+	?	+	?	?	+	+	?
Functional Ambulation Category (FAC)	Stroke	Chronic	25	+	?	+	?	?	?	?	?
Functional Ambulation Category (FAC)	Stroke	Sub-acute	55	+	?	+	?	?	?	+	?
Functional Ambulation Classification Hospital (FACHS)	Stroke	Chronic	31	+	?	?	?	?	?	+	?
Functional Gait Assessment (FGA)	Stroke	Chronic	45	+	?	?	+	+	?	?	?
Pedometers	Stroke	Chronic		+	?	?	?	?	?	?	?
Ambulatory Monitoring (AM Accelerometer)	Stroke	Chronic	25	+	?	?	?	?	?	+	?
Van Peppen (2007) [32]											
Ten Meter Waling Test	Stroke	Chronic		?	?	?	+	+	?	+	?
Barthel Index (BI)	Stroke	Chronic		?	?	+	+	?	?	+	?
Berg Balance Scale (BBS)	Stroke	Chronic		?	?	+	+	?	?	+	?
Frenchay Activities Index (FAI)	Stroke	Chronic		?	?	+	?	?	?	+	?
Functional Ambulation Category (FAC)	Stroke	Chronic		?	?	?	+	+	?	+	?
Motricity index (MI)	Stroke	Chronic		?	?	+	+	?	?	+	?
Trunk Control Test	Stroke	Chronic		?	?	?	+	+	?	+	?
Velstra (2011) [33]											
Action Research Arm test	Stroke	Chronic	53	?	?	+	+	?	?	?	-
Action Research Arm test (ARAT)	Stroke	Chronic	40	+	+	+	+	?	?	?	-
Fugl-Meyer Assessment (FMA)	Stroke	Chronic	377	?	?	+	+	?	?	?	?
Functional Independence measure (FIM)	Stroke	Chronic	18	+	?	?	-	?	?	?	-
Grasp-Release test	Stroke	Chronic	60	?	?	?	?	?	?	?	-
Grasp-Release test	Stroke	Chronic	12	?	+	?	?	?	?	?	+
Jebsen Hand Function Test	Stroke	Chronic	33	?	?	?	?	?	?	?	
Medical Outcomes Study 36-Item Short Form Health Survey (SF-36)	Stroke	Chronic	19	+	?	?	+	?	?	?	-
Modified Ashworth scale	Stroke	Acute	36	?	?	?	+	?	?	?	?
Motor Activity Log	Stroke	Chronic		+	+	-	?	?	?	?	-
Quadriplegia Index of Function	Stroke	Chronic	60	?	?	+	?	?	?	?	-
Van Lieshout Test Short Form	Stroke	Chronic	60	?	?	?	?	?	?	?	-
Van Lieshout Test Short Form	Stroke	Chronic	30	?	?	?	-	?	?	?	-
Wolf Motor Function Test (WMFT)	Stroke	Chronic	24	?	+	+	+	?	?	?	?
Verheyden (2006) [34]											

Trunk Control test	Stroke	Chronic	20	?	+	?	?	-	?	+	?
Trunk Impairment Scale	Stroke	Chronic		+	+	?	+	+	+	+	?
Trunk Impairment Scale	Stroke	Chronic	73	?	+	?	?	+	?	?	+
Wilde (2010) [35]											
European Quality of life scale-EQ5D	Traumatic brain injury		86	?	?	+	?	?	?	?	?
Functional Independence measure (FIM)	Traumatic brain injury		332	+	?	+	?	?	?	?	?
Functional Independence measure (FIM)	Traumatic brain injury			?	?	?	+	?	?	?	?
Grooved Pegboard Test (GPT)	Traumatic brain injury			?	?	+	?	?	?	-	?
Mayo-Portland Adaptability Inventory (MPAI-4)	Traumatic brain injury		339	?	+	?	+	?	?	+	?
Medical Outcomes Study 36-Item Short Form Health Survey (SF-36)	Traumatic brain injury			?	+	?	?	?	?	+	?
Satisfaction with Life Scale (SWLS)	Traumatic brain injury			+	?	+	?	?	?	?	?

Appendix 6. Synthesis the results of measurement properties (overall rating and modified-GRADE approach)

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
10MWT [22]	Stroke	Acute	42	?	?	?	?	?	?	?	+
10MWT [22]	Stroke	Acute	50	?	?	?	?	?	?	?	+
10MWT [30]	Stroke	Acute	81	?	?	?	+	?	?	?	?
Overall rating	**Stroke**	**Acute**		?	?	?	+	?	?	?	+
Quality of evidence	**Stroke**	**Acute**		Inconsistent	Inconsistent	Inconsistent	High	Inconsistent	Inconsistent	Inconsistent	High
10MWT [9]	Stroke	Chronic		?	?	+	+	?	?	-	+
10MWT [27]	Stroke	Chronic		?	?	+	?	?	?	?	+
10MWT [30]	Stroke	Chronic	22	?	?	?	+	?	?	?	?
10MWT [30]	Stroke	Chronic	40	?	?	?	?	?	?	+	?
10MWT [30]	Stroke	Chronic	60	?	?	?	+	+	?	?	?
10MWT [30]	Stroke	Chronic	19	?	?	?	?	?	?	?	+
10MWT [31]	Stroke	Chronic	50	+	?	+	?	?	+	?	?
10MWT [31]	Stroke	Chronic	28	+	?	?	?	?	?	+	?
10MWT [31]	Stroke	Chronic	18	+	?	?	?	?	+	?	?
10MWT [31]	Stroke	Chronic	50	+	?	?	+	?	+	?	?
10MWT [31]	Stroke	Chronic	20	+	?	+	?	?	?	+	?
10MWT [32]	Stroke	Chronic		?	?	?	+	+	?	+	?
Overall rating	**Stroke**	**Chronic**		+	?	+	+	?	+	+	+
Quality of evidence	**Stroke**	**Chronic**		High	Inconsistent	High	High	Inconsistent	Moderate (-1)	High	Low (-2)
10MWT [4]	Stroke	Sub-acute		?	?	+	?	?	?	-	+
10MWT [27]	Stroke	Sub-acute		?	?	+	?	?	?	?	?
10MWT [31]	Stroke	Sub-acute	12	+	?	+	?	?	+	+	?
10MWT [31]	Stroke	Sub-acute	12	+	?	+	?	?	?	?	?
10MWT [31]	Stroke	Sub-acute	43	+	?	?	?	?	?	+	?
Overall rating	**Stroke**	**Sub-acute**		+	?	+	?	?	+	+	+
Quality of evidence	**Stroke**	**Sub-acute**		Moderate (-1)	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Low (-2)	Low (-2)	Low (-2)
10MWT [27]	TBI		94	?	?	+	?	?	?	?	?
10MWT [30]	TBI		12	?	?	?	?	+	?	+	?
10MWT [30]	TBI		13	?	?	+	+	?	?	?	?
10MWT	**TBI**			?	?	+	+	+	?	+	?
10MWT	**TBI**			Inconsistent	Inconsistent	High	Low (-2)	Low (-2)	Inconsistent	Low (-2)	inconsistent
12MWT [30]	Stroke	Acute	18	?	?	?	+	+	?	?	?
Overall rating	**Stroke**	**Acute**		?	?	?	+	+	?	?	?

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Quality of evidence	**Stroke**	**Acute**		Inconsistent	Inconsistent	Inconsistent	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Inconsistent
12MWT [18]	Stroke	Chronic	25	+	?	?	?	?	?	+	?
12MWT [22]	Stroke	Chronic	18	?	?	?	?	?	?	?	+
12MWT [31]	Stroke	Chronic	18	+	?	?	+	+	?	?	?
12MWT [31]	Stroke	Chronic	25	+	?	?	?	?	?	+	?
Overall rating	**Stroke**	**Chronic**		+	?	?	+	+	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Moderate (-1)	Inconsistent	Inconsistent	Low (-2)	Low (-2)	Inconsistent	Moderate (-1)	Low (-2)
12MWT [18]	Stroke	Sub-acute	20	+	?	?	?	+	?	+	?
Overall rating	**Stroke**	**Sub-acute**		+	?	?	?	+	?	+	?
Quality of evidence	**Stroke**	**Sub-acute**		Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent	Low (-2)	Inconsistent
2MWT [22]	Stroke	Acute	18	?	?	+	+	?	?	?	+
2MWT	**Stroke**	**Acute**		?	?	+	+	?	?	?	+
2MWT	**Stroke**	**Acute**		Inconsistent	Inconsistent	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)
2MWT [18]	Stroke	Chronic	61	+	?	?	?	+	+	?	?
2MWT [18]	Stroke	Chronic	12	+	?	?	?	+	+	?	?
2MWT [18]	Stroke	Chronic	32	+	?	?	?	+	+	?	?
2MWT [18]	Stroke	Chronic	17	+	?	?	?	+	+	?	?
2MWT [30]	Stroke	Chronic		?	?	+	+	?	?	?	?
2MWT [31]	Stroke	Chronic	18	+	?	?	+	+	?	?	?
Overall rating	**Stroke**	**Chronic**		+	?	+	+	+	+	?	?
Quality of evidence	**Stroke**	**Chronic**		High	Inconsistent	Low (-2)	Low (-2)	High	High	Inconsistent	Inconsistent
5MWT [18]	Stroke	Chronic	9	+	?	?	?	+	+	?	?
5MWT [18]	Stroke	Chronic	20	+	?	?	?	?	?	+	?
5MWT [18]	Stroke	Chronic	10	+	?	?	?	?	?	+	?
5MWT [27]	Stroke	Chronic		?	?	+	?	?	?	?	?
5MWT [30]	Stroke	Chronic	61	?	?	?	?	?	?	?	+
5MWT [30]	Stroke	Chronic	35	?	?	?	+	+	?	+	?
5MWT [31]	Stroke	Chronic	35	+	?	+	?	?	?	?	?
Overall rating	**Stroke**	**Chronic**		+	?	+	?	+	+	+	+
Quality of evidence	**Stroke**	**Chronic**		Moderate (-1)	Inconsistent	Low (-2)	Low (-2)	Low (-2)	Low (-2)	Moderate (-1)	Moderate (-1)
6MWT [18]	Stroke	Acute	37	+	?	?	?	+	+	?	?
6MWT [18]	Stroke	Acute	24	+	?	?	?	+	+	?	?
6MWT [18]	Stroke	Acute	13	+	?	?	?	+	+	?	?
6MWT [18]	Stroke	Acute	41	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Acute	30	+	?	?	?	?	?	+	?
6MWT [30]	Stroke	Acute	18	?	?	?	+	+	?	?	?
Overall rating	**Stroke**	**Acute**		+	?	?	+	+	+	+	?

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Quality of evidence	Stroke	Acute		High	Inconsistent	Inconsistent	Low (-2)	Moderate (-1)	Moderate (-1)	Moderate (-1)	Inconsistent
6MWT [9]	Stroke	Chronic		?	?	?	+	+	?	-	?
6MWT [18]	Stroke	Chronic	83	+	?	?	?	+	?	?	?
6MWT [18]	Stroke	Chronic	12	+	?	?	?	+	+	?	?
6MWT [18]	Stroke	Chronic	10	+	?	?	?	+	?	?	?
6MWT [18]	Stroke	Chronic	50	+	?	?	?	+	+	?	?
6MWT [18]	Stroke	Chronic	27	+	?	?	?	+	+	?	?
6MWT [18]	Stroke	Chronic	27	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	36	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	34	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	50	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	61	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	64	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	12	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	34	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	25	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	48	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	30	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	21	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	40	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	77	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	40	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	49	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	17	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	42	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	50	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	68	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	25	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	25	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	30	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Chronic	77	+	?	?	?	?	?	+	?
6MWT [22]	Stroke	Chronic	18	?	?	?	?	?	?	?	+
6MWT [27]	Stroke	Chronic		?	?	+	+	?	?	?	?
6MWT [30]	Stroke	Chronic	37	?	?	?	+	?	?	+	?
6MWT [31]	Stroke	Chronic	15	+	?	+	?	?	+	?	?
6MWT [31]	Stroke	Chronic	18	+	?	+	+	?	?	?	?
6MWT [31]	Stroke	Chronic	25	+	?	?	?	?	?	+	?
6MWT [31]	Stroke	Chronic	12	+	?	+	?	?	?	?	?
Overall rating	Stroke	Chronic		+	?	+	+	+	+	+	+
Quality of evidence	Stroke	Chronic		High	Inconsistent	High	High	High	High	High	Low (-2)
6MWT [31]	Stroke	Sub-acute	24	+	?	+	?	?	?	+	?
6MWT [18]	Stroke	Sub-	50	+	?	?	?	?	?	+	?

274

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
		acute									
6MWT [18]	Stroke	Sub-acute	63	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Sub-acute	48	+	?	?	?	?	?	+	?
6MWT [18]	Stroke	Sub-acute	25	+	?	?	?	?	?	+	?
6MWT [31]	Stroke	Sub-acute	37	+	?	+	?	?	+	+	?
6MWT [31]	Stroke	Sub-acute	83	+	?	+	?	?	+	?	?
6MWT [31]	Stroke	Sub-acute	45	+	?	+	+	?	+	+	?
6MWT [4]	Stroke	Sub-acute		?	?	+	?	?	+	+	?
Overall rating	**Stroke**	**Sub-acute**		+	?	+	+	?	+	+	?
Quality of evidence	**Stroke**	**Sub-acute**		High	Inconsistent	High	Low (-2)	Inconsistent	High	High	Inconsistent
6MWT [27]	TBI		36	?	?	+	?	?	?	?	?
6MWT [30]	TBI		23	?	?	?	+	?	?	?	?
6MWT [30]	TBI		13	?	?	?	+	?	?	?	?
Overall rating	**TBI**			?	?	+	+	?	?	?	?
Quality of evidence	**TBI**			Inconsistent	Inconsistent	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Inconsistent
ABILHAND [1]	Stroke	Chronic		+	+	+	+	?	?	+	+
ABILHAND [3]	Stroke	Chronic		?	?	+	?	?	?	+	+
ABILHAND [5]	stroke	Chronic	103	?	?	?	?	?	?	+	?
ABILHAND [11]	Stroke	Chronic	103	+	?	+	?	?	?	+	?
ABILHAND [12]	Stroke	Chronic		+	?	?	+	?	?	?	?
ABILHAND [17]	Stroke	Chronic		+	?	+	?	?	?	-	?
ABILHAND [24]	Stroke	Chronic		?	?	?	?	?	?	?	+
ABILHAND [25]	Stroke	Chronic		?	?	+	?	?	?	-	?
Overall rating	**Stroke**	**Chronic**		+	+	+	+	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		High	Low (-2)	High	Low (-2)	Inconsistent	Inconsistent	High	Low (-2)
Action Research Arm test (ARAT) [6]	Stroke	Chronic		?	?	?	+	?	?	+	?
Action Research Arm test	Stroke	Chronic		+	-	?	?	?	?	-	-

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
(ARAT) [3]											
Action Research Arm test (ARAT) [5]	stroke	Chronic		?	?	+	+	?	?	+	?
Action Research Arm test (ARAT) [11]	Stroke	Chronic	191	+	+	+	?	?	?	+	?
Action Research Arm test (ARAT) [11]	Stroke	Chronic	351	+	?	?	?	?	?	+	?
Action Research Arm test (ARAT) [17]	Stroke	Chronic		?	+	+	+	?	?	+	+
Action Research Arm test (ARAT) [24]	Stroke	Chronic		?	?	?	?	?	?	+	?
Action Research Arm test [25]	Stroke	Chronic		?	?	+	+	?	?	+	+
Action Research Arm test (ARAT) [33]	Stroke	Chronic	40	+	+	+	+	?	?	?	-
Action Research Arm test (ARAT) [12]	Stroke	Chronic		?	?	?	?	?	?	?	?
Action Research Arm test (ARAT) [12]	Stroke	Chronic		?	?	?	?	?	?	?	?
Action Research Arm test [33]	Stroke	Chronic	53	?	?	+	+	?	?	?	-
Overall rating	**Stroke**	**Chronic**		+	+	+	+	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		High	High	High	Low (-2)	Inconsistent	Inconsistent	High	Low (-2)
Activity Cart Sort (ACS) [13]	Stroke	Chronic	29	?	?	?	?	?	?	+	?
Activity Cart Sort (ACS) [29]	Stroke	Chronic		+	-	+	?	?	?	+	?
Activity Cart Sort (ACS) [13]	Stroke	Chronic	60	?	+	+	?	?	?	+	?
Overall rating	**Stroke**	**Chronic**		+	+	+	?	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Low (-2)	Moderate (-1)	Moderate (-1)	Inconsistent	Inconsistent	Inconsistent	Moderate (-1)	Inconsistent
Actiwatch [8]	Stroke	Acute	52	?	?	?	?	?	?	+	?
Overall rating	**Stroke**	**Acute**		?	?	?	?	?	?	+	?
Quality of evidence	**Stroke**	**Acute**		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Moderate (-1)	Inconsistent
Actiwatch [8]	Stroke	Chronic	11	?	?	?	?	?	?	+	?

276

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Overall rating	Stroke	Chronic		?	?	?	?	?	?	+	?
Quality of evidence	Stroke	Chronic		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Ambulatory Monitoring (AM Accelerometer) [8]	Stroke	Acute	43	?	?	?	?	?	?	+	?
Overall rating	Stroke	Acute		?	?	?	?	?	?	+	?
Quality of evidence	Stroke	Acute		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Ambulatory Monitoring (AM Accelerometer) [31]	Stroke	Chronic	25	+	?	?	?	?	?	+	?
Overall rating	Stroke	Chronic		+	?	?	?	?	?	+	?
Quality of evidence	Stroke	Chronic		Low (-2)	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Arm Motor Ability Test (AMAT) [17]	Stroke	Sub-acute	32	?	+	+	-	?	?	-	+
Overall rating	Stroke	Sub-acute		?	+	+	-	?	?	-	+
Quality of evidence	Stroke	Sub-acute		Inconsistent	Low (-2)	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Low (-2)	Low (-2)
Arm Motor Ability Test (AMAT) [11]	Stroke	Chronic	36	+	?	?	?	?	?	?	?
Arm Motor Ability Test (AMAT) [12]	Stroke	Chronic		?	?	?	?	?	?	?	?
Arm Motor Ability Test (AMAT) [25]	Stroke	Chronic		?	?	+	+	?	?	?	?
Overall rating	Stroke	Chronic		+	?	+	+	?	?	?	?
Quality of evidence	Stroke	Chronic		Low (-2)	Inconsistent	Inconsistent	Low (-2)	Inconsistent	inconsistent	inconsistent	inconsistent
Barthel Index (BI) [21]	Stroke	Acute	22	?	+	+	+	+	?	+	+
Overall rating	Stroke	Acute		?	+	+	+	+	?	+	+
Quality of evidence	Stroke	Acute		inconsistent	Low (-2)	Low (-2)	Low (-2)	Low (-2)	Inconsistent	Low (-2)	Low (-2)
Barthel Index	Stroke	Chronic	30	?	?	+	?	?	?	+	+

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
(BI) [4]											
Barthel Index (BI) [32]	Stroke	Chronic		?	?	+	+	?	?	+	?
Barthel Index (BI) [15]	Stroke	Chronic		?	?	+	?	+	?	+	+
Barthel Index (BI) [25]	Stroke	Chronic	167	?	?	+	+	?	?	-	+
Overall rating	**Stroke**	**Chronic**		?	?	+	+	+	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	High	High	Low (-2)	Inconsistent	High	High
Beck Depression Inventory (BDI) [4]	Stroke	Acute	202	?	?	+	?	?	?	+	-
Overall rating	**Stroke**	**Acute**		?	?	+	?	?	?	+	-
Quality of evidence	**Stroke**	**Acute**		Inconsistent	Inconsistent	High	Inconsistent	Inconsistent	Inconsistent	High	Moderate (-2)
Beck Depression Inventory (BDI) [19]	Stroke	Chronic	202	+	+	-	?	?	?	+	+
Overall rating	**Stroke**	**Chronic**		+	+	-	?	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		High	High	Moderate (-2)	Inconsistent	Inconsistent	Inconsistent	High	High
Berg Balance Scale (BBS) [21]	Stroke	Acute		?	+	+	+	?	?	+	+
Berg Balance Scale (BBS) [22]	Stroke	Acute	50	?	?	?	?	?	?	?	+
Berg Balance Scale (BBS) [22]	Stroke	Acute	110	?	?	?	?	?	?	?	+
Berg Balance Scale (BBS) [22]	Stroke	Acute	93	?	?	?	?	?	?	?	+
Berg Balance Scale (BBS) [22]	Stroke	Acute	80	?	?	?	?	?	?	?	+
Berg Balance Scale (BBS) [22]	Stroke	Acute	93	?	?	?	?	?	?	?	+
Berg Balance Scale (BBS)	Stroke	Acute	80	?	?	?	?	?	?	?	+

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
[22]											
Berg Balance Scale (BBS) [22]	Stroke	Acute	60	?	?	?	?	?	?	?	+
Overall rating	**Stroke**	**Acute**		?	+	+	+	?	?	+	+
Quality of evidence	**Stroke**	**Acute**		Inconsistent	Low (-2)	Low (-2)	Low (-2)	Inconsistent	inconsistent	Low (-2)	High
Berg Balance Scale (BBS) [4]	Stroke	Chronic	70	?	?	+	?	?	?	+	+
Berg Balance Scale (BBS) [32]	Stroke	Chronic		?	?	+	+	?	?	+	?
Overall rating	**Stroke**	**Chronic**		?	?	+	+	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		inconsistent	inconsistent	Moderate (-1)	Low (-2)	Inconsistent	inconsistent	Moderate (-1)	Moderate (-1)
Berg Balance Scale (BBS) [9]	Stroke	Sub-acute	15	?	?	+	+	?	?	-	+
Overall rating	**Stroke**	**Sub-acute**		?	?	+	+	?	?	-	+
Quality of evidence	**Stroke**	**Sub-acute**		inconsistent	inconsistent	Low (-2)	Low (-2)	Inconsistent	inconsistent	Low (-2)	Low (-2)
Berg Balance Scale three point (BBS-3P) [22]	Stroke	Acute	202	?	?	?	?	?	?	?	+
Berg Balance Scale three point (BBS-3P) [22]	Stroke	Acute	167	?	?	?	?	?	?	?	+
Berg Balance Scale three point (BBS-3P) [22]	Stroke	Acute	167	?	?	?	?	?	?	?	+
Overall rating	**Stroke**	**Acute**		?	?	?	?	?	?	?	+
Quality of evidence	**Stroke**	**Acute**		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	High
Box and Block test [5]	Stroke	Chronic	15	?	?	+	+	+	?	+	?
Box and Block test [25]	Stroke	Chronic	37	?	?	+	?	?	?	-	-
Overall rating	**Stroke**	**Chronic**		?	?	+	+	+	?	+	-
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Moderate (-1)	Low (-2)	Low (-2)	Inconsistent	Low (-2)	Low (-2)
Caltrac accelerometer [7]	Stroke	Chronic	17	?	?	-	?	?	?	?	?
Caltrac accelerometer [8]	Stroke	Chronic	27	?	?	-	?	?	?	?	?

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Overall rating	**Stroke**	**Chronic**		?	?	-	?	?	?	?	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent
Chedoke Arm and Hand Inventory (CAHAI) [17]	Stroke	Chronic		+	+	+	-	?	?	+	+
Chedoke Arm and Hand Inventory (CAHAI) [12]	Stroke	Chronic		?	?	?	?	?	?	?	?
Chedoke Arm and Hand Inventory (CAHAI) [25]	Stroke	Chronic		?	?	?	+	?	?	?	+
Chedoke Arm and Hand Inventory (CAHAI) [3]	Stroke	Chronic	109	+	+	+	+	?	?	+	?
Overall rating	**Stroke**	**Chronic**		+	+	+	+	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		High	High	High	High	Inconsistent	Inconsistent	High	Low (-2)
Chedoke McMaster Stroke assessment scale (CMSA) [4]	Stroke	Acute	32	?	?	+	?	?	?	+	+
Overall rating	**Stroke**	**Acute**		?	?	+	?	?	?	+	+
Quality of evidence	**Stroke**	**Acute**		Inconsistent	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Low (-2)
Chedoke McMaster Stroke assessment scale (CMSA) [21]	Stroke	Chronic	127	?	+	+	+	+	?	+	+
Chedoke McMaster Stroke assessment scale (CMSA) [25]	Stroke	Chronic		?	?	?	+	?	?	-	?
Chedoke McMaster Stroke assessment scale (CMSA) [6]	Stroke	Chronic		?	?	?	+	?	?	+	?

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Overall rating	**Stroke**	**Chronic**		?	+	+	+	+	?	-	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	High	High	High	High	Inconsistent	High	High
Community balance and mobility scale (CB&M) [16]	Stroke	Chronic	44	?	?	?	?	?	?	+	+
Overall rating	**Stroke**	**Chronic**		?	?	?	?	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Low (-2)
Community balance and mobility scale (CB&M) [30]	TBI		32	?	?	?	+	+	?	+	?
Overall rating	**TBI**			?	?	?	+	+	?	+	?
Quality of evidence	**TBI**			Inconsistent	Inconsistent	Inconsistent	Low (-2)	Low (-2)	Inconsistent	Low (-2)	Inconsistent
Dynamic Gait Index (DGI) [16]	Stroke	Chronic		?	?	+	-	-	?	?	?
Dynamic Gait Index (DGI) [31]	Stroke	Chronic	25	+	?	+	+	?	?	?	?
Overall rating	**Stroke**	**Chronic**		+	?	+	+	-	?	?	?
Quality of evidence	**Stroke**	**Chronic**		Low (-2)	Inconsistent	Low (-2)	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Inconsistent
Dynamic Gait Index (DGI) [31]	Stroke	Sub-acute	45	+	?	+	?	?	?	+	?
Overall rating	**Stroke**	**Sub-acute**		+	?	+	?	?	?	+	?
Quality of evidence	**Stroke**	**Sub-acute**		Low (-2)	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
European Quality of life scale (EQ5D) [35]	TBI		86	?	?	+	?	?	?	?	?
Overall rating	**TBI**			?	?	+	?	?	?	?	?
Quality of evidence	**TBI**			Inconsistent	Inconsistent	Moderate (-1)	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent
European Quality of life scale (EQ5D) [25]	Stroke	Acute		?	?	+	?	?	?	-	?
Overall rating	**Stroke**	**Acute**		?	?	+	?	?	?	-	?
Quality of	**Stroke**	**Acute**		Inconsistent	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
evidence				nt							
European Quality of life scale (EQ5D) [4]	Stroke	Chronic		?	?	-	?	?	?	-	+
European Quality of life scale (EQ5D) [14]	Stroke	Chronic	15	?	?	+	?	?	?	?	?
European Quality of life scale (EQ5D) [20]	Stroke	Chronic		?	?	-	?	?	?	+	?
European Quality of life scale (EQ5D) [28]	Stroke	Chronic		?	?	+	?	?	?	?	?
Overall rating	Stroke	Chronic		?	?	+	?	?	?	+	+
Quality of evidence	Stroke	Chronic		Inconsistent	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Low (-2)
Five times Sit to Stand test [23]	Stroke	Chronic	19	+	?	+	?	?	+	?	?
Five times Sit to Stand test [23]	Stroke	Chronic	12	+	?	+	+	+	?	+	+
Five times Sit to Stand test [23]	Stroke	Chronic	27	+	?	?	?	?	?	+	?
Overall rating	Stroke	Chronic		+	?	+	+	+	+	+	+
Quality of evidence	Stroke	Chronic		Moderate (-1)	Inconsistent	Moderate (-1)	Low (-2)	Low (-2)	Low (-2)	Low (-2)	Low (-2)
Footswitches [8]	Stroke	Chronic	25	?	?	?	?	?	?	+	?
Overall rating	Stroke	Chronic		?	?	?	?	?	?	+	?
Quality of evidence	Stroke	Chronic		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Footswitches [31]	Stroke	Sub-acute	25	+	?	+	?	?	+	+	?
Overall rating	Stroke	Sub-acute		+	?	+	?	?	+	+	?
Quality of evidence	Stroke	Sub-acute		Low (-2)	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Low (-2)	Low (-2)	Inconsistent
Frenchay Activities Index (FAI) [21]	Stroke	Acute	35	?	+	+	+	?	?	-	?
Overall rating	Stroke	Acute		?	+	+	+	?	?	-	?
Quality of evidence	Stroke	Acute		Inconsistent	Low (-2)	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Frenchay	Stroke	Chronic	36	?	?	?	+	?	?	+	?

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Activities Index (FAI) [13]											
Frenchay Activities Index (FAI) [13]	Stroke	Chronic	238	?	?	?	?	?	?	+	?
Frenchay Activities Index (FAI) [13]	Stroke	Chronic	52	?	?	+	?	?	?	?	?
Frenchay Activities Index (FAI) [13]	Stroke	Chronic	127	?	+	?	?	?	?	?	?
Frenchay Activities Index (FAI) [13]	Stroke	Chronic	70	?	?	?	?	?	?	+	+
Frenchay Activities Index (FAI) [13]	Stroke	Chronic	163	?	?	?	?	?	?	?	+
Frenchay Activities Index (FAI) [13]	Stroke	Chronic	45	?	?	?	+	?	?	?	?
Frenchay Activities Index (FAI) [13]	Stroke	Chronic	22	?	?	+	?	?	?	?	?
Frenchay Activities Index (FAI) [13]	Stroke	Chronic	68	?	?	?	+	?	?	?	?
Frenchay Activities Index (FAI) [13]	Stroke	Chronic	188	?	+	?	?	?	?	+	?
Frenchay Activities Index (FAI) [13]	Stroke	Chronic	14	?	?	?	+	?	?	?	?
Frenchay Activities Index (FAI) [13]	Stroke	Chronic	581	+	?	?	?	?	?	?	?
Frenchay Activities Index (FAI) [13]	Stroke	Chronic	935	?	?	?	?	?	?	+	?
Frenchay Activities Index (FAI) [13]	Stroke	Chronic	383	?	?	?	?	?	?	?	+
Frenchay Activities Index (FAI) [29]	Stroke	Chronic		+	+	?	+	?	?	+	?
Frenchay Activities Index	Stroke	Chronic		?	?	+	?	?	?	+	?

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
(FAI) [32]											
Frenchay Activities Index (FAI) [13]	Stroke	Chronic		?	?	+	?	?	?	+	?
Frenchay Activities Index (FAI) [14]	Stroke	Chronic		?	?	-	?	?	?	?	?
Overall rating	Stroke	Chronic		+	+	+	+	?	?	+	+
Quality of evidence	Stroke	Chronic		High	High	Moderate (-1)	High	Inconsistent	Inconsistent	High	High
Frenchay Arm Test (FAT) [12]	Stroke	Chronic	45	?	?	?	+	?	?	?	?
Frenchay Arm Test (FAT) [4]	Stroke	Chronic	38	?	?	-	?	?	?	+	-
Frenchay Arm Test (FAT) [25]	Stroke	Chronic	10	?	?	+	+	?	?	?	?
Overall rating	Stroke	Chronic		?	?	+	+	?	?	+	-
Quality of evidence	Stroke	Chronic		Inconsistent	Inconsistent	Low (-2)	Moderate (-1)	Inconsistent	Inconsistent	Moderate (-1)	Low (-2)
Fugl-Meyer Assessment (FMA) [25]	Stroke	Acute		?	?	+	+	?	?	-	+
Fugl-Meyer Assessment (FMA) [10]	Stroke	Acute	78	?	+	+	+	?	?	+	+
Fugl-Meyer Assessment (FMA) [19]	Stroke	Acute		?	+	?	+	+	?	+	+
Overall rating	Stroke	Acute		?	+	+	+	+	?	+	+
Quality of evidence	Stroke	Acute		Inconsistent	Moderate (-1)	Moderate (-1)	Moderate (-1)	Low (-2)	Inconsistent	Moderate (-1)	Moderate (-1)
Fugl-Meyer Assessment (FMA) [3]	Stroke	Chronic		?	-	?	?	?	?	-	-
Fugl-Meyer Assessment (FMA) [4]	Stroke	Chronic		?	?	+	?	?	?	+	+
Fugl-Meyer Assessment (FMA) [33]	Stroke	Chronic	377	?	?	+	+	?	?	?	?
Fugl-Meyer Assessment (FMA) [6]	Stroke	Chronic		?	?	?	+	?	?	+	?
Overall rating	Stroke	Chronic		?	-	+	+	?	?	+	+
Quality of evidence	Stroke	Chronic		Inconsistent	Inconsistent	High	High	Inconsistent	Inconsistent	Low (-2)	Low (-2)

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Fugl-Meyer test-Balance subscale (FM-B) [22]	Stroke	Acute	110	?	?	?	?	?	?	?	+
Fugl-Meyer test-Balance subscale (FM-B) [22]	Stroke	Acute	93	?	?	?	?	?	?	?	+
Fugl-Meyer test-Balance subscale (FM-B) [22]	Stroke	Acute	80	?	?	?	?	?	?	?	+
Fugl-Meyer test-Balance subscale (FM-B) [22]	Stroke	Acute	93	?	?	?	?	?	?	?	+
Fugl-Meyer test-Balance subscale (FM-B) [22]	Stroke	Acute	80	?	?	?	?	?	?	?	+
Overall rating	**Stroke**	**Acute**		?	?	?	?	?	?	?	+
Quality of evidence	**Stroke**	**Acute**		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	High
Functional Ambulation Category (FAC) [9]	Stroke	Acute		?	?	+	+	?	?	-	+
Functional Ambulation Category (FAC) [22]	Stroke	Acute	101	?	?	?	?	?	?	?	+
Overall rating	**Stroke**	**Acute**		?	?	+	+	?	?	-	+
Quality of evidence	**Stroke**	**Acute**		Inconsistent	Inconsistent	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Low (-2)	High
Functional Ambulation Category (FAC) [30]	Stroke	Chronic	31	?	?	?	?	+	?	+	?
Functional Ambulation Category (FAC) [30]	Stroke	Chronic	55	?	?	?	+	+	?	+	?
Functional Ambulation Category (FAC) [31]	Stroke	Chronic	25	+	?	+	?	?	?	?	?

285

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Functional Ambulation Category (FAC) [32]	Stroke	Chronic		?	?	?	+	+	?	+	?
Overall rating	**Stroke**	**Chronic**		+	?	+	+	+	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Low (-2)	Inconsistent	Low (-2)	Moderate (-1)	Moderate (-1)	Inconsistent	Moderate (-1)	Inconsistent
Functional Ambulation Category (FAC) [22]	Stroke	Sub-acute	55	?	?	?	?	?	?	?	+
Functional Ambulation Category (FAC) [30]	Stroke	Sub-acute	20	?	?	?	?	?	?	+	?
Functional Ambulation Category (FAC) [31]	Stroke	Sub-acute	55	+	?	+	?	?	?	+	?
Overall rating	**Stroke**	**Sub-acute**		+	?	+	?	?	?	+	+
Quality of evidence	**Stroke**	**Sub-acute**		Moderate (-1)	Inconsistent	Moderate (-1)	Inconsistent	Inconsistent	Inconsistent	Moderate (-1)	Moderate (-1)
Functional Independence measure (FIM) [21]	Stroke	Acute	52	?	+	+	+	?	?	+	+
Overall rating	**Stroke**	**Acute**		?	+	+	+	?	?	+	+
Quality of evidence	**Stroke**	**Acute**		Inconsistent	Moderate (-1)	Moderate (-1)	Moderate (-1)	Inconsistent	Inconsistent	Moderate (-1)	Moderate (-1)
Functional Independence measure (FIM) [33]	Stroke	Chronic	18	+	?	?	-	?	?	?	-
Functional Independence measure (FIM) [15]	stroke	Chronic		?	?	?	+	+	?	+	+
Functional Independence measure (FIM) [4]	stroke	Chronic		?	?	+	?	?	?	-	+
Functional Independence measure (FIM) [25]	Stroke	Chronic	83	+	?	+	+	?	?	-	+

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Functional Independence measure (FIM) [14]	Stroke	Chronic		?	?	+	?	?	?	?	?
Overall rating	**Stroke**	**Chronic**		+	?	+	+	+	?	+	+
Quality of evidence	**Stroke**	**Chronic**		High	Inconsistent	Moderate (-1)	Moderate (-1)	Low (-2)	Inconsistent	Moderate (-2)	Moderate (-1)
Functional Independence measure (FIM) [35]	TBI	332		+	?	+	?	?	?	?	?
Functional Independence measure (FIM) [35]	TBI			?	?	?	+	?	?	?	?
Overall rating	**TBI**			+	?	+	+	?	?	?	?
Quality of evidence	**TBI**			High	Inconsistent	High	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Inconsistent
Grasp-Release test [33]	Stroke	Chronic	60	?	?	?	?	?	?	?	-
Grasp-Release test [33]	Stroke	Chronic	12	?	+	?	?	?	?	?	+
Overall rating	**Stroke**	**Chronic**		?	+	?	?	?	?	?	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Moderate (-1)
Human activity profile (HAP) [2]	Stroke	Chronic		+	+	+	+	?	?	-	-
Human activity profile (HAP) [13]	Stroke	Chronic	24	?	?	?	?	?	?	+	?
Overall rating	**Stroke**	**Chronic**		+	+	+	+	?	?	+	-
Quality of evidence	**Stroke**	**Chronic**		Low (-2)	Low (-2)	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Low (-2)	Low (-2)
Jebsen Hand Function Test [33]	Stroke	Chronic	33	?	?	?	?	?	?	?	-
Jebsen Hand Function Test [12]	Stroke	Chronic		?	?	+	?	?	?	+	+
Overall rating	**Stroke**	**Chronic**		?	?	+	?	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Low (-2)
London Handicap scale (LHS) [29]	Stroke	Chronic	37	+	+	+	?	?	?	+	?

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Overall rating	Stroke	Chronic		+	+	+	?	?	?	+	?
Quality of evidence	Stroke	Chronic		Low (-2)	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
London handicap score-LHS [28]	Stroke	Acute	361	+	?	+	+	?	?	+	?
Overall rating	Stroke	Acute		+	?	+	+	?	?	+	?
Quality of evidence	Stroke	Acute		High	inconsistent	High	High	Inconsistent	Inconsistent	High	Inconsistent
MESUPES (Motor Evaluation Scale for Upper Extremity in Stroke Patients) [12]	Stroke	Chronic		?	?	?	?	?	?	?	?
MESUPES (Motor Evaluation Scale for Upper Extremity in Stroke Patients) [11]	Stroke	Chronic	396	+	?	+	?	?	?	+	?
Overall rating	Stroke	Chronic		+	?	+	?	?	?	+	?
Quality of evidence	Stroke	Chronic		High	Inconsistent	High	Inconsistent	Inconsistent	Inconsistent	High	Inconsistent
Mini Mental State Examination (MMSE) [4]	Stroke	Acute	116	?	?	+	?	?	?	-	?
Overall rating	Stroke	Acute		?	?	+	?	?	?	-	?
Quality of evidence	Stroke	Acute		Inconsistent	Inconsistent	High	Inconsistent	Inconsistent	Inconsistent	Moderate (-2)	Inconsistent
Mini-Mental State Examination (MMSE) [19]	Stroke	Chronic	75	?	-	-	-	+	?	+	?
Overall rating	Stroke	Chronic		?	-	-	-	+	?	+	?
Quality of evidence	Stroke	Chronic		Inconsistent	Moderate (-2)	Moderate (-1)	Moderate (-2)	Moderate (-1)	Inconsistent	Moderate (-1)	Inconsistent
Modified Ashworth scale [4]	Stroke	Acute		?	?	-	?	?	?	-	?
Modified Ashworth scale [25]	Stroke	Acute		?	?	+	+	?	?	-	?

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Modified Ashworth scale [33]	Stroke	Acute	36	?	?	?	+	?	?	?	?
Modified Ashworth scale [19]	Stroke	Acute		?	?	?	-	-	?	+	?
Overall rating	**Stroke**	**Acute**		?	?	+	+	-	?	+	?
Quality of evidence	**Stroke**	**Acute**		Inconsistent	Inconsistent	Low (-2)	Low (-2)	Low (-2)	Inconsistent	Low (-2)	Inconsistent
Modified Emory Functional Ambulation Profile (M-EFAM) [22]	Stroke	Acute	40	?	?	?	?	?	?	?	+
Overall rating	**Stroke**	**Acute**		?	?	?	?	?	?	?	+
Quality of evidence	**Stroke**	**Acute**		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)
Modified Emory Functional Ambulation Profile (M-EFAM) [16]	Stroke	Chronic	26	?	?	+	?	?	?	+	+
Modified Emory Functional Ambulation Profile (M-EFAM) [30]	Stroke	Chronic	28	?	?	?	?	+	?	+	?
Modified Emory Functional Ambulation Profile (M-EFAM) [30]	Stroke	Chronic	26	?	?	?	+	+	?	+	?
Modified Emory Functional Ambulation Profile (M-EFAM) [30]	Stroke	Chronic	40	?	?	?	+	?	?	+	?
Overall rating	**Stroke**	**Chronic**		?	?	+	+	+	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Low (-2)	Moderate (-1)	Moderate (-1)	Inconsistent	High	Low (-2)
Modified Functional Reach test (MFRT) [26]	Stroke	Chronic		?	?	+	?	+	?	?	+
Modified Functional	Stroke	Chronic	35	?	?	?	?	?	?	?	+

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Reach test (MFRT) [22]											
Overall rating	**Stroke**	**Chronic**		?	?	+	?	+	?	?	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Low (-2)	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Low (-2)
Modified Rankin Handicap scale [4]	Stroke	Acute	1034	?	?	+	?	?	?	-	-
Overall rating	**Stroke**	**Acute**		?	?	+	?	?	?	-	-
Quality of evidence	**Stroke**	**Acute**		Inconsistent	Inconsistent	High	Inconsistent	Inconsistent	Inconsistent	Moderate (-1)	Moderate (-1)
Modified Rankin Handicap Scale	Stroke	Chronic	63	?	?	+	-	?	?	+	+
Overall rating	**Stroke**	**Chronic**		?	?	+	-	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Moderate (-1)	Moderate (-2)	Inconsistent	Inconsistent	Moderate (-1)	Moderate (-1)
Motor activity log [5]	Stroke	Chronic	56	?	?	?	?	?	?	+	?
Motor activity log [5]	Stroke	Chronic	20	?	?	?	?	?	?	+	?
Motor activity log [5]	Stroke	Chronic	41	?	?	?	?	?	?	+	?
Motor activity log [5]	Stroke	Chronic	27	?	?	+	?	?	?	?	?
Motor activity log (MAL-14) [1]	Stroke	Chronic		?	+	-	-	?	?	-	?
Motor activity log (MAL-14) [12]	Stroke	Chronic	56	?	?	?	?	?	?	?	?
Motor Activity Log [33]	Stroke	Chronic		+	+	-	?	?	?	?	-
Motor Activity Log [17]	Stroke	Chronic		+	+	-	?	?	?	-	+
Overall rating	**Stroke**	**Chronic**		+	+	+	?	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Low (-2)	Low (-2)	Low (-2)	Low (-2)	Inconsistent	Inconsistent	High	Low (-2)
Motor Assessment Scale (MAS) [22]	Stroke	Acute	61	?	?	?	?	?	?	?	+
Overall rating	**Stroke**	**Acute**		?	?	?	?	?	?	?	+
Quality of evidence	**Stroke**	**Acute**		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Moderate (-1)

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Motor Assessment Scale (MAS) [4]	Stroke	Chronic		?	?	+	?	?	?	+	+
Motor Assessment Scale (MAS) [6]	Stroke	Chronic		?	?	?	+	?	?	+	?
Motor Assessment Scale (MAS) [10]	Stroke	Chronic	37	?	?	+	+	?	?	+	?
Motor Assessment Scale (MAS) [25]	Stroke	Chronic		?	?	+	+	?	?	-	?
Overall rating	**Stroke**	**Chronic**		?	?	+	+	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Low (-2)	Low (-2)
Motor status score-MSS [25]	Stroke	Acute		?	?	+	+	?	?	-	?
Motor status score-MSS [5]	Stroke	Acute	18	?	?	?	?	?	?	+	?
Overall rating	**Stroke**	**Acute**		?	?	?	?	?	?	+	?
Quality of evidence	**Stroke**	**Acute**		Inconsistent	Inconsistent	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Motricity index (MI) [9]	Stroke	Chronic		?	?	?	+	?	?	-	?
Motricity index (MI) [4]	Stroke	Chronic		?	?	-	?	?	?	+	?
Motricity index (MI) [6]	Stroke	Chronic		?	?	?	+	?	?	+	?
Motricity index (MI) [32]	Stroke	Chronic		?	?	+	+	?	?	+	?
Motricity index (MI) [10]	Stroke	Chronic	55	?	+	?	+	?	?	+	?
Overall rating	**Stroke**	**Chronic**		?	+	+	+	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Moderate (-1)	Low (-2)	Moderate (-1)	Inconsistent	Inconsistent	Moderate (-1)	Inconsistent
Nine-Hole Peg test (NHPT) [6]	Stroke	Chronic		?	?	+	-	?	?	+	?
Nine-Hole Peg test (NHPT) [5]	Stroke	Chronic	62	?	?	+	?	?	?	+	?
Nine-Hole Peg test (NHPT) [25]	Stroke	Chronic		?	?	?	+	?	?	-	?
Overall rating	**Stroke**	**Chronic**		?	?	+	+	?	?	+	?
Quality of	**Stroke**	**Chronic**		Inconsiste	Inconsistent	Moderate (-	Low (-2)	Inconsistent	Inconsistent	Moderate (-	Inconsistent

291

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
evidence				nt		1)				1)	
Nottingham leisure activity (NLA) [20]	Stroke	Chronic		?	+	+	-	?	?	+	?
Nottingham leisure activity (NLA) [13]	Stroke	Chronic	21	?	?	-	?	?	?	?	?
Nottingham leisure activity (NLA) [13]	Stroke	Chronic	20	?	?	?	-	?	?	?	?
Overall rating	Stroke	Chronic		?	?	+	-	?	?	+	?
Quality of evidence	Stroke	Chronic		Inconsistent	Low (-2)	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Pedometer (Conventional) [7]	Stroke	Chronic	16	?	?	-	?	?	?	?	?
Pedometer (model 650 Yamasa Tokei Co., Yamax Digi Walker) [7]	Stroke	Chronic	20	?	?	?	?	?	?	-	+
Pedometers [8]	Stroke	Chronic	16	?	?	?	?	?	?	+	?
Pedometers [31]	Stroke	Chronic		?	?	?	?	?	?	?	?
Overall rating	Stroke	Chronic		?	?	-	?	?	?	+	+
Quality of evidence	Stroke	Chronic		Inconsistent	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Low (-2)
Postural Assessment Scale for Stroke Patients (PASS) [22]	Stroke	Acute	202	?	?	?	?	?	?	?	+
Overall rating	Stroke	Acute		?	?	?	?	?	?	?	+
Quality of evidence	Stroke	Acute		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	High
Postural Assessment Scale for Stroke Patients (PASS) [22]	Stroke	Chronic	167	?	?	?	?	?	?	?	+
Postural Assessment Scale for Stroke Patients (PASS) [22]	Stroke	Chronic	167	?	?	?	?	?	?	?	+
Postural Assessment	Stroke	Chronic		?	?	?	?	?	?	?	+

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Scale for Stroke Patients (PASS) [26]											
Overall rating	**Stroke**	**Chronic**		?	?	?	?	?	?	?	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	High
Postural Assessment Scale for Stroke Patients Trunk Control (PASS-TC) [22]	Stroke	Acute	110	?	?	?	?	?	?	?	+
Postural Assessment Scale for Stroke Patients Trunk Control (PASS-TC) [22]	Stroke	Acute	246	?	?	?	?	?	?	?	+
Overall rating	**Stroke**	**Acute**		?	?	?	?	?	?	?	+
Quality of evidence	**Stroke**	**Acute**		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	High
Postural Assessment Scale for Stroke Patients Trunk Control (PASS-TC) [22]	Stroke	Chronic	93	?	?	?	?	?	?	?	+
Postural Assessment Scale for Stroke Patients Trunk Control (PASS-TC) [22]	Stroke	Chronic	80	?	?	?	?	?	?	?	+
Postural Assessment Scale for Stroke Patients Trunk Control (PASS-TC) [22]	Stroke	Chronic	93	?	?	?	?	?	?	?	+
Postural Assessment Scale for Stroke Patients Trunk Control (PASS-TC) [22]	Stroke	Chronic	80	?	?	?	?	?	?	?	+
Postural Assessment	Stroke	Chronic	203	?	?	?	?	?	?	?	+

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Scale for Stroke Patients Trunk Control (PASS-TC) [22]											
Postural Assessment Scale for Stroke Patients Trunk Control (PASS-TC) [22]	Stroke	Chronic	189	?	?	?	?	?	?	?	+
Overall rating	**Stroke**	**Chronic**		?	?	?	?	?	?	?	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	High
Rivermead mobility index (RMI) [2]	Stroke	Acute	38	+	+	+	+	?	?	+	+
Rivermead mobility index (RMI) [21]	Stroke	Acute		+	+	+	+	?	?	+	+
Overall rating	**Stroke**	**Acute**		+	+	+	+	?	?	+	+
Quality of evidence	**Stroke**	**Acute**		Low (-2)	Low (-2)	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Low (-2)	Low (-2)
Rivermead mobility index (RMI) [10]	Stroke	Chronic		?	+	?	?	?	?	+	?
Rivermead mobility index (RMI) [15]	Stroke	Chronic		?	?	+	?	?	?	+	?
Rivermead mobility index (RMI) [22]	Stroke	Chronic		?	?	?	?	?	?	?	?
Rivermead mobility index (RMI) [22]	Stroke	Chronic		?	?	?	?	?	?	?	?
Rivermead mobility index (RMI) [30]	Stroke	Chronic	73	?	?	?	?	?	?	+	+
Rivermead mobility index (RMI) [30]	Stroke	Chronic	38	?	?	?	?	?	?	+	?
Overall rating	**Stroke**	**Chronic**		?	+	+	?	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Inconsistent	High	Moderate (-1)
Rivermead mobility index (RMI) [9]	Stroke	Sub-acute	73	?	+	+	+	?	?	-	+

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Overall rating	**Stroke**	**Sub-acute**		?	+	+	+	?	?	-	+
Quality of evidence	**Stroke**	**Sub-acute**		Inconsistent	Moderate (-1)	Moderate (-1)	Moderate (-1)	Inconsistent	Inconsistent	Moderate (-2)	Moderate (-1)
Rivermead mobility index (RMI) [30]	TBI		20	?	?	?	?	?	?	+	?
Overall rating	**TBI**			?	?	?	?	?	?	+	?
Quality of evidence	**TBI**			Inconsistent	inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Rivermead mobility Assessment (RMA) [21]	Stroke	Acute	51	?	?	-	?	?	?	+	?
Overall rating	**Stroke**	**Acute**		?	?	-	?	?	?	+	?
Quality of evidence	**Stroke**	**Acute**		Inconsistent	Inconsistent	Moderate (-2)	Inconsistent	Inconsistent	Inconsistent	Moderate (-1)	Inconsistent
Rivermead mobility Assessment (RMA) [4]	Stroke	Chronic		?	?	-	?	?	?	-	-
Rivermead mobility Assessment (RMA) [6]	Stroke	Chronic		?	?	?	-	?	?	+	?
Rivermead mobility Assessment (RMA) [5]	stroke	Chronic		?	?	?	?	?	+	+	?
Rivermead mobility Assessment (RMA) [10]	Stroke	Chronic	158	?	+	+	?	?	?	?	?
Rivermead mobility Assessment (RMA) [25]	Stroke	Chronic		?	?	+	?	?	?	-	?
Rivermead mobility Assessment (RMA) [11]	Stroke	Chronic		?	?	?	?	?	?	?	?
Overall rating	**Stroke**	**Chronic**		?	+	+	-	?	+	+	-
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	High	High	Low (-2)	Inconsistent	Low (-2)	Low (-2)	Low (-2)
Medical Outcomes Study	TBI			?	+	?	?	?	?	+	?

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
36-Item Short Form Health Survey (SF-36) [35]											
Overall rating	**TBI**			?	+	?	?	?	?	+	?
Quality of evidence	**TBI**			Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Medical Outcomes Study 36-Item Short Form Health Survey (SF-36) [4]	Stroke	Chronic		?	?	-	?	?	?	+	+
Medical Outcomes Study 36-Item Short Form Health Survey (SF-36) [14]	Stroke	Chronic	60	?	?	-	?	?	?	?	?
Medical Outcomes Study 36-Item Short Form Health Survey (SF-36) [15]	Stroke	Chronic		?	+	?	?	?	?	+	?
Medical Outcomes Study 36-Item Short Form Health Survey (SF-36) [20]	Stroke	Chronic		?	+	+	?	?	?	+	+
Medical Outcomes Study 36-Item Short Form Health Survey (SF-36) [33]	Stroke	Chronic	19	+	?	?	+	?	?	?	-
Overall rating	**Stroke**	**Chronic**		+	+	-	+	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Low (-2)	Low (-2)	Moderate (-2)	Low (-2)	Inconsistent	Inconsistent	Low (-2)	Low (-2)
Sickness Impact profile (SIP) [2]	TBI		25	+	+	+	?	?	?	+	+
Overall rating	**TBI**			+	+	+	?	?	?	+	+
Quality of evidence	**TBI**			Low (-2)	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Low (-2)
Sickness Impact profile (SIP) [4]	stroke	Chronic		?	?	-	?	?	?	-	?

296

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Sickness Impact profile (SIP) [14]	Stroke	Chronic	574	?	?	+	?	?	?	-	?
Sickness impact profile (SIP) [14]	Stroke	chronic		?	?	+	?	?	?	?	?
Sickness Impact profile (SIP) [20]	Stroke	Chronic		?	+	?	?	?	?	+	?
Overall rating	**Stroke**	**Chronic**		?	+	+	?	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Low (-2)	High	Inconsistent	Inconsistent	Inconsistent	Moderate (-1)	Inconsistent
StepWatch Activity Monitor or Step Activity Monitor (SAM) [7]	Stroke	chronic	17	?	?	+	?	?	?	?	?
StepWatch Activity Monitor or Step Activity Monitor (SAM) [7]	Stroke	Chronic	16	?	?	+	?	?	?	?	?
StepWatch Activity Monitor or Step Activity Monitor (SAM) [7]	Stroke	Chronic	40	?	?	+	?	?	?	?	?
StepWatch Activity Monitor or Step Activity Monitor (SAM) [7]	Stroke	Chronic	30	?	?	?	?	?	?	+	+
StepWatch Activity Monitor or Step Activity Monitor (SAM) [7]	Stroke	Chronic	25	?	?	?	?	?	?	+	+
StepWatch Activity Monitor or Step Activity Monitor (SAM)	Stroke	Chronic	16	?	?	?	?	?	?	?	+

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
[7]											
StepWatch Activity Monitor or Step Activity Monitor (SAM) [8]	Stroke	Chronic	16	?	?	+	?	?	?	+	?
StepWatch Activity Monitor or Step Activity Monitor (SAM) [8]	Stroke	Chronic	21	?	?	?	?	?	?	+	?
StepWatch Activity Monitor or Step Activity Monitor (SAM) [8]	Stroke	Chronic	53	?	?	?	?	?	?	+	?
StepWatch Activity Monitor or Step Activity Monitor (SAM) [8]	Stroke	Chronic	17	?	?	+	?	?	?	?	?
StepWatch Activity Monitor or Step Activity Monitor (SAM) [8]	Stroke	Chronic	50	?	?	?	?	?	?	+	+
StepWatch Activity Monitor or Step Activity Monitor (SAM) [8]	Stroke	Chronic	25	?	?	?	?	?	?	+	?
StepWatch Activity Monitor or Step Activity Monitor (SAM) [8]	Stroke	Chronic	27	?	?	?	?	?	?	+	?
StepWatch Activity Monitor or Step Activity	Stroke	Chronic	19	?	?	?	?	?	?	+	?

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Monitor (SAM) [30]											
StepWatch Activity Monitor or Step Activity Monitor (SAM) [30]	Stroke	Chronic	17	?	?	?	+	?	?	?	?
Overall rating	**Stroke**	**Chronic**		?	?	+	+	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Low (-2)	Low (-2)	Inconsistent	Inconsistent	High	Moderate (-1)
Stroke impact scale (SIS) [2]	Stroke	Chronic		+	+	+	+	?	?	+	-
Stroke impact scale (SIS) [4]	Stroke	Chronic	696	?	?	-	?	?	?	+	-
Stroke impact scale (SIS) [14]	Stroke	Chronic		?	?	-	?	?	?	?	?
Stroke Impact Scale (SIS) [20]	Stroke	Chronic		?	+	+	?	-	?	+	+
Stroke impact scale (SIS) [24]	Stroke	Chronic		?	?	?	?	?	?	?	+
Stroke impact scale (SIS) [28]	Stroke	Chronic		?	?	?	?	?	?	+	?
Stroke impact scale (SIS) [25]	Stroke	Chronic		?	?	+	?	?	?	-	?
Overall rating	**Stroke**	**Chronic**		+	+	+	+	-	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Low (-2)	Low (-2)	Moderate (-1)	Low (-2)	Low (-2)	Inconsistent	High	Moderate (-1)
Stroke impact scale (SIS) [29]	Stroke	Sub-acute	25	+	+	+	?	?	?	+	?
Overall rating	**Stroke**	**Sub-acute**		+	+	+	?	?	?	+	?
Quality of evidence	**Stroke**	**Sub-acute**		Low (-2)	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Stroke Rehabilitation assessment of movement (STREAM) [5]	Stroke	Chronic		?	?	+	?	?	?	+	?
Stroke Rehabilitation assessment of movement (STREAM) [10]	Stroke	Chronic	134	?	+	+	+	?	?	?	+
Stroke Rehabilitation	Stroke	Chronic	351	+	?	+	?	?	?	+	?

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
assessment of movement (STREAM) [11]											
Stroke Rehabilitation assessment of movement (STREAM) [3]	Stroke	Chronic	80	?	+	+	+	+	?	+	+
Overall rating	**Stroke**	**Chronic**		+	+	+	+	+	?	+	+
Quality of evidence	**stroke**	**Chronic**		High	High	High	High	Moderate (-2)	Inconsistent	High	High
Stroke Specific Quality of Life Scale (SSQOL) [14]	Stroke	Chronic		?	?	-	?	?	?	?	?
Stroke Specific Quality of Life Scale (SSQOL) [4]	Stroke	Chronic		?	+	+	?	?	?	-	+
Stroke Specific Quality of Life Scale (SSQOL) [20]	Stroke	Chronic	71	?	+	?	-	?	?	+	+
Overall rating	**Stroke**	**Chronic**		?	+	+	-	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Moderate (-1)	Low (-2)	Moderate (-2)	Inconsistent	Inconsistent	Moderate (-1)	Moderate (-1)
Three Point Postural Assessment Scale for Stroke Patients (PASS-3P) [22]	Stroke	Acute	202	?	?	?	?	?	?	?	+
Three Point Postural Assessment Scale for Stroke Patients (PASS-3P) [22]	Stroke	Acute	167	?	?	?	?	?	?	?	+
Three Point Postural Assessment Scale for Stroke Patients (PASS-3P) [22]	Stroke	Acute	167	?	?	?	?	?	?	?	+
Overall rating	**Stroke**	**Acute**		?	?	?	?	?	?	?	+
Quality of evidence	**Stroke**	**Acute**		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	High

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Timed Up and Go test (TUG) [21]	Stroke	Chronic		?	?	+	+	?	?	-	+
Timed Up and Go test (TUG) [4]	Stroke	Chronic		?	?	+	?	?	?	-	?
Timed Up and Go test (TUG) [16]	Stroke	Chronic	50	-	?	+	?	?	?	?	+
Timed Up and Go test (TUG) [16]	Stroke	Chronic	11	?	?	+	?	?	?	?	?
Timed Up and Go test (TUG) [16]	Stroke	Chronic	44	?	?	?	?	?	?	+	+
Timed Up and Go test (TUG) [27]	Stroke	Chronic	343	?	?	+	?	?	?	?	?
Timed Up and Go test (TUG) [30]	Stroke	Chronic	11	?	?	?	+	?	?	+	?
Timed Up and Go test (TUG) [30]	Stroke	Chronic	50	?	?	?	+	?	?	?	?
Overall rating	**Stroke**	**Chronic**		-	?	+	+	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Low (-2)	Inconsistent	High	Moderate (-1)	Inconsistent	Inconsistent	Moderate (-1)	Moderate (-1)
Timed Up and Go test (TUG) [27]	TBI		24	?	?	+	?	?	?	?	?
Overall rating	**TBI**			?	?	+	?	?	?	?	?
Quality of evidence	**TBI**			Inconsistent	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent
Triaxial accelerometer/ RT3 [8]	Stroke	Chronic	20	?	?	+	?	?	?	+	?
Triaxial accelerometer/ RT3 [8]	Stroke	Chronic	52	?	?	+	?	?	?	?	?
Triaxial accelerometer/ RT3 [7]	Stroke	Chronic	20	?	?	-	?	?	?	?	?
Overall rating	**Stroke**	**Chronic**		?	?	+	?	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Moderate (-1)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Trunk Control	Stroke	Chronic		?	?	?	+	+	?	+	?

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Test [32]											
Trunk Control test [34]	Stroke	Chronic	20	?	+	?	?	-	?	+	?
Trunk Control test [26]	Stroke	Chronic		?	+	?	+	?	?	+	?
Overall rating	**Stroke**	**Chronic**		?	+	?	+	+	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Low (-2)	Inconsistent	Low (-2)	Low (-2)	Inconsistent	Low (-2)	Inconsistent
Trunk Impairment Scale [34]	Stroke	Chronic		+	+	?	+	+	+	+	?
Trunk Impairment Scale [34]	Stroke	Chronic	73	?	+	?	?	+	?	?	+
Trunk Impairment Scale (TIS)-Verheyden version [26]	Stroke	Chronic		?	-	+	+	?	?	+	?
Trunk Impairment Scale - Fujiwara version [26]	Stroke	Chronic		?	+	?	+	?	?	+	+
Trunk Impairment Scale [26]	Stroke	Chronic		?	+	?	+	+	?	?	?
Trunk Impairment Scale [26]	Stroke	Chronic		?	+	+	+	+	?	?	?
Overall rating	**Stroke**	**Chronic**		+	+	+	+	+	+	+	+
Quality of evidence	**Stroke**	**Chronic**		Moderate (-1)	Moderate (-1)	Low (-2)	Low (-2)	Moderate (-1)	Low (-2)	Low (-2)	Moderate (-1)
Uniaxial accelerometer [8]	Stroke	Acute	34	?	?	?	?	?	?	+	?
Uniaxial accelerometer [8]	Stroke	Acute	45	?	?	?	?	?	?	+	?
Overall rating	**Stroke**	**Acute**		?	?	?	?	?	?	+	?
Quality of evidence	**Stroke**	**Acute**		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Moderate (-1)	Inconsistent
Upper Limb-Motor Assessment Scale (UL-MAS) [11]	Stroke	Chronic	80	+	?	+	?	?	?	+	?

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Upper Limb-Motor Assessment Scale (UL-MAS) [17]	Stroke	Chronic		+	+	+	+	+	?	+	+
Overall rating	**Stroke**	**Chronic**		+	+	+	+	+	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Moderate (-1)	Low (-2)	Moderate (-1)	Low (-2)	Low (-2)	Inconsistent	Moderate (-1)	Low (-2)
Van Lieshout Test Short Form [33]	Stroke	Chronic	60	?	?	?	?	?	?	?	-
Van Lieshout Test Short Form [33]	Stroke	Chronic	30	?	?	?	-	?	?	?	-
Overall rating	**Stroke**	**Chronic**		?	?	?	-	?	?	?	-
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Moderate (-2)
Wolf Motor Function Test (WMFT) [12]	Stroke	Chronic		?	?	?	?	?	?	?	?
Wolf Motor Function Test (WMFT) [4]	Stroke	Chronic		?	+	+	+	?	?	-	+
Wolf Motor Function Test (WMFT) [11]	Stroke	Chronic	189	+	+	+	?	?	?	+	?
Wolf Motor Function Test (WMFT) [17]	Stroke	Chronic		?	+	+	+	?	?	-	?
Wolf Motor Function Test (WMFT) [24]	Stroke	Chronic		?	?	?	?	?	?	+	?
Wolf Motor Function Test (WMFT) [33]	Stroke	Chronic	24	?	+	+	+	?	?	?	?
Wolf Motor Function Test (WMFT) [25]	Stroke	Chronic		?	?	+	+	?	?	-	+
Overall rating	**Stroke**	**Chronic**		+	+	+	+	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		High	High	High	Low (-2)	Inconsistent	Inconsistent	High	Low (-2)
Motor-free Visual Perception Test (MVPT) [19]	Stroke	Chronic	30	?	-	+	?	?	?	+	?
Motor Free	Stroke	Chronic		?	?	+	?	?	?	-	?

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Visual Perception Test [4]											
Overall rating	Stroke	Chronic		?	-	+	?	?	?	+	?
Quality of evidence	Stroke	Chronic		Inconsistent	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
IDEEA-the Intelligent Device for Energy Expenditure and Activity [7]	Stroke	Chronic	42	?	?	-	?	?	?	?	?
Intelligent Device for Energy Expenditure and Activity [8]	Stroke	Chronic	6	?	?	+	?	?	?	?	?
Overall rating	Stroke	Chronic		?	?	+	?	?	?	?	?
Quality of evidence	Stroke	Chronic		Inconsistent	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent
Assessment of Life Habits (LIFE-H) [29]	Stroke	Chronic	84	+	?	+	?	?	?	+	?
Assessment of Life Habits (LIFE-H) [14]	Stroke	Chronic	80	?	?	+	?	?	?	?	?
Overall rating	Stroke	Chronic		+	?	+	?	?	?	+	?
Quality of evidence	Stroke	Chronic		Moderate (-1)	Inconsistent	High	Inconsistent	Inconsistent	Inconsistent	Moderate (-1)	Inconsistent
Brain injury community rehabilitation outcome scale (BICRO) [2]	BI		127	+	+	+	+	?	?	+	?
Overall rating	BI		127	+	+	+	+	?	?	+	?
Quality of evidence	BI			High	High	High	High	Inconsistent	Inconsistent	High	Inconsistent
DASH (Disabilities of the Arm, Shoulder and Hand) [11]	Stroke	Chronic	300	?	+	+	?	?	?	+	?
Overall rating	Stroke	Chronic	300	?	+	+	?	?	?	+	?
Quality of evidence	Stroke	Chronic		Inconsistent	High	High	Inconsistent	Inconsistent	Inconsistent	High	Inconsistent
6-item Short	Stroke	Acute	262	?	?	?	?	?	?	?	+

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Form Postural Assessment Scale for Stroke Patients (6 SFPASS) [22]											
Overall rating	Stroke	Acute	262	?	?	?	?	?	?	?	+
Quality of evidence	Stroke	Acute		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	High
Kinematics [25]	Stroke	Chronic	8	?	?	+	?	?	?	-	+
Overall rating	Stroke	Chronic	8	?	?	+	?	?	?	-	+
Quality of evidence	Stroke	Chronic		Inconsistent	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Low (-2)
Postural Control and Balance for Stroke (PCBS) [22]	Stroke	Acute	50	?	?	?	?	?	?	?	+
Overall rating	Stroke	Acute	50	?	?	?	?	?	?	?	+
Quality of evidence	Stroke	Acute		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Moderate (-1)
Short Form Berg Balance Scale (SFBBS) [22]	Stroke	Acute	81	?	?	?	?	?	?	?	+
Overall rating	Stroke	Acute	81	?	?	?	?	?	?	?	+
Quality of evidence	Stroke	Acute		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Moderate (-1)
Smart Balance Master (SBM) [22]	Stroke	Acute	40	?	?	?	?	?	?	?	+
Overall rating	Stroke	Acute	40	?	?	?	?	?	?	?	+
Quality of evidence	Stroke	Acute		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)
300mWT (Three hundred metre Walk Test in community) [31]	Stroke	Chronic	28	+	?	+	?	?	?	+	?
Overall rating	Stroke	Chronic	28	+	?	+	?	?	?	+	?
Quality of evidence	Stroke	Chronic		Low (-2)	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
30mCWT (Thirty metre Comfortable Walk Test) [31]	Stroke	Chronic	18	+	?	?	?	?	?	+	?
Overall rating	Stroke	Chronic	18	+	?	?	?	?	?	+	?
Quality of	Stroke	Chronic		Low (-2)	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
evidence											
4mCWT (Four metre Comfortable Walk Test) [31]	Stroke	Chronic	25	+	?	?	?	?	?	+	?
Overall rating	**Stroke**	**Chronic**	25	+	?	?	?	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Low (-2)	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Actical [7]	Stroke	Chronic	40	?	?	+	?	?	?	?	?
Overall rating	**Stroke**	**Chronic**	40	?	?	+	?	?	?	?	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent
Activities of Daily Living observation [12]	Stroke	Chronic	81	?	?	?	+	?	?	+	?
Overall rating	**Stroke**	**Chronic**	81	?	?	?	+	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Moderate (-1)	Moderate (-1)	Inconsistent	Inconsistent	Moderate (-1)	Inconsistent
Actual Amount of Use Test (AAUT) [12]	Stroke	Chronic	11	?	?	+	?	?	?	+	?
Overall rating	**Stroke**	**Chronic**	11	?	?	+	?	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Assessment of Motor and Process Skills (AMPS) [12]	Stroke	Chronic	76	?	?	+	+	?	?	+	?
Overall rating	**Stroke**	**Chronic**	76	?	?	+	+	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Moderate (-1)	Moderate (-1)	Inconsistent	Inconsistent	Moderate (-1)	Inconsistent
Balance Assessment in Sitting and Standing Position (BASSP) [26]	Stroke	Chronic	1193	?	?	?	?	+	?	+	+
Overall rating	**Stroke**	**Chronic**	1193	?	?	?	?	+	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Inconsistent	Inconsistent	High	Inconsistent	High	High
Balance Evaluation System test (Bentest) [16]	Stroke	Chronic	115	+	?	+	?	?	?	+	+
Overall rating	**Stroke**	**Chronic**	115	+	?	+	?	?	?	+	+
Quality of	**Stroke**	**Chronic**		High	Inconsistent	High	Inconsistent	Inconsistent	Inconsistent	High	High

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
evidence											
Biaxial accelerometer [8]	Stroke	Chronic	6	?	?	+	?	?	?	+	?
Overall rating	**Stroke**	**Chronic**	6	?	?	+	?	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Brunel Balance Assessment [16]	Stroke	Chronic	92	+	?	+	?	?	?	+	?
Overall rating	**Stroke**	**Chronic**	92	+	?	+	?	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Moderate (-1)	Inconsistent	Moderate (-1)	Inconsistent	Inconsistent	Inconsistent	Moderate (-1)	Inconsistent
Canadian Occupational Performance Measure (COPM) [12]	Stroke	Chronic	26	?	?	+	?	?	?	+	+
Overall rating	**Stroke**	**Chronic**	26	?	?	+	?	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Low (-2)
Centre for Epidemiological Studies Depression [4]	Stroke	Chronic	27	?	+	+	+	?	?	+	+
Overall rating	**Stroke**	**Chronic**	27	?	+	+	+	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Low (-2)	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Low (-2)	Low (-2)
Climbing stairs questionnaire (CSQ) [2]	Stroke	Chronic	15	+	+	+	+	?	?	-	?
Overall rating	**Stroke**	**Chronic**	15	+	+	+	+	?	?	-	?
Quality of evidence	**Stroke**	**Chronic**		Low (-2)	Low (-2)	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Coded activity diary [13]	Stroke	Chronic	16	?	?	?	?	?	?	+	?
Overall rating	**Stroke**	**Chronic**	16	?	?	?	?	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Computer Science and Applications Inc. Model 7164 activity monitors x 4 [7]	Stroke	Chronic	9	?	?	?	?	?	?	+	?
Overall rating	**Stroke**	**Chronic**	9	?	?	?	?	?	?	+	?
Quality of	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
evidence				nt							
Dimensional gait analysis (3-DGA) [8]	Stroke	Chronic	25	?	?	?	?	?	?	+	?
Overall rating	Stroke	Chronic	25	?	?	?	?	?	?	+	?
Quality of evidence	Stroke	Chronic		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Duruoz Hand Index (DHI) [12]	Stroke	Chronic	56	?	?	+	?	?	?	+	?
Overall rating	Stroke	Chronic	56	?	?	+	?	?	?	+	?
Quality of evidence	Stroke	Chronic		Inconsistent	Inconsistent	Moderate (-1)	Inconsistent	Inconsistent	Inconsistent	Moderate (-1)	Inconsistent
Functional Ambulation Classification Hospital (FACHS) [31]	Stroke	Chronic	31	+	?	?	?	?	?	+	?
Overall rating	Stroke	Chronic	31	+	?	?	?	?	?	+	?
Quality of evidence	Stroke	Chronic		Low (-2)	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Functional Gait Assessment (FGA) [31]	Stroke	Chronic	28	+	?	?	+	+	?	+	?
Overall rating	Stroke	Chronic	28	+	?	?	+	+	?	+	?
Quality of evidence	Stroke	Chronic		Low (-2)	Inconsistent	Inconsistent	Low (-2)	Low (-2)	Inconsistent	Low (-2)	Inconsistent
Finger Tapping (uniaxial accelerometer) [8]	Stroke	Chronic	60	?	?	?	?	?	?	+	?
Overall rating	Stroke	Chronic	60	?	?	?	?	?	?	+	?
Quality of evidence	Stroke	Chronic		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Moderate (-1)	Inconsistent
Fitbit Ulta [7]	Stroke	Chronic	30	?	?	?	?	?	?	-	+
Overall rating	Stroke	Chronic	30	?	?	?	?	?	?	-	+
Quality of evidence	Stroke	Chronic		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Low (-2)
Fitts Reaching test [5]	Stroke	Chronic	18	?	?	+	?	?	?	+	?
Overall rating	Stroke	Chronic	18	?	?	+	?	?	?	+	?
Quality of evidence	Stroke	Chronic		Inconsistent	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Fugl-Meyer Assessment-Upper extremity	Stroke	Chronic	512	+	?	+	?	?	?	+	?

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
[11]											
Overall rating	**Stroke**	**Chronic**	512	+	?	+	?	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		High	Inconsistent	High	Inconsistent	Inconsistent	Inconsistent	High	Inconsistent
Four Square Step [16]	Stroke	Chronic	37	-	?	?	?	?	?	+	+
Overall rating	**Stroke**	**Chronic**	37	-	?	?	?	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Low (-2)	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Low (-2)
Function in Sitting Test (FIST) [26]	Stroke	Acute	31	+	+	?	?	?	+	+	?
Overall rating	**Stroke**	**Acute**	31	+	+	?	?	?	+	+	?
Quality of evidence	**Stroke**	**Acute**		Low (-2)	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Low (-2)	Inconsistent
Functional Arm Activity Behavioral Observation System (FAABOS) [12]	ABI		9	?	?	?	+	?	?	?	?
Overall rating	**ABI**		9	?	?	?	+	?	?	?	?
Quality of evidence	**ABI**			Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Inconsistent
Functional Test for the Hemiplegic Upper Extremity (FTHUE) [12]	Stroke	Chronic	82	?	?	?	+	?	?	?	?
Overall rating	**Stroke**	**Chronic**	82	?	?	?	+	?	?	?	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Inconsistent	Moderate (-1)	Inconsistent	Inconsistent	Inconsistent	Inconsistent
Geriatric Depression scale-long form (GDS) [4]	Stroke	Chronic		?	+	+	?	?	?	+	+
Overall rating	**Stroke**	**Chronic**		?	+	+	?	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Low (-2)
Grip strength [25]	**Stroke**	**Chronic**	27	?	?	+	+	?	?	?	?
Overall rating	**Stroke**	**Chronic**	27	?	?	+	+	?	?	?	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Inconsistent
Hand Function	Stroke	Chronic	45	?	?	+	?	?	?	+	?

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Survey (HFS) [12]											
Overall rating	**Stroke**	**Chronic**	45	?	?	+	?	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
International classification of functioning, health, and disability-Activity measure (ICF-AM) [11]	Stroke	Chronic	317	?	?	?	+	?	?	+	?
Overall rating	**Stroke**	**Chronic**	317	?	?	?	+	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Inconsistent	High	Inconsistent	Inconsistent	High	Inconsistent
Motor Activity Log-28 items [1]	Stroke	Sub-acute	222	?	+	?	?	?	?	-	?
Overall rating	**Stroke**	**Sub-acute**	222	?	+	?	?	?	?	-	?
Quality of evidence	**Stroke**	**Sub-acute**		Inconsistent	High	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Moderate (-1)	Inconsistent
Manual Function Test (MFT) [12]	Stroke	Acute	51	?	+	+	?	?	?	+	?
Overall rating	**Stroke**	**Acute**	51	?	+	+	?	?	?	+	?
Quality of evidence	**Stroke**	**Acute**		Inconsistent	Moderate (-1)	Moderate (-1)	Inconsistent	Inconsistent	Inconsistent	Moderate (-1)	Inconsistent
Multimedia activity recall for children and adults (MARCA) [13]	Stroke	Chronic	40	?	?	+	?	?	?	+	?
Overall rating	**Stroke**	**Chronic**	40	?	?	+	?	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
National Institute of Health Stroke Scale [4]	Stroke	Chronic	65	?	?	+	?	?	?	+	-
Overall rating	**Stroke**	**Chronic**	65	?	?	+	?	?	?	+	-
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Moderate (-1)	Inconsistent	Inconsistent	Inconsistent	Moderate (-1)	Moderate (-2)
Neurobehavioral Cognition Status	Stroke	Chronic		?	?	-	-	?	?	+	+

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Exam (NCSE) [4]											
Overall rating	**Stroke**	**Chronic**		?	?	-	-	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Low (-2)	Low (-2)
Nike+Fuelband [7]	Stroke	Chronic	30	?	?	?	?	?	?	-	+
Overall rating	**Stroke**	**Chronic**	30	?	?	?	?	?	?	-	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Low (-2)
Nottingham Extended ADL index (N-ADL) [2]	Stroke	Chronic	78	+	+	+	+	?	?	+	+
Overall rating	**Stroke**	**Chronic**	78	+	+	+	+	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Moderate (-1)	Moderate (-1)	Moderate (-1)	Moderate (-1)	Inconsistent	Inconsistent	Moderate (-1)	Moderate (-1)
OPTIMAL (Outpatient Physical Therapy Improvement in Movement Assessment Log) [11]	Stroke	Chronic	3138	?	?	?	?	?	?	+	?
Overall rating	**Stroke**	**Chronic**	3138	?	?	?	?	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	High	Inconsistent
Ottawa Sitting Scale (OSS) [26]	Stroke	Chronic	71	?	?	?	+	+	?	?	?
Overall rating	**Stroke**	**Chronic**	71	?	?	?	+	+	?	?	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Moderate (-1)	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent
PAL2 (Gorman ProMed Pty. Ltd) [7]	Stroke	Chronic	20	?	?	?	?	?	?	-	?
Overall rating	**Stroke**	**Chronic**	20	?	?	?	?	?	?	-	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Physical Ability Scale (PAS) [26]	Stroke	Sub-acute	10	?	?	?	-	-	?	?	?
Overall rating	**Stroke**	**Sub-acute**	10	?	?	?	-	-	?	?	?
Quality of	**Stroke**	**Sub-**		Inconsistent	Inconsistent	Inconsistent	Low (-2)	Low (-2)	Inconsistent	Inconsistent	inconsistent

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
evidence		acute		nt							
Quadriplegia Index of Function [33]	Stroke	Chronic	60	?	?	+	?	?	?	?	-
Overall rating	**Stroke**	**Chronic**	60	?	?	+	?	?	?	?	-
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Moderate (-1)	Inconsistent	Inconsistent	Inconsistent	inconsistent	Moderate (-2)
Reintegration to normal living index (RNLI) [28]	Stroke	Chronic	57	?	?	+	?	?	?	+	?
Overall rating	**Stroke**	**Chronic**	57	?	?	+	?	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Moderate (-1)	Inconsistent	Inconsistent	Inconsistent	Moderate (-1)	Inconsistent
Stroke Arm Ladder (SAL) [11]	Stroke	Chronic	942	+	?	+	?	?	?	+	?
Overall rating	**Stroke**	**Chronic**	942	+	?	+	?	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		High	Inconsistent	High	Inconsistent	Inconsistent	Inconsistent	High	Inconsistent
Sensewear Pro 3 Armband [7]	Stroke	Chronic	12	?	?	?	?	?	?	-	+
Overall rating	**Stroke**	**Chronic**	12	?	?	?	?	?	?	-	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Low (-2)
Sitting Rising Test (SRT) [26]	Stroke	Chronic	60	?	?	+	+	?	?	+	?
Overall rating	**Stroke**	**Chronic**	60	?	?	+	+	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Moderate (-1)	Moderate (-1)	Inconsistent	Inconsistent	Moderate (-1)	Inconsistent
SmartShoe [7]	Stroke	Chronic	12	?	?	?	?	?	?	+	+
Overall rating	**Stroke**	**Chronic**	12	?	?	?	?	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Low (-2)
Sodring motor evaluation for stroke patients [10]	Stroke	Chronic	123	?	+	?	+	?	?	+	+
Overall rating	**Stroke**	**Chronic**	123	?	+	?	+	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	High	Inconsistent	High	Inconsistent	Inconsistent	High	High
Sollerman hand function test [5]	Stroke	Chronic	24	?	?	+	+	?	?	?	?

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Overall rating	**Stroke**	**Chronic**	24	?	?	+	+	?	?	?	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Low (-2)	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Inconsistent
Step test [16]	Stroke	Chronic	41	+	?	+	?	?	?	+	+
Overall rating	**Stroke**	**Chronic**	41	+	?	+	?	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Low (-2)	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Low (-2)
Stride analyzer system (SAS) [8]	Stroke	Chronic	6	?	?	+	?	?	?	+	?
Overall rating	**Stroke**	**Chronic**	6	?	?	+	?	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Subjective index of physical and social outcome (SIPSO) [28]	Stroke	Chronic	260	?	?	?	?	?	?	?	?
Overall rating	**Stroke**	**Chronic**	260	?	?	?	?	?	?	?	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent
Timed walk [15]	Stroke	Chronic	22	+	?	?	?	+	?	+	+
Overall rating	**Stroke**	**Chronic**	22	+	?	?	?	+	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Low (-2)	Inconsistent	Low (-2)	Inconsistent	Low (-2)	Inconsistent	Low (-2)	Low (-2)
Trunk Recovery Scale (TRS) [26]	BI		59	?	+	?	+	?	+	+	?
Overall rating	**BI**		59	?	+	?	+	?	+	+	?
Quality of evidence	**BI**			Inconsistent	Moderate (-1)	Inconsistent	Moderate (-1)	Inconsistent	Moderate (-1)	Moderate (-1)	inconsistent
Upper Extremity Functional Index (UEFI) [11]	Stroke	Chronic	239	?	?	?	+	?	?	+	?
Overall rating	**Stroke**	**Chronic**	239	?	?	?	+	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Inconsistent	High	Inconsistent	Inconsistent	High	Inconsistent
Upper Body Dressing Scale (UBDS) [12]	Stroke	Chronic	51	?	?	?	+	?	?	+	+
Overall rating	**Stroke**	**Chronic**	51	?	?	?	+	?	?	+	+
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Inconsistent	Moderate (-1)	Inconsistent	Inconsistent	Moderate (-1)	Moderate (-1)
Up per Extremity	Stroke	Chronic	29	?	?	+	?	?	?	+	?

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Performance Test for Elderly (Test d'Évaluation des Membres supérieurs de Personnes Âgées (TEMPA) [12]											
Overall rating	**Stroke**	**Chronic**	29	?	?	+	?	?	?	+	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Wireless Triaxial Accelerometers [7]	Stroke	Chronic	12	?	?	?	?	?	?	-	?
Overall rating	**Stroke**	**Chronic**	12	?	?	?	?	?	?	-	?
Quality of evidence	**Stroke**	**Chronic**		Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
3MWT [18]	Stroke	Sub-acute	14	+	?	?	?	+	?	+	?
Overall rating	**Stroke**	**Sub-acute**	14	+	?	?	?	+	?	+	?
Quality of evidence	**Stroke**	**Sub-acute**		Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent	Low (-2)	Inconsistent
Accelerometer (ActiGraph) [8]	Stroke	Sub-acute	20	?	?	+	?	?	?	+	?
Overall rating	**Stroke**	**Sub-acute**	20	?	?	+	?	?	?	+	?
Quality of evidence	**Stroke**	**Sub-acute**		Inconsistent	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
Grooved Pegboard Test (GPT) [35]	TBI			?	?	+	?	?	?	-	?
Overall rating	**TBI**			?	?	+	?	?	?	-	?
Quality of evidence	**TBI**			Inconsistent	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent
HiMAT-High Level Mobility Assessment [30]	TBI		103	?	?	?	+	+	?	+	?
Overall rating	**TBI**		103	?	?	?	+	+	?	+	?
Quality of evidence	**TBI**			Inconsistent	Inconsistent	Inconsistent	High	High	Inconsistent	High	Inconsistent
Mayo-Portland Adaptability Inventory	TBI		339	?	+	?	+	?	?	+	?

Name of the measure	Type of population	Setting	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
(MPAI-4) [35]											
Overall rating	**TBI**		339	?	+	?	+	?	?	+	?
Quality of evidence	**TBI**			Inconsistent	High	Inconsistent	High	Inconsistent	Inconsistent	High	Inconsistent
Pens taped to feet [30]	TBI		12	?	?	?	?	+	?	+	?
Overall rating	**TBI**		12	?	?	?	?	+	?	+	?
Quality of evidence	**TBI**			Inconsistent	Inconsistent	Inconsistent	Inconsistent	Low (-2)	Inconsistent	Low (-2)	Inconsistent
Satisfaction with Life Scale (SWLS) [35]	TBI			+	?	+	?	?	?	?	?
Overall rating	**TBI**			+	?	+	?	?	?	?	?
Quality of evidence	**TBI**			Low (-2)	Inconsistent	Low (-2)	Inconsistent	Inconsistent	Inconsistent	Inconsistent	Inconsistent

10MWT: ten-meter walking test; 12MWT: twelve-meter walking test; 2MWT: two-meter walking test; 5MWT: five-meter walking test; 6MWT: six-minute walking test; TBI: traumatic brain injury

Appendix 7. Measurement properties

A. Individuals with stroke in acute setting

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
10-Meter Walking Test (10MWT) [22, 30]	PerfO	<100				ICC=0.98 (Comfortable) ICC=0.99 (Fast)				Comfortable pace: ES = 0.74, SRM = 0.92 Maximum pace: ES = 0.55, SRM = 0.83 (n=92)
12-Meter Walking Test (12MWT) [30]	PerfO	18				ICC=0.71	ICC=0.68			
2-Meter Waling Test (2MWT) [22]	PerfO	18			ICC=0.85	ICC=0.85				SRM=1.34
6-Minute Walking Test (6MWT) [18, 30]	PerfO	<100				ICC=0.74 (n=18)	ICC=0.74-0.97 (n=18)	SEM=16.7 – 32.2 (n=74)	Timed Up and Go test: r=0.80 (admission); r=0.73 (discharge) (n=41) Peak Oxygen Consumption (VO2 Max): r=0.34 (n=30)	
Actiwatch [8]	TechO	52							Actiwatches vs. motor score in patients with acute stroke without neglect: r =–0.88 Actiwatches vs. motor score in patients with acute stroke with neglect: r =–0.75	
Ambulatory Monitoring (AM Accelerometer) [8]	TechO	43							National Institute of Health Stroke Scale: r= –0.59 Activity of Impaired Arm: r=0.75 Fugel-Meyer assessment: r=0.54. Sensitivity and specificity of accelerometer 1.0 and .89, respectively.	
Barthel Index (BI)	PerfO	22	Experts	C α=0.90-0.93	r=0.87	r=0.88	r=0.77-0.99		Functional	ES=0.71 (0-6 wks post-

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
[21]			consensus						Independence Measure: r=0.93 London Handicap Scale: r= 0.37 36-item short form survey: r=0.22	stroke) ES=0.25 (6-12 wks) AUC for change score=0.66 ES= 0.37 (from admission to discharge) SRM=0.63 and 0.86 for those known to change SRM=1.72 (admission to discharge) AUC/ROC=0.82 (using FIM as reference measures)
Beck Depression Inventory (BDI) [4]	PRO	202	BDI assesses 6/9 criteria delineated in the DSM-III. 2/3 remaining items are partially assessed. One criterion does not appear on the inventory	C α=0.76-0.86	r=0.48-0.86				Known groups: BDI discriminated between patients with varying levels of depression as indicated by rating of Depth of Depression. Differences between adjacent Depth of Depression categories (0 – 4— none to severe) significant at p-value=0.0004 and p-value=0.02 (moderate to severe)	Sensitivity/Specificity: via ROC analysis, determined that with the standardized/optimal cut-off of BDI=10, sensitivity was 80% and specificity 61.4%. Area under the curve was 0.89 for men and 0.69 for women (a higher rate of misdiagnosis for female stroke patients—this effect decreased when level of handicap measured on the Rankin scale was taken into consideration.
Berg Balance Scale (BBS) [21, 22]	PerfO	>100								SRM=1.04 (n=50) 14 to 30 days (ES=0.80) (n=110) 30-90 days (ES=0.69) (n=93) 90-180 days (ES=0.40) (n=80) 14 to 90 days (ES=1.07) (n=93) 14 to 180 days (ES=1.11) (n=80) 2 to 6 weeks: ES=0.66; SRM=0.81 6 to 12 weeks: ES=0.25; SRM=0.69 2 to 12 weeks: ES=0.97; SRM=1.08

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
										(n=60)
Berg Balance Scale three point (BBS-3P) [22]	PerfO	>100								14 to 30 days: SRM=0.82 (n=202) 30 to 90 days: SRM=0.70 (n=167) 90 to 180 days: SRM= 1.11 (n=167)
Chedoke McMaster Stroke assessment scale (CMSA) [4]	ClinRO	32		r= 0.98 (total scale): (r= 0.94 (impairment) and r= 0.97 – 0.98 (disability))	ICC=0.96-0.98	ICC=0.85-0.96	ICC=0.93-0.98		Fugl-Meyer: r =0.76 – 0.95 Disability inventory sub scores correlated with corresponding Functional Independence Measure sub scores: r=0.85 – 0.90	FIM and CMSA yielded significant variance ratios (p<0.001, one-tailed) from admission to discharge, however CMSA 1.92 times greater relative efficiency
European Quality of life scale (EQ5D) [25]	PRO	NR			ICC>0.75				r=0.3-0.6	
Frenchay Activities Index (FAI) [21]	SRO	35		C α= 0.78	r=0.80	r=0.80			Stroke Impact Profile: r = 70.73 to 70.56	
Fugl-Meyer Assessment (FMA) [10, 19, 25]	ClinRO	>100		r=0.88 r =0.97, 0.90 and 0.88 for the upper extremity, lower extremity, and balance sections (n=28)	ICC=0.96-0.99 (n=28)	r=0.98 (n=28)			Stroke Rehabilitation Assessment of Movement: r=0.73 (n=50) BI correlated with UE-FMA: r=0.75, with total motor-FMA: r =0.74, with balance: r =0.76, and with FMA total scores: r=0.67	SRM=0.94-0.99 (n=78)
Fugl-Meyer test-Balance subscale (FM-B) [22]	ClinRO	>100								14 to 30 days, ES = 0.82 (n=110) 30 to 90 days, ES = 0.63 (n=93) 90 to 180 days, ES = 0.33 (n=80) 14 to 90 days, ES = 1.06 (n=93) 14 to 180 days, ES = 1.14 (n=80)

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Function in Sitting Test (FIST) [26]	PerfO	31		C α=0.98				SEM=2.97	static and dynamic sitting balance: r=0.92	
Functional Ambulation Category (FAC) [9, 22]	ClinRO	101			ICC≥0.75	ICC≥0.75			r≥0.60	ES=0.5 to 0.8 Responsiveness ratios based on a 10% MCID exceeded the smallest detectable difference and ranged from 4.36 to 17.70
Functional Independence measure (FIM) [21]	ClinRO	52		C α= 0.93-0.95	ICC= 0.95	r=0.95			Known groups: Functional Independence Measure scores discriminated between groups based on right or left-sided involvement in stroke patients both at admission (p-value<0.005) and discharge (p-value<0.05). Most of this score difference occurred on the communication domain; on admission and discharge, FIM scores discriminated groups with and without neglect (p-value<0.001; p-value<0.02) and with or without aphasia (p-value<0.01; p-value<0.09).	ESs of 0.30, 0.34 and 0 were reported for the total-FIM, motor-FIM and cognitive-FIM respectively. ES=0.31 (0.46 in known changers) and AUC ROC curve=0.675 SRM=2.18 from admission to discharge from rehabilitation
London handicap score (LHS) [28]	PRO	361	Focus groups and interviews results		ICC=0.91	r=0.90			Barthel Index: r=0.56 Nottingham Health Profile: r=0.28-0.41	
Manual Function Test (MFT) [12]	ClinRO	51		C α= 0.95	r=0.95	r=0.95			Brunnstrom Stage: r= 0.8 Stroke Impairment Assessment Set:	

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
									r=0.8 Barthel Index: r=0.90	
Mini-Mental State Examination (MMSE) [4]	ClinRO	116		C α= 0.54 – 0.96	ICC=0.38 – 0.99	ICC=0.69	ICC=0.69		ADL scores and the MMSE of r= 0.40 – 0.75 Wechsler Adult Intelligence Scale verbal: r =0.78, and performance-IQ: r =0.66 scores	
Modified Ashworth scale [4, 19, 25, 33]	ClinRO	36			ICC>0.75	ICC=0.5-0.75	r =0.55-0.74		Ashworth knee extensor scores related to resistance torque (r=0.53 – 0.59), stiffness (r=0.56 – 0.73) and joint angle (onset of stretch response 30, r =70.80). Ashworth knee flexor scores were related to stiffness 120 (r =0.56) and onset angle (120, r =0.58); Ashworth knee extensor scores related to functional outcomes assessed on Global Function Scale (r=70.48) and Gross Motor Function Measure (r =70.68)	
Modified Emory Functional Ambulation Profile (M-EFAM) [22]	ClinRO	40								SRM=1.1 (discharge)
Modified Rankin Handicap Scale [4]	PRO	1034			Kw=0.95.	K=0.56 overall; K=0.82 and 0.51 for outpatient and inpatient groups, respectively			ADL measured on the BI (0.73) and IADL (0.65), mobility (0.60) and living arrangements (0.74) measured on subscales of the	MRS detected change in significantly fewer patients post stroke than the FIM (P<0.005) ROC/AUC=0.29 using the FIM as reference measure

320

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
									Sickness Impact Profile—The weakest associations reported were between modified-Rankin Scale and the Stroke Impact Profile subscales of cognitive alertness (0.34) and social interaction (0.37)	
Motor Assessment Scale (MAS) [22]	ClinRO	61								mean time admission to discharge 56.4+/− 38.1 days: Item 1, ES = 1.03 Item 2, ES = 0.74 Item 3, ES = 0.61 Item 4, ES = 0.85 Item 5, ES = 1.02
Motor status scale (MSS) [5, 22, 25]	ClinRO	18							Arm section of Motricity index at 6, 12, 18 wk after stroke: r=0.73-0.76 Fugl-Meyer assessment: r=0.96	
Postural Assessment Scale for Stroke Patients (PASS) [22]	PerfO	202								14 to 30 days, SRM = 0.84
Postural Assessment Scale for Stroke Patients Trunk Control (PASS-TC) [22]	PerfO	>100								14 to 30 days, ES = 0.89 (n=110) 14 to 30 days, SRM = 0.65 (n=246)
Postural Control and Balance for Stroke (PCBS) [22]	PerfO	50								7-120 days, P<0.001
Rivermead mobility index (RMI) [2, 21]	SRO	38	Unidimensional results		ICC=0.96	r=0.94			Guttmann analysis yielded a CR of 0.93 and a CS of 0.79 CR=0.95 and CS at admission and discharge of 0.74	Significant change in RMI scores from admission to discharge from rehabilitation ward (P<0.001), ES=1.00 – relative efficiency as compared to the BI

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
									and 0.79 respectively Rasch analysis revealed the ordering and item calibration to be consistent—trend of difficulty was the same in two groups at both admission and discharge; At admission and 5 weeks CR=0.95 and 0.93, CS=0.67—but, a larger percentage of patients were able to sit unsupported (item 3) than could move from lying to sitting or turn over in bed. RMI scores correlated with Barthel Index scores at 14, 30, 90 and 180 days post stroke (r=0.72, 0.88, 0.86 and 0.88); RMI scores at admission and at 5 weeks correlated with Motor-Functional Independence Measure (r=0.73, 0.91) Motricity Index—leg (r=0.49, 0.51) and Trunk Control Test (r=0.89, 0.83) RMI scores did not correlate significantly with cognitive Functional Independence Measure scores at either admission or	=1.42 Effect sizes were greatest in the interval between 14 and 30 days (SRM=1.14) and diminished the further one moved through time from stroke (30 – 90 days, SRM=0.86 and 90 – 180 days =0.24) Significant difference in RMI scores from admission to discharge (P<0.0001) and ES=0.89

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
									at 5 weeks (r =0.10, r =0.20)	
Rivermead Motor Assessment (RMA) [2, 21]	PerfO	51			r=0.66				CR=0.90 (leg and trunk) to 0.98 (gross function) Coefficients of scalability CS=0.79 (leg and trunk) to 0.96 (gross function) A strong correlation between Barthel Index (ADL) scores and RMA (motor function) scores at initial (r =0.847), 1 month (r=0.777) and 1 year (r =0.627). The degree of asymmetry in weight distribution correlated significantly with RMA motor function (r= 70.45; p<0.001) RMA arm and leg scores correlated with Motricity Index arm and leg scores at 8, 12 and 18 weeks post stroke (r=0.73) and RMA gross function scale correlated with Trunk Control Test at same times post-stroke (r=0.70)	
Short Form Berg Balance Scale (SFBBS) [22]	PerfO	81								14-item BBS, ES = 0.85 7-item BBS, ES = 0.78 6-item BBS, ES = 0.78 5-item BBS, ES = 0.70 4-item BBS, ES = 0.69
Short Form Postural Assessment Scale for Stroke	PerfO	262								ES=0.43-0.44

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Patients-6 items (6 SFPASS) [22]										
Smart Balance Master (SBM) [22]	TechO	40								Equilibrium score, ES = 0.63 Limits of stability time, ES = 0.27 Limits of stability path, ES = 0.33 Weight shifting, ES = 0.04-0.29
Three Point Postural Assessment Scale for Stroke Patients (PASS-3P) [22]	PerfO	>100								14 to 30 days, SRM = 0.86 (n=202) 30 to 90 days, SRM = 0.67 (n=167) 90 to 180 days, SRM = 1.04 (n=167)
Uniaxial accelerometer [8]	TechO	<100							3.3h/d for the paretic arm (range, 0.8–8.1); 6h/d for the non-paretic arm (range, 3.2–9.4) Substantially (P<0.001) less than the 8.7h and 8.4h for healthy subjects' dominant and non-dominant arms, respectively (n=34) Physical activity scale for individual with physical disabilities: r=0.3 (n=45)	

ADL: activity of daily living, AUC: area under the curve, ClinRO: clinicians-reported outcome, Cα: Cronbacha alpha, CR: Coefficients of reproducibility, CS: Coefficients of scalability, DSM-III: Diagnostic and Statistical Manual of Mental Disorders third edition, ES: effect size, IADL: instrumental activity of daily living, ICC: Interclass Correlation Coefficient K: Kappa, Kw: weighted Kappa, PerfO: performance-reported outcome, PRO: patients-reported outcome, r: Pearson correlation, ROC: receiver operating characteristic curve, SRO: self-reported outcome, SOI: source of information, SEM: standardized error of measurement, SRM: standardized root of mean, TechO: technology-reported outcome

B. Individuals with stroke in sub-acute setting

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	construct validity	Responsiveness
10-Meter Walking Test (10MWT) [9, 27, 31]	PerfO	<50			ICC=0.74-0.98 (n=12)			SEM 0.08 m/s LoA=-0.72 to 0.78 sec. (n=12)	10-Meter Comfortable Walking Test: r=0.69 (n=43)	
12-Meter Walking Test (12MWT) [18]	PerfO	20					ICC= 0.68			
3-Meter Walking Test (3MWT) [18]	PerfO	14					ICC=0.90		Dynamometer: r = 0.41	
6-Minute Walking Test (6MWT) [18, 31]	PerfO	>100			ICC=0.95-0.97 (n=24-37)	r=0.99 (n=45)		SEM 23.2 m (n=37) SEM: 18.6m. (n=83) SEM=12.4m. (n=45)	10MCWT: r= 0.91 (n=24) Strength knee flexor dynamometer: r=0.71 (n=50) Strength knee extensor dynamometer: r= 0.39 (n=63) Strength dorsi-flexor dynamometer: r=0.50 (n=48) Strength ankle planter flexor dynamometer: r=0.43 (n=25) 5MCWT: r=0.89 Functional Independence Measure locomotion: r=0.69 FIM locomotion stairs: r= 0.69 (n=37) 10-Meter Walking Test: ICC=0.99 (n=45)	
ActiGraph [8]	TechO	20			ICC=0.82-0.94				Motor activity log (MAL): r=0.74	
Arm Motor Ability Test (AMAT) [17]	PerfO	32		C α=0.93-0.99	r=0.93-0.99	Test performance (κ = 0.68 to 0.77, r= 0.97-0.99) Performance time (κ and r = 0.99)			Fugl-Meyer Assessment: r = 0.92-0.94 upper limb section Motricity Index: r = 0.45-0.61	Changes in scores for time, functional ability, and quality of movement after 14 days of intensive therapy for the affected upper extremity
Berg Balance Scale (BBS) [9]	PerfO	15			ICC-0.75	ICC-0.75			r≥0.60	ES≥0.8
Dynamic Gait Index	PerfO	45			ICC=0.94				10-Meter Comfortable	

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	construct validity	Responsiveness
(DGI) [31]									Walking Test: r=0.91	
Footswitches [31]	TechO	25			ICC=0.92-0.95			SEMC gait speed 4.31 and 4.37 m/min SEMC cadence 7.45 and 6.16 steps/min (intra vs. inter)	Functional Ambulation Category: r=0.73	
Functional Ambulation Category (FAC) [22, 30, 31]	ClinRO	<100			k=0.85-0.91 (n=20)				Gait speed: r=0.58 Walking distance: r=0.55 Gait energy cost: r=0.64 Functional Independence Measure: r=0.72 (n=20) 6-Minute Fast Walking Test: r= 0.91–0.95 10-Meter Fast Walking Test: r= 0.90–0.95 (n=55)	2-week SRM=1.016 2 to 4-week SRM = 0.842 4-week to 6-month SRM = 0.699 (n=55) Sensitivity: 67-100% (n=55)
Motor Activity Log-28 items (MAL-28) [1, 17]	SRO	222		C α = 0.80	ICC = 0.79-0.82				Patient and carer quality of movement and Accelerometer (r = 0.52-0.61)	
Physical Ability Scale (PAS) [26]	PRO	10				k=0.62	ICC=0.70			
Rivermead mobility index (RMI) [9]	SRO	73		C α=0.92	ICC=0.75	ICC=0.75			r≥0.60	ES≥0.8
Stroke impact scale (SIS) [29]	PRO	25	The authors briefly described the development process of the SIS: literature reviews, and stroke survivors and caregivers' input, indicating 2 of the 3 content validity criteria were met.	C α= 0.83-0.90	ICC=0.70-0.92				Known group methods, each SIS domain was compared with Rankin scores. The results of this analysis indicated that strength, hand function, activities of daily living (ADL), mobility, and participation were able to discriminate across Rankin scores (P<.001)	

ClinRO: clinician-reported outcome, CI: confidence interval, ES: effect size, ICC: Interclass Correlation Coefficient K: Kappa, Cα: Cronbacha alpha, PerfO: performance-reported outcome, PRO: patients-reported outcome, r: Pearson correlation,

LoA: limits of agreement, SRO: self-reported outcome, SOI: source of information, SEM: standardized error of measurement, SRM: standardized root of mean, TechO: technology-reported outcome

C. Individuals with stroke in chronic setting

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
10-Meter Walking Test (10MWT) [9, 27, 30-32]	PerfO	>100			ICC=0.85-0.98 (n=70)	ICC=0.87-1 (n=132)	ICC=0.89-0.99 (n=79)	SEM 0.07 m/s (n=50) SEM=0.08 m/s (n=20)	Barthel index: r=0.78 Instrumental activities of daily living: r=0.76 (n=40) Number of steps: r=0.97 (n=50) Infrared gating: r=1 (n=12) 300-Meter Walking Test: r=0.88 (n=28)	ES=1.17 m/s (n=19)
12-Meter Walking Test (12MWT) [18, 22, 31]	PerfO	<50				ICC=0.68 (n=18)	ICC=0.71 (n=18)		Chedoke-McMaster stroke assessment: r = 0.69 Berg Balance Scale: r = 0.80 8-m comfortable walk test: r = 0.91 6-Minute Walking Test distance: r=0.97 4-Meter Comfortable Walking Test: r=0.91 (n=25)	SRM=1.90 (n=18)
2-Meter Walking Test (2MWT) [18, 30, 31]	PerfO	>100				ICC=0.85 (n=18)	ICC=0.85-0.98 (n=140)	SEM=4.8 (n=61) SEM= 5.1 (n=12) SEM=4.8 (n=32) SEM=4.9 (n=17)		
300-Meter Walking Test (300MWT) [31]	PerfO	28			walking speeds: r=0.74-0.84 different walking steps: r=0.86				10-Meter Comfortable Walking Test: r=0.88	
30-Meter Walking Test (30MCWT) [31]	PerfO	18							10-Meter Comfortable Walking Test: r=0.91	
4-Meter Comfortable Walking Test (4MCWT) [31]	PerfO	25							6-Minute Walking Test distance: r=0.97 4MCWT: r=0.91	
5-Meter Walking Test(5MWT) [18, 30, 31]	PerfO	<100			ICC=0.80-0.97 (n=9)	ICC=0.99 (n=35)	ICC=0.97-0.99 (n=44)	SEM=6.9 (n=9) SEM=6.10 (n=55)	Functional Ambulation Scale: r = 0.55 5-m walk test: r = 0.80 (n=20) Dynamometer: r = 0.41 (n=10) Berg Balance Scale:	ES=0.81 m/s (n=61)

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
									r=0.64 Rivermead Mobility Index: r=0.64 (n=35)	
6-Minute Walking Test (6MWT) [9, 18, 22, 27, 30, 31]	PerfO	>100			ICC=0.78-0.99 (n=45)	ICC=0.74-0.97 (n=55)	ICC=0.98-0.99 (n=182)	SEM=12.4 (n=12) SEM=18.6 (n=50) SEM=18.1 (n=27) SEM=18.6 m (n=15) SEM=12.4 m (n=12)	VO2 Peak/age-predicted VO2 max: r=0.84 10-Meter Comfortable Walking Test: r=0.91 10-Meter Fast Walking Test: r=0.89 (n=27)" Max exercise test duration: r=0.60 (n=36) 5-Meter Comfortable Walking Test: r=0.79 5-Meter Fast Walking Test: r=0.82 (n=34)" 10MWT comfortable: r=0.84 10MWT fast: r=0.94 (n=50)" 3 –item short form survey-Physical: r=0.39 (n=61)" "EQ5D-Visual Analogue Scale: r=0.22 (n=64)" "Relative VO: r=0.66 (n=12)" Fugl-Meyer Lower extremity score: r=0.72 (n=34) Chedoke McMaster Stroke Assessment: r=0.75 (n=25) strength hip extensor dynamometer: r=0.40 (n=48) Stroke impact scale: r=0.52 (n=30) Berg Balance Scale: r=0.67 (n=21) Physical activity scale for individual with disabilities: r=0.31 (n=40) ICF measure activity: r=0.32 (n=77)	SRM=1.52 (n=18)

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
									Accelemeter activity: r=0.67 (n=40) Step Activity Monitor: r=0.58 (n=49) AvtivPAL: r=0.48 (n=17) The Intelligent Device for Energy Expenditure and Activity -Activity: r=0.60 (n=42) stair climbing-descent: r=0.80 stair climbing-Ascent: r=0.82 (n=50) five times sit to stand: r=0.60 (n=68) 12-Meter Walking Test : r=0.97 (n=25) 8-Meter Comfortable Walking speed: r=0.92 (n=25) Stroke impact scale-mobility: r=0.72 Stroke impact Scale-participation: r=0.56 (n=30) ICF measure participation: r=0.31 (n=77) Gait speed: r=0.89 Functional Independence Measure (walk): r= 0.69 Functional Independence Measure (motor): r=0.52 (n=37) 12-Meter Walking Test: r= 0.97 4-Meter Comfortable Walking Test: r= 0.92 (n=25)	
ABILHAND [1, 3, 5, 11, 12, 17, 24, 25]	PRO	103	Unidimensional results	Cα = 0.80	ICC=0.90-0.96	r=0.90			Grip strength: r=0.56 Box and Block test: r=0.598 Fugl-Meyer assessment-upper limb: r=0.73 grip strength (r = 0.56) and manual dexterity (r = 0.598)	ES=0.5-0.8 Obtained by distribution-based method:ES = 0.26 (in logits) obtained by anchor-based methods:0.35 (in logits) compared to % of Recovery (10–15% or 50% recovery on the

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
										Stroke Impact Scale global recovery item)
Actical [7]	TechO	40			ICC=0.95					
Action Research Arm test (ARAT) [3, 5, 6, 11, 12, 17, 24, 25, 33]	ClinRO	351	Unidimensional results	Cα = 0.97	r=0.75-0.98	ICC=0.98-0.99			Motor assessment scale: r=0.96 Motoricity index: r=0.87 Motor assessment chart: r=0.94 Fugl-Meyer test: r=0.91-0.94 Wolf motor function test: r=0.96 Motor activity log: r=0.91-0.97 Motor assessment scale: r=0.96 Motricity index: r=0.87 Modified Motor assessment Chart: r=0.94 Fugl-Meyer Motor: r = 0.93 Ashworth Scale: r = -0.30 Box and Block Test: r= 0.95 Motricity Index: r = 0.81 Fugl-Meyer joint motion/pain: r = 0.42 Fugl-Meyer sensation: r= 0.30 Modified Barthel Index: r= 0.05 Fugl-Meyer Assessment: r=0.93	ES=0.5-0.8 (n=30)
Activities of Daily Living scale [12]	ObserO	81				: ICC= 0.98 (total score)				Apraxia: r=0.43 Motor functioning: r= 0.37 Barthel Index: r=0.60	
Activity Cart Sort (ACS) [13, 29]	PRO	<100	The ACS was developed within the person environment framework, with reference to the current literature, and in consultation with carers and participants	Cα =0.71-0.89 (n=60)	ICC=0.98 (n=60)					Reintegration to Normal Living Index: r=0.51 Stroke impact scale-recovery: r= 0.38 Stroke impact scale-communication: r=0.46 Stroke impact scale-participation: r=0.41 Stroke impact scale-physical domain: r=0.64 36-item short form survey	

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
		(n=29)							(physical function): r=0.60 (n=29) Comprehensive quality of life scale: r=0.86 (n=60)	
Actiwatch [8]	TechO	11							Validity testing of threshold filtered accelerometry worn at the wrist: Ratio determined by accelerometers for ADLs was 1:2.1:2.9 vs. the expected excellent ratio of 1:2:3 98% agreement between accelerometry and video 89% agreement between accelerometry and clinic or home setting	
Actual Amount of Use Test (AAUT) [12]	ClinRO	11			r=0.76				Motor activity log: r=0.45	
Ambulatory Monitoring (AM Accelerometer) [31]	TechO	25							dimensional gait analysis indoor: r= 0.87–0.96; outdoor: r=0.96–0.99	
Arm Motor Ability Test (AMAT) [11, 12, 25]	PerfO	32	Unidimensional results		ICC=0.75	ICC=0.75				
Assessment of Motor and Process Skills (AMPS) [12]	PerfO	76			Motor and process sub scores (r = 0.88 and r = 0.86, respectively).	Inter-rater: ICC=0.97-0.99			the Scale of Independent Behavior: r=0.62-0.85 Functional Independence Measure: r=0.62	
Balance Assessment in Sitting and Standing Position (BASSP) [26]	ClinRO	1193					Rasch reliability coefficient of 0.93		Postural Assessment Scale for Stroke: r=0.75	ES-1.2
Balance Evaluation System test (BESTest) [16]	PerfO	115	Unidimensional results						NR Rasch results	
Barthel Index (BI) [4, 15, 25, 32]	PerfO	167			ICC=0.98		k=0.75		Office Population Censuses Surveys: r=0.84 36-items short form survey-Physical r=0.3	ES=0.24–0.39 SRM=0.56
Beck Depression Inventory (BDI) [19]	PRO	202			ICC=0.92				r>0.70	ES<0.5

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Berg Balance Scale (BBS) [4, 32]	PerfO	<100		Cα =0.83 and 0.97 Item to total correlations ranged from 0.67 – 0.95 (n=70)	ICC=0.96-0.99 (n=56)	ICC=0.98 (n=56)			Barthel Index: r =0.80 Fugl-Meyer scale scores: r=0.62 – 0.94 Functional Independence Measure: r =0.57 to 0.70 Timed up and go test: r=70.7 Fraters: r=0.88 (n=70)	ES= 0.66 for initial 6-week, post-stroke evaluation period, ES=0.25 for 6 – 12 weeks and overall ES of 0.97 Effect sizes were greatest in the interval between 14 and 30 days (0.80) and diminished the further one moved through time from the stroke event (90 – 100 days—effect size=0.40) (n=70)
Biaxial accelerometer [8]	TechO	6			ICC=0.85				The accelerometry system showed concurrent validity because no differences in spatiotemporal measures of gait were found between the accelerometry system and the Stride Analyzer System	
Box and Block test [5, 25]	ClinRO	<100			ICC=0.93-0.98 (n=52)	r=0.96 (n=52)	r=0.99 (n=52)		Grip strength: r=0.87 Test d'Evaluation de la performance des Membres Supérieurs des Personnes Agées: r=-0.73 to 0.78 Fugl-Meyer Assessment (motor) r= 0.92 Fugl-Meyer Assessment (joint movement/pain) r= 0.43 Action Research Arm Test r= 0.95 Motricity Index r= 0.798 Barthel Index r =0.044 (n=15)	
Brunel Balance Assessment [16]	ClinRO	92	Each item of the Brunel Balance Assessment has been evaluated with people post stroke for validity, hierarchical positioning in the scale and redundancy of		k=1				Berg Balance Scale: r=0.97 Rivermead Mobility Index: r=0.95	

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
			items							
Caltrac accelerometer [7, 8]	TechO	27			ICC=0.44					
Canadian Occupational Performance Measure (COPM) [12]	PRO	26			r=0.89				Barthel Index: r=0.335 Frenchay Activities Index: r=0.115 Stroke Impact Profile: r=0.102 EQ5D: r=0.143 Rankin Handicap scale: r=0.21	AUC=0.79-0.85
Centre for Epidemiological Studies Depression [4]	PRO	27		Cα =0.83–0.91					r>0.70	
Chedoke Arm and Hand Inventory (CAHAI) [3, 12, 17, 25]	PerfO	109	Items generated by stroke survivors and judged by a team of experts in stroke rehabilitation	Cα = 0.98	ICC=0.96-0.98	ICC=0.75-0.98			Chedoke arm and hand inventory r=0.93 Action Research Arm Test: ICC = 0.95	ROC curve areas = 0.72 ES=0.8
Chedoke McMaster Stroke Assessment (CMSA) [6, 21, 25]	ClinRO	127			ICC=0.96-0.98	ICC=0.88-0.93			Fugl-Meter sensorimotor assessment: r=0.95	ES>0.8
Climbing stairs questionnaire (CSQ) [2]	PRO	15	Focus groups results	Cα = 0.70-0.96	ICC=0.77	k>0.7			r>0.70	
Coded activity diary [13]	PRO	16							Metabolic equivalent minutes (MET.min) between patient's diaries and observer's diaries: rs= 0.75 Metabolic equivalent minutes (MET.min) between patient's diaries and Sensewear Pro2 armband (SWP2A): rs= 0.15 Energy expenditure (kcal/12 h) between patient's diaries and observer's diaries: rs= 0.92 Energy expenditure (kcal/12 h) between patient's diaries and Sensewear Pro2armband	

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
									(SWP2A): rs= 0.29	
Community balance and mobility scale (CB&M) [16]	PerfO	44							Berg Balance Scale: r=0.83 Timed up and go test: r=0.75	SRM=0.83
Computer Science and Applications Inc. Model 7164 activity monitors x 4 [7]	TechO	9							Video: ICC=0.99	
Dimensional gait analysis (3-DGA) [8]	TechO	25							Step Activity Monitor: r=0.89-0.95	
Disabilities of the Arm, Shoulder and Hand (DASH) [11]	SRO	300		Cα = 0.98	r=0.96				Fit statistics =7 items misfit 'heavy chores,' 'carry heavy object,' 'open door,' 'recreational activities,' 'stiffness,' 'less capable,' 'tingling'	
Duruoz Hand Index (DHI) [12]	SRO	56		Cα = 0.97	ICC=0.99				Functional Independence Measure-self-care item: r=0.73	
Dynamic Gait Index (DGI) [16, 31]	PerfO	25			ICC=0.96	ICC=0.96				
European Quality of life scale (EQ5D) [4, 14, 20, 28]	PRO	15			ICC=0.77				Barthel Index: r=0.709 Frenchay Activities Index: r=0.65	
Finger Tapping [8]	TechO	60							European stroke scale: r=0.526 IT-MAX (minimal index to thumb movement on 15 sec): r=0.68	
Fitbit Ulta [7]	TechO	30							Pedometer: ICC=0.70	Mean inference with video: 16 steps in 2-Meter Walking Test
Fitts Reaching test [5]	PerfO	18			ICC=0.74-0.95				Action Research Arm test: r=0.27-0.54 Hand motor assessment scale: r=0.64	
Five times Sit to Stand test (5xSTST) [23]	PerfO	<100	Experts consensus (n=58)		ICC=0.87-1 (n=31)	ICC=0.99 (n=12)	ICC= 0.98 (n=12)	SEM=1.8 (n=19)	Isometric strength knee: r=0.75-0.83 (n=12) PLR=2.4 and NLR=0.46 (n=27)	Sensitivity: 0.83%; Specificity: 0.75% (n=12)

334

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Footswitches [8]	TechO	25							Step Activity Monitor: r=0.99-0.96 LOA: 9 (mean error, 4.5% to 2.5%) and 57 (mean error, 42% to 16%) steps for nonparetic and paretic limbs, respectively	
Four Square Step [16]	ClinRO	37							Step test: r=0.73 - 0.86	Ambulatory in and outpatient (9–1094 days post-stroke). Change after 4 weeks of rehabilitation, ES=0.33
Frenchay Activities Index (FAI) [13, 14, 29, 32]	PRO	>100	Factor analysis results (n=581)	Cα =0.78-0.87 (n=188)	ICC=0.89-0.91 (n=74)	ICC=0.90-0.93 (n=114)			Nottingham Extended Activities of Daily Living: r=0.90 (n=238) Stroke impact scale: r=0.40 Motor Activity Log/amount of use: r= 0.30 Motor Activity Log/quality of movement: r=0.30 Reintegration to Normal Living Index: r=0.61 Activities-specific Balance Confidence Scale: r=0.55 Timed up and go test: r=0.68 (n=383) Barthel Index: r=0.80 Stroke impact profile: r=0.14 (n=188) NIHSS: r=0.23 (n=36)	SRM=0.5 (n=70) ES=0.59 (n=163)
Frenchay Arm Test (FAT) [4, 12, 25]	ClinRO	93			ICC>0.75	r = 0.75 to 0.99				
Fugel-Meyer Assessment (FMA) [4, 6, 33]	ClinRO	377			ICC=0.80	r=0.99 ICC=0.97			Chedoke McMaster Stroke Assessment: r=0.95 Motor assessment scale: r=0.91	
Fugl-Meyer Assessment-Upper extremity (FMA-UE) [11]	ClinRO	512	Unidimensional results		r=0.96				Fit statistics=2 items misfit/removed additional reflex item (elbow reflex) 'biceps reflex,' 'triceps	RR=0.41 compared to RR=2.03 for Action Research Arm scores following a

335

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
									reflex'	programme of intensive forced use to improve arm function in chronic stroke patients (51 year post stroke ES=0.24 for total FMA scores from admission to 5 weeks post stroke — ES for UE, LE and balance scales were 0.20, 0.19 and 0.33 respectively
Functional Ambulation Category (FAC) [30-32]	ClinRO	<100			ICC=0.36 (n=25)	ICC=0.95 (n=55)	ICC=0.74-0.96 (n=55)		Velocity: r=0.74-0.84 Number of steps: r=0.86 (n=31) Rivermead Mobility Index: r=0.69-0.89 6-Minute Walking Test: r=0.90-0.95 Velocity: r=0.90-0.95 Step length: r=0.88-0.95 (n=55)	Specificity: 16-100% (n=25)
Functional Independence Measure (FIM) [4, 14, 15, 25, 33]	ClinRO	18	Experts consensus		ICC= 0.87-0.91	ICC=0.75-0.99	ICC=0.94-0.98		Ambulatory Index: r= -0.73 Barthel Index: r=0.88 36-item short form survey-Physical: r=0.88	ES=0.27-0.46 SRM=0.48
Functional Gait Assessment (FGA) [31]	PerfO	28	Experts consensus						Barthel Index: r=0.71 Berg Balance Scale: r=0.93 Rivermead Mobility Index: r=0.85 Functional Activity Category: r=0.83 Gait speed: r=0.82	
Functional Test for the Hemiplegic Upper Extremity (FTHUE) [12]	ClinRO	82				r=0.976				
Geriatric Depression scale-long form (GDS) [4]	PRO	NR			ICC=0.85					
Grasp-Release test [33]	PerfO	60		Cα =0.75		k=0.75				ES=0.5-0.9
Grip strength [25]	ClinRO	27			ICC=0.75	ICC=0.75				
Hand Function Survey (HFS) [12]	SRO	45			r=0.79-0.94				Motor Activity Log: r=0.93-0.98	
Human activity	PRO	24	Focus groups	Cα = 0.70-0.94	ICC=0.78	k>0.8			Max activity score: r=0.95	ES=0.3-0.6

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
profile (HAP) [2, 13]			results						Adjusted activity score: r=0.99	
International Classification of Functioning, Health and Disability-Activity Measure (ICF-AM) [11]	SRO	317				ICC=0.86-0.90			Fit statistics =2 items misfit 'pushing a shopping cart,' 'typing on a computer keyboard'	
Jebsen Hand Function Test [12, 33]	PerfO	33			r=0.95				Nine Hole Peg Test: r=0.86-0.88	ES= 0.5-1.02 from 1-3 months; ES=0.56-0.86 from 1 to 6 months
Kinematics [25]	TechO	8			ICC=0.75				r=0.3-0.6	ES>0.8
Assessment of Life Habits (LIFE-H) [14, 29]	PerfO	84	The LIFE-H is model based (the Disability Creation Process Model and was developed in consultation with experts and consumers, as well as review of the literature		ICC=0.95				Functional autonomy measurement system: r= 0.7 (total score); activity of daily living: r=0.76, social roles: r=0.43 (Discriminate validity tested the hypothesis that LIFE-H scores could differ from one living environment to another. LIFE-H scores were able to distinguish between those living in their own home compared with those living in a nursing home or in long-term care in daily activities sub-scores, but not using the social roles sub-scores. Construct validity was also tested using known group methods in 46 older stroke survivors and 46 healthy older adults.37 Scores for healthy older adults were significantly higher than stroke survivors (P values from .002 to <.001) except for the domain of "interpersonal relationships". Hence, not all domains covered in the test met the criterion for	

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
									construct validity	
London Handicap scale (LHS) [28]	PRO	37	The development of the LHS was based on the International Classification of Impairments, Disabilities and Handicaps (ICIDH) conceptual framework, in consultation with health practitioners and consumers, and in review of the literature	Cα =0.80	r=0.91				Barthel index: r=0.56 Nottingham Extended Activities of Daily Living Scale: r=0.69	
Medical Outcomes Study 36-Item Short Form Health Survey (SF-36) [4, 14, 15, 20, 33]	PRO	60		Cα =0.94	ICC=0.61-0.81	r=0.75			Functional Independence Measure: r=0.81 Barthel Index: r=0.3	ESs (admission to outpatient rehabilitation to discharge) =0.48
Mini Mental State Examination (MMSE) [19]	ClinRO	75			ICC>0.75				r>0.60	
Modified Emory Functional Ambulation Profile (M-EFAM) [16, 30]	ClinRO	<100			ICC=0.99 (n=26)	ICC=0.97-0.99 (n=40)	ICC=0.99 (n=28)		10-Meter Walking Test: r=0.78 Berg Balance Scale: r=0.59- 0.73 (n=28) Functional Independence Measure (motor): r=0.14-0.78 (n=26) 10-Meter Walking Test: r=0.88-0.93 Rivermead Mobility Index: r=0.67-0.81 (n=40)	Demonstrated decrease time scores over outpatient physiotherapy treatment (mean 16.034.68, 45-minute mobility treatment sessions) (n=26)
Modified Functional Reach test (MFRT) [22, 26]	PerfO	35			ICC=0.90-0.95		ICC=0.90-0.97			ES=0.80 6-weeks reach direction: Paretic side: ES = 0.80 Forward, ES = 0.60 Non-paretic side, ES = 0.57
Motor activity log (MAL-14) [1, 5, 12,	SRO	>100	Established by examining item-	Cα = 0.81 (n=56)	r = 0.44-0.91 (n=27)				(Patient and carer quality of movement: ICC = 0.52-	Responsiveness ratio 1.9-2.0

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
17, 33]			total correlations, reliability, and frequency with which item was deemed not appropriate for test						0.7 Action Research Arm Test: r = 0.63 (n=56) Global Change Rating: r = 0.16 Accelerometer: r=0.74 (n=20) Accelerometer: r=0.7-0.91 (n=41)	
Motor Assessment Scale (MAS) [4, 6, 10, 25]	ClinRO	37			ICC=0.98	r=0.95-1			Fugl-Meyer Assessment; r=0.88 Action Research Arm Test: r=0.87	Item 5 (walking) showed a large effect size; the other items have small effect sizes (d 0.36–0.5) and the majority of subjects showed no change over time
Motor Evaluation Scale for Upper Extremity in Stroke Patients (MESUPES) [11, 12]	ClinRO	396	Two dimensions: arm and hand		ICC=0.95-0.97				Fit statistics =5 items misfit (not able to identify the misfit items)	
Motor Free Visual Perception Test [4, 19]	ClinRO	30			ICC-0.98				r>0.60	
Motricity index (MI) [4, 6, 9, 10, 32]	ClinRO	55		Cα = 0.77	ICC=0.56-0.91	r=0.88			Rivermead Mobility Assessment (6 weeks: r=0.76; 12 weeks: r=0.73, 18 weeks: r=0.74) Nine-Hole Peg test: r=0.82 Action Research arm test: r=0.87 Fugl-Meyer-leg: r=0.69 Fugl-Mayer-arm: r=0.71 Rivermead Mobility Assessment: r=0.75-0.81	
Multimedia activity recall for children and adults (MARCA) [13]	SRO	40			ICC=0.83-0.95				activPAL3 activity monitor (total sitting time): ICC=0.67	
National Institute of	ClinRO	65							r=0.75	Low Sensitivity

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Health Stroke Scale (NIHSS) [4]										
Neurobehavioral Cognition Status Exam (NCSE) [4]	ClinRO	65			r= 0.69	r=0.57				Patients who have scores that are lower than those in the average range on any test are impaired in that specific skill.99 For geriatric population (77.6 years 5.2 years) the normal ranges for the different tests are: Orientation 11.7 0.7; Attention test 7.7 0.9; Comprehension 5.9 0.4; Repetition 12.4 0.8; Naming 8.2 1.1; Constructions 4.4 1.5; Memory 10.1 2.2; Calculations 3.9 0.3; Similarities 5.6 1.3; Judgment 5.0 0.8
Nike+Fuelband [7]	TechO	30							Pedometer: ICC=0.19	Mean difference with video: 73.05 steps in 2-Meter Walking Test
Nine-Hole Peg test (NHPT) [5, 6, 25]	ClinRO	62			ICC=0.85-0.89	r=0.68-0.99			Grip strength: r=0.71 Jebson hand function: r=0.83-0.85 Upper Extremity Performance Test for Elderly (Test d'Evaluation des Membres supérieurs de Personnes Agées: r=0.79-0.90	
Nottingham Extended ADL index (N-ADL) [2]	PRO	78	Focus groups results	Cα = 0.70-0.95	ICC=0.77	k>0.7			r>0.70	ES=0.5-0.8
Nottingham leisure activity (NLA) [13, 20]	PRO	21		Cα =0.87	r=0.77	ICC=0.3-0.57			Nottingham Health Profile- emotional reaction scale at six months post stroke: r =0.71 Nottingham Health Profile scores (all sections) distinguished between stroke survivors and age-matched controls at one	

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
									and 6 months post-stroke (p<0.01) and between those able to walk vs. unable to walk at 1 and 6 months post stroke (p<0.05)	
OMRON HJ-113-E Piezoelectric Pedometers [7]	TechO	50								Underestimates step counts. Mean difference with video –32.4 steps in 6-Minute Walking Test
Ottawa Sitting Scale (OSS) [26]	ClinRO	71				ICC=0.96-0.98	ICC=0.99			
Outpatient Physical Therapy Improvement in Movement Assessment Log (OPTIMAL) [11]	PRO	3138							Fit statistics =no item misfit	
PAL2 (Gorman ProMed Pty. Ltd) [7]	TechO	20							Visual observation: ICC= 0.68-0.74 (measured over 8 hours)	
Pedometers [7, 8, 31]	TechO	20			r=0.64				Hand held counter/visual observation: ICC=0.58 Accordance for both speeds (self-selected and fastest comfortable speed) 98.7 1.2% vs. 87.2 11.3%, P<0.001; and 97.8 2.3% vs. 84.8 14.8%, P<0.01, respectively, in favor of Step Activity Monitor	Mean difference with visual observation: 31 steps in 2-Meter Walking Test
Postural Assessment Scale for Stroke Patients (PASS) [22, 26]	PerfO	167								30 to 90 days, SRM = 0.65 90 to 180 days, SRM = 1.02 ES=0.90 SRM=1.32
Postural Assessment Scale for Stroke Patients Trunk Control (PASS-TC) [22]	PerfO	93								30 to 90 days, ES = 0.64 (n=93) 90 to 180 days, ES = 0.31 (n=80) 14 to 90 days, ES = 1.07 (n=93) 14 to 180 days, ES = 1.12 (n=80) 30 to 90 days, SRM =

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
										0.42 (n=203) 90 to 180 days, SRM = 0.02 (n=189)
Quadriplegia Index of Function [33]	ClinRO	60			ICC=0.80 vg					ES=0.5-0.7
Reintegration to normal living index (RNLI) [28]	PRO	57			ICC=0.89				Activity Cart Sort: r=0.56	
Rivermead mobility Assessment (RMI) [10, 15, 22, 30]	SRO	>100		Cα =0.88 - 0.95 (n=107)	r=0.79-0.98 (n=51)				Functional Independence Measure: r=0.38-0.86 (n=51) 10-Meter Walking Test: r=0.80 to 0.82 Ambulatory Index: r = -0.96 6-Minute Walking Test: r=0.63 Functional Independence Measure: r=0.73-0.91 Motricity Index- leg: r=0.49-0.51 Trunk Control Test: r=0.83-0.89 (n=73) Barthel Index: r=0.6 Berg Balance Scale: r=0.8 (n=38)	ES=0.89 (n=73)
Rivermead motor assessment (RMA) [4-6, 10, 11, 25]	PerfO	158			ICC=0.61				Motricity Index 6 weeks: r=0.76 12 weeks: r=0.73 18 weeks: r=0.74	
Sensewear Pro 3 Armband [7]	TechO	12							Step Activity Monitor: ICC=0.35	Mean difference: 3.8% (measured for 10 days)
Short form of the Wolf Motor Function Test (S-WMFT) [11]	PerfO	172	Unidimensional results	Cα =0.91	r=0.89-0.91				Fit statistics =no item misfit	
Sickness Impact profile (SIP) [4, 14, 20]	PRO	574		Cα =0.85	ICC=0.83				Barthel Index: r =70.587 Rankin Handicap Scale: r=0.468 Frenchay Activities Index: r =70.426 European Quality of life: r=70.48	
Sitting Rising Test (SRT) [26]	ClinRO	60			ICC=0.679-0.863	ICC=0.872-0.967			Ankle dorsiflexion: r=0.376 Ankle plantarflexion: r=0.46	

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
SmartShoe [7]	TechO	12							Video: ICC=0.99	Fast and self-selected speeds. Accuracy for correctly identifying postures: 97.2%
Sodring motor evaluation for stroke patients [10]	ClinRO	>100		Cα =0.94-0.99 (n=123)		ICC=0.95 (n=30)			Brigitta Landmark motor assessment: r= 0.83-0.94	SRM=1.10-1.26
Sollerman hand function test [5]	PerfO	24			ICC=0.96	r=0.92				
Step test [16]	ClinRO	41			ICC=0.93 (affected) to ICC=0.94 (unaffected)				Functional reach: r=0.68 (affected leg stepping up); r= 0.73 (unaffected leg) Gait speed: r= 0.83 Stride length: r=0.82	Ambulatory in and outpatient (9–1094 days post stroke). Change after 4 weeks of PT: ES=0.47–0.60 Inpatient rehabilitation initiated within 4 weeks post stroke. Change after 8 weeks: SEM= 0.92–0.95 (note: 41% of participants unable to perform test on admission skewing results)
StepWatch Activity Monitor or Step Activity Monitor (SAM) [7, 8, 30]	TechO	<100			ICC=0.95 (n=40)	ICC=0.96 (n=17)			Video: ICC=0.97 (n=30) Footswitches: ICC=0.96 (non-hemi leg); ICC=0.896 (hemi leg) (n=25) Functional Independence Measure: r=0.52 at baseline; r=0.62 at 3 months) (n=21) Berg Balance Scale: r=0.58 (n=50) Dynamic gait index: r=0.89-0.95 Footswitches: r=0.96-0.99. (n=25) Gait speed: r=0.45 Rivearmead Mobility Index: r=0.3 Femur: r=0.52–0.62 (n=19)	Mean difference with video: 4.73 steps in 2-Meter Walking Test (n=30) Increased error with hemi leg outdoors. (n=25) Extreme slow stride counts (mean steps/d: 2837-1503) compared with norms for older and/or sedentary adults (5000–7000) (n=50)
Stride analyzer system (SAS) [8]	TechO	6			ICC=0.85				Actual Amount of Use Test (ACS) vs. SAS, no differences between	

343

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
									spatiotemporal parameters	
Stroke Arm Ladder (SAL) [11]	ClinRO	942	Unidimensional results		r=0.90-0.91				Fit statistics =no item misfit in the final item bank	
Stroke Impact Scale (SIS) [2, 4, 14, 20, 24, 25, 28]	PRO	696	Focus groups results	Cα = 0.83-0.90	ICC=0.7-0.82	k>0.7	ICC=0.50-0.83		Construct validity (convergent/discriminate): SIS physical domains (strength, ADL/IADL, mobility and hand function) correlated most strongly with WHOQOL physical domain (r =0.40, 0.61, 0.63 and 0.40 respectively) and least with WHOQOL social relationships (r=0.13, 0.13, 0.18, 0.18), memory and emotion scores were more associated with WHOQOL psychological domain (r=0.49 and 0.70) and Zung Depression Scores (r=70.38 and 70.62) than with the physical domain of WHOQOL (r=0.32 and 0.41). Memory was least correlated with WHOQOL environment scores (r=0.15). Participation was correlated with all domains of WHOQOL and with Zung (r=0.45 – 0.69 and 70.56). Neither Zung nor WHOQOL assess communication—correlations with SIS communication ranged from 0.11 – 0.28 and 70.28 for the Zung Depression Scale score	SIS showed significant change in the expected direction in patients' recovery between assessments done at 1 and 3 months and 1 and 6 months, but sensitivity was affected by severity and time post stroke. For hand function, mobility, ADL/IADL, combined physical and participation, change is significant from 1 – 3 and 1 – 6 months, but not 3 – 6 months among patients recovering from minor stroke. For moderate strokes, significant change is seen for the same two time periods in all domains and from 3 – 6 months for mobility, ADL/IADL, combined physical and participation domains

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Stroke Rehabilitation assessment of movement (STREAM) [3, 5, 10, 11]	ClinRO	351	Three dimensions: upper limb movements, lower limb movements, and mobility	Cα = 0.98	ICC=0.75		r=0.99		Fugl-Meyer assessment: r=0.91	SRM=0.51-1.2
Stroke Specific Quality of Life Scale (SSQOL) [4, 14, 20]	PRO	71		Cα = 0.75	ICC=0.41	r=0.59			Discriminative of patients rating health-related quality of life as same vs. worse than pre-stroke (p<0.001) though only one domain (family roles) was significantly different between groups when scores were examined on the domain level	Socio-economic Status scores for the interval between 1- and 3-months post stroke were found to be between 0.20 (personality) and 0.83 (social roles). One half of SSQOL domains demonstrated less than moderate effect sizes; amount of help response set appears to lack responsiveness
The Intelligent Device for Energy Expenditure and Activity (IDEEA) [7, 8]	TechO	42			ICC=0.69-0.80					
Timed Up and Go test (TUG) [4, 16, 21, 27, 30]	PerfO	50			ICC=0.96	ICC=0.94			Berg balance scale: r= -0.70 Community balance and mobility: r=-0.75 Gait parameters: r=0.62-0.90 Ankle strength: r=0.86 6-Minute Walking Test: r=0.96	Ambulatory inpatient (post-stroke with change reported post 304 days of treatment): SRM=0.73
Timed walk [15]	PerfO	22	Has established face validity and is relatively independent of distance				ICC=0.96-0.99		Max walk: r= -0.79 2 min walk: r= -0.61 Rivearmead Mobility Index: r= -0.80	
Triaxial accelerometer/ RT3 [7, 8]	TechO	52			ICC=0.70-0.93				Triaxial accelerometer to measure trunk asymmetry during gait and reliability of accelerometer to determine asymmetry indexes: Significant differences between control and experimental group for anteroposterior, vertical,	

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
									and mediolateral asymmetries measured by accelerometers; the vertical trunk parameter has the best discriminating ability with a sensitivity of 82.5, specificity of 85%, and an area under the curve of 0.90 (P<0.001)	
Trunk Control test [26, 32, 34]	ClinRO	20		Cα = 0.83-0.86		ICC=0.96	r=0.87		Motricity Index-leg: r=0.71 Functional Activity Category: r=0.69 Rivearmead Mobility Assessment: r=0.70	
Trunk Impairment Scale [26, 34]	ClinRO	73	Literature review, observing stroke patients, clinical experience, and discussion with specialists in stroke rehabilitation	Cα = 0.65-0.89		ICC=0.87-0.96	ICC=0.85-0.99	Inter- and test–retest examiner measurement error (inter: 1.84 to 1.84, test–retest: 2.90 to 3.68)	Barthel Index: r=0.86	
Trunk Impairment Scale (TIS)-Verheyden version [26]	ClinRO	73		Cα = 0.65-0.89	ICC=0.46-1	k=)70-1			Barthel Index: r=0.86 Trunk Control Test: r=0.83	
Trunk Impairment Scale - Fujiwara version [26]	ClinRO	NR		Rasch analysis: all but 3 items showed mean square fit statistic within 1.3		K=0.66-1			Trunk Control Test: r=0.91 Functional Independence Measure (at discharge): r=0.09	SRM=0.94
Upper Body Dressing Scale (UBDS) [12]	ClinRO	51		Cα = 0.88		ICC=0.87 (total score)			FIM-dressing item: r=0.72	AUC=0.86
Upper Extremity Functional Index (UEFI) [11]	ClinRO	239				ICC=0.95			Fit statistics =5 items misfit 'sleeping', 'usual hobbies,' 'dressing', 'throwing a ball,' 'typing and lacing shoes'	
Up per Extrémité Performance Test for Erdély (Test d'Évaluation des	ClinRO	29			ICC=0.70 - 1				Acton Research Arm test: r=0.7 Box and block test: r= 0.5 functional independence	

Name of the measure	SOI	Sample size	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
Membres supérieurs de Personnes Âgées (TEMPA) [12]									to basic personal care: r=0.74	
Upper Limb-Motor Assessment Scale (UL-MAS) [11, 17]	ClinRO	80	Unidimensional results	Cα = 0.83	r=0.98	Kappa coefficient item 6, 7 and 8 = 0.93, 1.0, 1.0 Items 6, 7 and 8 (rs = 1.0) Items 6, 7 and 8 (rs = 1.0, 1.0, 0.98)	Kendall's rank order correlation coefficient for items 6, 7 and 8 = 0.74, 1.0, 1.0		Fugl-Meyer Assessment-Upper limb: r = 0.89-0.92 Fit statistics =1 item misfit 'radial deviation test'	ES = 0.45, Wilcox on Z = 4.54, p<0.001, rho = 0.7 Ability of UL-MAS subscale items to discriminate between abilities
Van Lieshout Test Short Form [33]	ClinRO	60				k=0.5-0.7				ES=0.5-0.7
Wireless Triaxial Accelerometers [7]	TechO	12							Activity logs and bouts of walking: ICC=0.70	
Wolf Motor Function Test (WMFT) [4, 11, 12, 17, 24, 25, 33]	PerfO	189	Unidimensional results	Cα = 0.98	Functional ability (ICC = 0.95) Performance time (ICC = 0.90)	Functional ability (ICC >0.88) Performance time (ICC >0.97)			Fit statistics =1 item misfit 'radial deviation test'	

ADL: activity of daily living, AUC: area under the curve, ClinRO: clinicians-reported outcome, Cα: Cronbacha alpha, ES: effect size, IADL: instrumental activity of daily living, ICC: Interclass Correlation Coefficient, ClinRO: clinician-reported outcome, CR: Coefficients of reproducibility, CS: Coefficients of scalability, IADL: instrumental activity of daily living, ICF: International Classification of Functioning, Health and Disability,K: Kappa, LOA: limits of agreements, ObserO: observation-reported outcome, PerfO: performance-reported outcome, PRO: patients-reported outcome, PLR: positive likelihood ratio, r: Pearson correlation, SRO: self-reported outcome, SOI: source of information, NR: not reported, NLR: negative likelihood ratio, ROC: receiver operating characteristic curve, RR: Response Ration, SOI: source of information, SEM: standardized error of measurement, SRM: standardized root of mean, TechO: technology-reported outcome, WHOQOL: World Health Organisation Quality of Life

D. Individuals with traumatic brain injury

Name of the measure	SOI	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
10-Meter Walking Test (10MWT) [27, 30]	PerfO	>100			ICC=0.95-0.99 (n=94)	ICC=0.91-0.98 (n=13)				
6-Minute Walking Test (6MWT) [27, 30]	PerfO	36			ICC=0.94-0.96	ICC=0.94-0.96				
Brain injury community rehabilitation outcome scale (BICRO) [2]	PRO	127	Focus groups results	Cα= 0.70-0.94	ICC=0.77	k>0.7			r>0.70	
Community balance and mobility scale (CB&M) [30]	PerfO	32				ICC=0.98	ICC=0.98		Gait speed r=0.64	
European Quality of life scale (EQ5D) [35]	PRO	86			ICC=0.78					
Functional Independence Measure (FIM) [35]	ClinRO	332	Rasch analyses of 2 separate domains of items were defined: the motor domain consisting of 13 items and the cognitive domain consisting of 5 items.		r=0.90					
Grooved Pegboard Test (GPT) [35]	ClinRO	NR			r=0.67-0.86				Tapping Speed: r=0.35; Near Visual Acuity: r=0.62 Reaction Time: r=0.31; Digit Symbol: r=0.60; Block Design: r=0.34; Object Assembly: r=0.45	
High Level Mobility Assessment (HiMAT) [30]	PerfO	103	Experts consensus			ICC=0.99	ICC=0.99		Functional Independence Measure: r=0.53 Rivermead Mobility	

Name of the measure	SOI	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
									Index: r=0.87	
Mayo-Portland Adaptability Inventory (MPAI-4) [35]	PRO	339	Experts consensus	Cα =0.89		r=0.88-0.99			Disability rating scale: r=0.81 Goal Attainment Scaling: r=0.47 Independent Living Scale: r=0.26 Vocational Independence Scale: r=0.32	
Medical Outcomes Study 36-Item Short Form Health Survey (SF-36) [35]	PRO	NR	Experts consensus	Cα = 0.79-0.92					Beck depression inventory: r=0.77	
Pens taped to feet [30]	ClinRO	12					ICC=0.94-1		Step length and width: r=0.93	
Rivermead mobility index (RMI) [30]	SRO	20							Barthel Index: r=0.91 Functional Assessment Category: r=0.89 Gait speed: r=0.82 Bohannon Balance Scale: r=0.82 6-Minute Walking Test: r=0.63	
Satisfaction with Life Scale (SWLS) [35]	PRO	NR	Initially 48 items were included; factor analysis showed that 10 items loaded highly (0.60) on a factor reflecting cognitive judgmental evaluative processes; 5 items were redundant, resulting in the	ICC=0.89						

Name of the measure	SOI	Sample	Content validity	Internal consistency	Test-retest	Inter-rater	Intra-rater	Measurement error	Construct validity	Responsiveness
			current 5-item scale							
Sickness Impact profile (SIP) [2]	PRO	25	Focus groups results	Cα = 0.70-0.91	ICC=0,77	k>0.7			r>0.70	ES=0.5-0.9
Timed Up and Go test (TUG) [27]	PerfO	24			ICC=0.86					
Functional Arm Activity Behavioral Observation System (FAABOS) [12]	ObserO	9				ICC≥0.75				
Trunk Recovery Scale (TRS) [26]	ClinRO	59		Cα =0.9		ICC=0.97		SEM= 8.81 - 11.15	Trunk Control Test: r=0.94 Functional independence Measure: r=0.85	

ClinRO: clinicians-reported outcome, Cα: Cronbacha alpha, ES: effect size, ICC: Interclass Correlation Coefficient K: Kappa, ObserO: observation-reported outcome, PerfO: performance-reported outcome, PRO: patients-reported outcome, r:

Pearson correlation, SRO: self-reported outcome, SEM: standardized error of measurement, SOI: source of information, NR: not reported

Appendix 1. Inductive and deductive thematic analysis

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
Theme 1. Considering mobility holistically and individual needs, preferences, and unique experiences							
1.1. A comprehensive definition of mobility							
C01: *"mobility is a big topic that we deal with; it is not just a physical capacity, all the motivation, cognitive, planning, that can go just for that one appointment; need to be taken into account"*	clinician	Bio-psycho-social modal as a lens/frame to view mobility and what impacts it	Physical capacity Cognition Planning Motivation	Activity and Participation Body Function	d4 Mobility b1 Mental Function	d499 Mobility, unspecified b144 Memory functions b164 Higher-level cognitive functions b130 Energy and drive functions	b1449 Memory functions, unspecified b1641 Organization and planning b1301 Motivation
C01: *"travel, work and for leisure activities, biking is relate to mobility"*	clinician	Mobility: travel; work, leisure	Recreation Work Leisure activities Biking	Activity and Participation	d9 Community, social and civic life d8 Major life areas	d920 Recreation and leisure Work and employment (d840-d859) d920 Recreation and leisure	d9209 Recreation and leisure, unspecified d8509 Remunerative employment, unspecified d9209 Recreation and leisure, unspecified d9201 Sports
C05: *"safety because sometimes things are going well with our patients, but they're still very insecure"*	clinician	Mobility definition: add safety	Safety	Environmental Factor	e5 Services, systems and policies	e530 Utilities services, systems and policies	e5308 Utilities services, systems and policies, other specified (Safety standards for individuals with ABI)
C05: *"the notion of feeling safe of being comfortable with moving versus moving from point A to point B, but with a very high level of anxiety, they don't want to do it anymore"*	clinician	Mobility definition: add safety and fear, anxiety	Safety Walking Fear Anxiety	Environmental Factor Activity and Participation Body Function	e5 Services, systems and policies d4 Mobility b1 Mental Function	e530 Utilities services, systems and policies Walking and moving (d450-d469) b152 Emotional functions	e5308 Utilities services, systems and policies, other specified (Safety standards for individuals with ABI) b1528 Emotional functions, other specified (anxiety) b1522 Range of emotions
C05: *"we can add self confidence, fear and anxiety as factors that influence mobility"*	clinician	Mobility definition: add safety and fear	Safety Fear Self-confidence Anxiety	Environmental Factor Body Function	e5 Services, systems and policies b1 Mental Function	e530 Utilities services, systems and policies b152 Emotional functions b126 Temperament	e5308 Utilities services, systems and policies, other specified (Safety standards for individuals with ABI) b1266 Confidence b1528 Emotional functions, other specified

351

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
						and personality functions	(anxiety) b1522 Range of emotions
C01: "self-efficacy is predictor for re-integration into the workplace, into society"	clinician	Mobility: self efficacy, community	Self-efficacy	Body Function	b1 Mental Function	b180 Experience of self and time functions	b1800 Experience of self
C02: "defiantly, re-integration is a factor that influence mobility"	clinician	Mobility: community re-integration	Community re-integration	Activity and Participation	d9 Community, social and civic life	d999 Community, social and civic life, unspecified	
C11: "So If you really trying to put the finger on mobility in TBI, the big part of it is a cognitive issue and the behaviour"	clinician	Cognitive deficits and behaviour impact on mobility	Cognitive deficits Behaviour	Body Function	b1 Mental Function	b144 Memory functions b164 Higher-level cognitive functions b147 Psychomotor functions	b1449 Memory functions, unspecified b1649 Higher-level cognitive functions, unspecified b1480 Psychomotor control
S01: "I think, the first thing I can think of is mobility is just ambulating, walking, that's what normally people would say, you know. They don't think about, maybe the bigger picture"	stroke	Mobility definition: mobility is walking, but it is also much more	Walking	Activity and Participation	d4 Mobility	Walking and moving (d450-d469)	
S03: "Walking, driving, whatever, I think it is a very physical thing"	stroke	Mobility definition: walking, driving, a physical thing	Walking Driving	Activity and Participation	d4 Mobility	Walking and moving (d450-d469) d475 Driving	d4759 Driving, unspecified
S02: "So, mobility, and it's kind of stole a lot from my independence, you know"	stroke	Mobility definition: what is lost post-stroke	Self-identity	Body Function	b1 Mental Function	b180 Experience of self and time functions	b1800 Experience of self
S05: "I just think mobility, is getting from point A to point B, pretty much, Yeah I do it, I don't enjoy it, but I get around"	stroke	Mobility definition: getting from one point to another	Walking	Activity and Participation	d4 Mobility	Walking and moving (d450-d469)	
S04: "it was just for me very psychological, that would hinder and then, I wasn't travelling, I would not go anywhere"	stroke	Fear, psychological factors impact on mobility; change in identity	Psychological Travel	Body Function Activity and Participation	b1 Mental Function d4 Mobility	b199 Mental functions, unspecified Moving around using transportation (d470-d489)	
T05: "Where I'm getting messed something up. So even taking the bus to rehab, you know, am I going to get off at the right stop. Can I remember the street?"	TBI	Memory impacts on mobility; routines, maps	Memory	Body Function	b1 Mental Function	b144 Memory Functions	
T04:" So they [people] really like it's hard to navigate your social life, your family	TBI	Navigating recovery with family, work and	Cognition Work	Body Function	b1 Mental Functions	b144 Memory functions	b1449 Memory functions, unspecified

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
life, your work life like, all of it like I have gone"		social life is difficult. All domains of life are challenging post-TBI	Social life Relationship with family	Activity and Participation	d9 Community, social and civic life d7 Interpersonal interactions and relationships d8 Major life areas	b164 Higher-level cognitive functions d910 Community life d760 Family relationships Work and employment (d840-d859)	b1649 Higher-level cognitive functions, unspecified d7609 Family relationships, unspecified
T02:"Now, I haven't received any money compensation from xxx to which has been a problem, and which contributed to anxiety, which I developed turned into self-isolation"	TBI	Financial difficulty; lack of services impact on mobility; anxiety	Finances Anxiety Self-isolation	Environmental Factors Body Function	e1 Products and Technology b1 Mental Function	e165 Assets b152 Emotional functions b180 Experience of self and time functions	e 1650 Financial assets b1528 Emotional functions, other specified (anxiety) b1800 Experience of self

1.2. Factors hindering mobility, participation and reintegration into the community

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
S02: "When I am tired, I still screw my words"	stroke	Factors: fatigue impact on word finding	Cognition Fatigue Finding words/Speech	Body Function	b1 Mental Functions b4 Functions of the cardiovascular, haematological, immunological and respiratory systems b3 Voice and speech functions	b144 Memory functions b455 Exercise tolerance functions b330 Fluency and rhythm of speech functions	b4552 Fatigability b3309 Fluency and rhythm of speech functions, unspecified
S04: "And it gets tiring to [to do your work], but maybe lazy tired, discouraged, depressed, whatever it is"	stroke	Fatigue, and other deficits lead to depression and feedback loop limiting mobility and participation	Fatigue Depression	Body Function	b4 Functions of the cardiovascular, haematological, immunological and respiratory systems b1 Mental Function	b455 Exercise tolerance functions b152 Emotional functions	b4552 Fatigability b1528 Emotional functions, other specified (depression)
S03 "I was so vulnerable at that point, I mean emotionally, physically"	stroke	Emotion and vulnerability impact mobility and participation	Emotional Physical	Body Function Activity and Participation	b1 Mental Functions d4 Mobility	b152 Emotional functions Walking and moving (d450-d469) Moving around using transportation	b1529 Emotional functions, unspecified

353

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
						(d470-d489)	
S02: *"I don't get around the city anymore, I tried it a bit of walking you know, I do some walking, but I find it's like it's just fatigue"*	stroke	Fatigue impacts on walking; physical activities and mobility	Fatigue	Body Functions	b4 Functions of the cardiovascular, haematological, immunological and respiratory systems	b455 Exercise tolerance functions	b4552 Fatigability
S04: *"it is only the one task, and if I picked the wrong one task you can do or schedule for the week involves, going here, going there. I know by this night here, I'm a veggie"*	stroke	Fatigue, energy levels limiting mobility and participation; setting a routine for morning and afternoon can be helpful	Fatigue	Body Functions	b4 Functions of the cardiovascular, haematological, immunological and respiratory systems	b455 Exercise tolerance functions	b4552 Fatigability
S04: *"In my case it is the memory thing"*	stroke	Memory and other cognitive issues impact on mobility	Memory	Body Function	b1 Mental Functions	b144 Memory functions	
S03: *"Me it was psychological, what was hindering my mobility just being petrified to leave the house, and what if it happens again and what if I was alone"*	stroke	Fear, psychological factors impact on mobility	Fear Psychological	Body Function	b1 Mental Function	b152 Emotional Function b199 Mental Functions, unspecified	b1522 Range of emotion
S03: *"I remember saying I don't feel like myself"*	stroke	Change in identity post stroke; impact on mobility	Self-identity	Body Function	b1 Mental Functions	b180 Experience of self and time functions	b1800 Experience of self
S02: *"It's like giving up a life, that you knew, and you get in a new life"*	stroke	Change in identity post stroke; impact on mobility	Self-identity	Body Function	b1 Mental Functions	b180 Experience of self and time functions	b1800 Experience of self
S03: *"I didn't experience, I mean other than, I lost my license, but I wasn't allowed to drive for a few months after my stroke"*	stroke	Loss of driver's license post-stroke	Loss of driving license Independence Self-identity Fear	Activity and Participation Body Function	d4 Mobility d2 General tasks and demands b1 Mental Functions	d475 Driving d210 Undertaking a single task d220 Undertaking multiple tasks b180 Experience of self and time functions b152 Emotional Function	d2109 Undertaking single tasks, unspecified d2209 Undertaking multiple tasks, unspecified b1800 Experience of self b1522 Range of emotion
S03: *"when something happens to you it affects your family as it did with me, and my husband and my kids"*	stroke	consequence of the deficits: affect family member (emotionally)	Emotion Relationship with family	Body Function Activity and Participation	b1 Mental Functions d7 Interpersonal interactions and relationships	b152 Emotional functions d760 Family relationships	b1529 Emotional functions, unspecified d7608 Family relationships, other specified (husband and kids)
T05: *"It's been almost a year since my concussion symptoms have been lingering. I am confused, have headaches, nausea,*	TBI	Deficits; nausea, headaches, vision, memory; difficult to	Confusion Memory Double vision	Body Function	b1 Mental Functions	b199 Mental functions,	b1565 Visuospatial perception

354

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
double vision, hallucinations, memory problems, and am still a far way from making progress"		make progress and recover	Nausea Headache Hallucination Dizziness		b2 Sensory functions and pain	unspecified b156 Perceptual functions b210 Seeing functions b240 Sensations associated with hearing and vestibular function b298 Sensory functions and pain, other specified (headache)	b2109 Seeing functions, unspecified b2403 Nausea associated with dizziness or vertigo b2401 Dizziness
T04: "after a brain injury, I lost my sleeping habit"	TBI	Change in sleeping routines	Sleep disturbance	Body Function	b1 Mental Functions	b134 Sleep functions	b1343 Quality of sleep
T02: "You think you can pull out of it, but you just can't [i.e. symptoms], it is so like am I dreaming this nausea, hangover, headache, be dizzy, unable to focus if I just put my mind to"	TBI	Cognitive and physiological deficits impact on mobility	Cognitive Nausea Dizziness Headache	Body Function	b1 Mental Functions b2 Sensory functions and pain	b199 Mental functions, unspecified b240 Sensations associated with hearing and vestibular function b298 Sensory functions and pain, other specified (headache)	b2403 Nausea associated with dizziness or vertigo b2401 Dizziness
T02:"I'm going to say the most disruptive immediate one, of course, is the headaches";	TBI	Headaches disruptive to participation in life	Headaches	Body Function	b2 Sensory functions and pain	b298 Sensory functions and pain, other specified (headache)	
T02:" they don't respond to a Tylenol or Advil. They come with a course for hours or a day. They completely put me out of there to be disruptive and can actually put me out of focus"	TBI	Headaches disruptive to participation in life	Headaches	Body Function	b2 Sensory functions and pain	b298 Sensory functions and pain, other specified (headache)	
C05: "fear of falling even if their the balance has improved, they have remained really insecure"	clinician	Mobility factors: safety add fear	Safety Fear	Environmental Factor Body Function	e5 Services, systems and policies b1 Mental Functions	e530 Utilities services, systems and policies b153 Emotional Functions	e5308 Utilities services, systems and policies, other specified (Safety standards for individuals with ABI) b1522 Range of emotion
C04: "so they feel like they are dizzy and after awhile they start losing confidence in them, so they think that they will fall but they don't because they can regain their balance, they don't have balance issue, it is	clinician	Mobility factors: dizziness, loss confidence, fall, balance, cognition	Dizziness Confidence Balance Cognition Fall	Body Function	b2 Sensory functions and pain	b240 Sensations associated with hearing and vestibular function	b2401 Dizziness

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
just because that their brain has difficulty"					b1 Mental Function	b126 Temperament and personality functions b144 Memory functions b164 Higher-level cognitive functions	b1266 Confidence b1449 Memory functions, unspecified b1649 Higher-level cognitive functions, unspecified
				Activity and Participation	d4 Mobility	Changing and maintaining body position (d410-d429)	
1.3. Impacts of biopsychosocial factors on everyday life							
T04: "I have too much fear all the time when I am driving"	TBI	Fear of driving impact mobility	Fear Driving	Body Function Activity and Participation	b1 Mental Functions d4 Mobility	b152 Emotional functions d475 Driving	b1522 Range of emotion d4759 Driving, unspecified
T02: "This is just the psychological stuff has been really hard", "the psychological stuff nipping in my life and not being outside of my life"	TBI	Psychological impact of TBI on mobility	Psychological Social life	Body Function Activity and Participation	b1 Mental Functions d9 Community, social and civic life	b199 Mental functions, unspecified d910 Community life	 d9109 Community life, unspecified
T03: "It's hard to explain to people that, you know, Oh, I can't remember your name. Lots of your memories gone, your ability to focus on anything is gone"	TBI	Memory, attention, executive functioning deficits impact on mobility	Cognitive Social life	Body Function Activity and Participation	b1 Mental Functions d9 Community, social and civic life	b164 Higher-level cognitive functions b199 Mental functions, unspecified d910 Community life	 d9109 Community life, unspecified
T02: "I couldn't go through and read all of their work. I have the same issue of the ability to at some point, my eye, brain gets tired and I can't actually focus"	TBI	Cognitive issues impact on return to work and mobility	Cognitive Reading/Comprehension Work	Body Function Activity and Participation	b1 Mental Functions d1 Learning and applying knowledge d8 Major life areas	b199 Mental functions, unspecified b164 Higher-level cognitive functions Applying knowledge (d160-d179) Work and employment (d840-d859)	
T02: "There's no longer the ability to actually make out words. So, then I know I'm tired. My brain is tired, and I have to stop [working]"	TBI	Cognitive, reading, comprehension, and fatigue impact on return to work	Cognitive Fatigue Reading/Comprehension Work	Body Function	b1 Mental Functions	b199 Mental functions, unspecified b164 Higher-level cognitive functions	

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
					b4 Functions of the cardiovascular, haematological, immunological and respiratory systems	b455 Exercise tolerance functions	b4552 Fatigability
				Activity and Participation	d1 Learning and applying knowledge d8 Major life areas	Applying knowledge (d160-d179) Work and employment (d840-d859)	
T02: "But it's the cognitive stuff, which is that I might read something three times and I still don't actually catch the meaning"	TBI	Cognitive issues (reading, comprehension) impact on mobility	Cognitive Reading/Comprehension Work	Body Function	b1 Mental Functions	b199 Mental functions, unspecified b164 Higher-level cognitive functions	
				Activity and Participation	d1 Learning and applying knowledge d8 Major life areas	Applying knowledge (d160-d179) Work and employment (d840-d859)	
T01: "There were days [at workstation] where I was just like, it's like you're okay. And all of a sudden, you're kind of just like you'd walk in somewhere and you're like, I don't really remember what I came in here for"	TBI	Memory impacted while navigating from place to place, not remembering what you are doing and searching for	Memory Work Leisure activities	Body Function Activity and Participation	b1 Mental Function d8 Major life areas d9 Community, social and civic life	b144 Memory Function Work and employment (d840-d859) d920 Recreation and leisure	d9209 Recreation and leisure, unspecified
T02:"it's just, you're out. You're like, looking at your life passing by things that you were so easy before it becomes difficult and focus and things get challenging that were very easy"	TBI	Change in identity post TBI; change in the difficulty level of activities impact on mobility	Self-identity Social life	Body Function Activity and Participation	b1 Mental Functions d9 Community, social and civic life	b180 Experience of self and time functions d910 Community life	b1800 Experience of self d9109 Community life, unspecified
T02: "going specializing in any kind of sort of take socializing family gatherings with going to restaurants, cafes you know whether, it was in movies or anything that was loud, You know, concerts, small place music whenever all those things were very difficult for me"	TBI	Sensitivity to stimulation, information, noise, light impact on socialization	Sensitivity to stimulation Social life	Body Function: Activity and Participation	b2 Sensory functions and pain d9 Community, social and civic life	b240 Sensations associated with hearing and vestibular function d910 Community life	b2408 Sensations associated with hearing and vestibular function, other unspecified d9109 Community life, unspecified
T02: "So all of my social life, family life, and my professional life are impacted"	TBI	Social life, relationships impact post-TBI	Social life	Activity and Participation	d9 Community, social and civic life	d910 Community life	d9109 Community life, unspecified
T03: "I can't read the kind of books I'm	TBI	Reading	Reading/Comprehen	Activity and	d1 Learning and	Applying	

357

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
used to reading. It's actually very simple stuff. I can't remember anything"		comprehension, memory impacted post-TBI	sion Leisure activities Memory	Participation Body Function	applying knowledge d9 Community, social and civic life b1 Mental Functions	knowledge (d160-d179) d920 Recreation and leisure b144 Memory Functions	d9209 Recreation and leisure, unspecified
S03:"my life changed, I went from you know, jogging and yoga and being super active, to being even when I physically could do those things, petrified, petrified to do them"	stroke	Psychological factors impact on mobility; change in identity	Psychological Sport	Activity and Participation Body Function	d9 Community, social and civic life b1 Mental Functions	d920 Recreation and leisure b144 Memory functions	d9201 Sports
T02: "I love my brain. I want it back, like my intellect; I think it was one of the best parts of me. I miss it"	TBI	Change in cognitive abilities; changes and loss difficult post-TBI	Cognitive	Body Function	b1 Mental Functions	b164 Higher-level cognitive functions	
T03: "I want my brain back"	TBI	Change in cognitive abilities; changes and loss difficult post-TBI	Cognitive	Body Function	b1 Mental Functions	b164 Higher-level cognitive functions b144 Memory functions	
T02: "so I couldn't do the basic work of checking their work and sending emails that I've developed an anxiety and phobia around this, and I had to give it up yesterday"	TBI	Symptoms impacts on work and develop anxiety and fear	Anxiety Fear Work	Body Function Activity and Participation	b1 Mental Functions d8 Major life areas	b152 Emotional functions Work and employment (d840-d859)	b1522 Range of emotion b1528 Emotional functions, other specified (anxiety)
T02: "I feel when I was after one month, I'm at home and then I feel me go into depression, I lost my job and there is no compensation after 7 months"	TBI	Transition to home difficult; loss of job, finances also difficult; cascades to depression	Depression Work Leisure activities Financial	Body Function Activity and Participation Environmental Factor	b1 Mental Functions d8 Major life areas d9 Community, social and civic life e1 Products and Technology	b152 Emotional functions Work and employment (d840-d859) d920 Recreation and leisure e165 Assets	b1528 Emotional functions, other specified (depression) d9209 Recreation and leisure, unspecified e 1650 Financial assets
T02: "It's weird because I was self-isolating and then the pandemic happens like wow, like the world is itself isolating so yeah it's completely comprehensively, Impacted all of those aspects"	TBI	Symptoms leads to self-isolation	Self-isolation	Personal Factor			
T03: "Stimulus any kind of stimulus visual, auditory everything gets to be too much very quickly, so you know even visiting my home, my family"	TBI	Sensitivity to stimulation, information, noise, light impact on mobility, relationships and family	Sensitivity to stimulation Visual Auditory Relationship with family	Body Function	b2 Sensory functions and pain	b240 Sensations associated with hearing and vestibular function b210 Seeing functions b230 Hearing	b2408 Sensations associated with hearing and vestibular function, other unspecified b2109 Seeing functions, unspecified b2309 Hearing

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
						functions	functions, unspecified
				Activity and Participation	d7 Interpersonal interactions and relationships	d760 Family relationships	d7609 Family relationships, other unspecified
T03: "There aren't very many of us [i.e. family], but the TV and the conversations and the kids are making sounds and I just have to remove myself from the situation at some point and try to explain that I'm not being rude, I'm just overwhelmed with stimulus and I need less so"	TBI	Sensitivity to stimulation, impacts relationship	Sensitivity to stimulation Family relationship	Body Function	b2 Sensory functions and pain	b240 Sensations associated with hearing and vestibular function	b2408 Sensations associated with hearing and vestibular function, other unspecified
				Activity and Participation	d7 Interpersonal interactions and relationships	d760 Family relationships	d7609 Family relationships, other unspecified
T03:"I was already self-isolating because I couldn't handle all the noise and the sounds, and the vision and I also can't drive. I haven't been able to drive for my car for over a year now"	TBI	Sensitivity to stimulation, information, noise, light & loss of driving impact on mobility	Sensitivity to stimulation Visual Auditory loss of driving licence	Body Function	b2 Sensory functions and pain	b240 Sensations associated with hearing and vestibular function b210 Seeing functions b230 Hearing functions	b2408 Sensations associated with hearing and vestibular function, other unspecified b2109 Seeing functions, unspecified b2309 Hearing functions, unspecified
				Activity and Participation	d4 Mobility	d475 Driving,	d4759 Driving, unspecified
T03: "And I found the winter, particularly difficult because you're I mean yourself isolating but you're really isolated in the wintertime, because nobody is outside. Even so, I don't know everybody's out there, living their lives and you just can't join in"	TBI	Winter, snow, leads to self-isolation	Self-isolation Weather	Personal Factor Environmental Factor	e2 Natural environment and human made changes to environment	e225 Climate	e 2255 Seasonal variation
Theme 2. Assessment and intervention guidelines							
2.1. Finding common goals with patients							
C04: "will clients objectives first of all; if he is not going to use stairs because he is not going to use them, we are not going to use them"	clinician	Mobility assessment methods: patients' objectives/complain	Patient objective	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C07: "also, patients' complain is important, so if the number one complaint is dizziness, then we're going to focus on that. If its pain, we'll look at pain"	clinician	Mobility assessment methods: patients' objectives/complain	Patient objective	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C02: "in OT, we would do cognitive screening [to assess cognitive	clinician	Mobility assessment methods; cognitive	Screening Cognitive	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems	e5808 Health services, systems and policies,

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
impairment]"		screening		Body Function	b1 Mental Function	and policies b144 Memory functions	other specified (guidelines) b1449 Memory functions, unspecified
C07: *"if he is able to carry things, does the laundry, able to prepare a meal, carry the pots. So, we can certainly do a little bit here [situational assessment]"*	clinician	Community-based ax: simulation / situational	Situational Assessment	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C03:*" part of the assessment is also establishing the persons self-reported difficulties, what they perceived to be difficult is a good starting to evaluate"*	clinician	Self-reported outcomes - as part of the assessment treatment cycle	Patient objective Self-reported	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C07: *"[we assess our patients focusing] More at the level of functional mobility, then more in the community and in using public transportation"*	clinician	Community-based assessment: simulation / situational	Situational assessment	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C05: *"In OT, in the back, [we go] shopping [with our patients] in the neighbourhood, we go with them to the bank, and for meal preparation at their home"*	clinician	Community-based assessment: simulation / situational	Situational assessment	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C05: *"Sometimes they don't achieve independency [while they are in rehab phase 2], so we train them in their neighbourhood or at least to make the trip from home to the outpatient clinic for their safety"*	clinician	Community-based assessment: simulation / situational	Situational assessment	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C07: *"we do a little preliminary assessment on the first day when the person is admitted; .... after the first contact, I am going to go more towards the main problem [to evaluate]"*	clinician	Choose measures depends on care pathway point; screening, patients complain	Self-reported Screening	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C03: *"we have what the clients subjectively reports is their difficulty but we also have a professional responsibility to screen everything that they might not thought off"*	clinician	Assessment: difference btw what clients says and does or cannot do; words vs. behaviour; self-reported outcomes and screening	Self-reported Screening	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C06: *"sometimes the questionnaire gave us the wrong picture about the patient if we don't ask him to do a task and observe"*	clinician	Caregiver/family depends on deficits - may be better to ask caregivers/family, patient-reported outcomes, observation/ mixing between assessment methods	Self-reported Observation	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C01:*" there are objective assessment tools that we use in conjunction to observation*	clinician	Observation/expert opinion; use of objective	Standardized measures	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems	e5808 Health services, systems and policies,

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
to help guide me [to get the full picture while evaluating the patient in the clinic]"		tools	Observation			and policies	other specified (guidelines)
C01: "we all use our clinical decision making, our experience to say what would be the most important tool to use"	clinician	Integrate experience / clinical decision-making; lack of standard set of tools; clinical experience & judgment guiding what to assess and how to treat	Clinical judgement Expertise	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C05: 'if I have patient with mild TBI, it's more about vestibular problems, balance, and perceptual that can have an impact on how people move around in the community"	clinician	Adapt assessment depends on deficit - which guides assessment measures	Functional capacity	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C02: "there is cognition and perception, also scanning and the vision aspects, [that need to be assessed]"	clinician	Executive dis-function: poor perception, decision making, planning etc. impact on mobility, vision, safety, awareness	Screening Assessment Executive dysfunction Safety Vision	Body Function Environmental Factors	b1 Mental function b2 Sensory functions and pain e5 Services, systems and policies	b164 Higher-level cognitive functions b210 Seeing functions e530 Utilities services, systems and policies e580 Health services, systems and policies	b2101 Visual field functions e5308 Utilities services, systems and policies, other specified (Safety standards for individuals with ABI) e5808 Health services, systems and policies, other specified (guidelines)
C03:"we need to look at flexibility, we need to look at pain, spasticity, In terms of things that we are going to change sure, coordination, we also, want to look at their endurance, strength, balance"	clinician	Assessment; pain, spasticity, coordination, endurance, strength, balance	Standardized measures Observation Pain Spasticity Coordination Endurance Strength Balance	Environmental Factor Body Function	e5 Services, systems and policies b2 Sensory Functions and Pain b4 Functions of the cardiovascular, haematological, immunological and respiratory systems b7 Neuromusculoskeletal and movement-related functions	e580 Health services, systems and policies Pain (b280-b289) b455 Exercise tolerance functions b735 Muscle tone functions b235 Vestibular functions	e5808 Health services, systems and policies, other specified (guidelines) b4550 General physical endurance b7358 Muscle tone functions, other specified (Spasticity) b2358 Vestibular functions, other specified (Balance, coordination)
C07: "we need to see how the person transfers; does he or she need to have a wheelchair? Does he or she need an aid? Walker, orthotic, a splint, depending on the condition"	clinician	Choose measures depends on condition/deficit; evaluate mobility: observation	Observation	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)

361

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
C03: "we need to evaluate different elements to have a set to get a sense what is the impairments and handicaps situation and everything the person is doing but also we are able to determine a month or 2 months later has there been a change"	clinician	Mobility assessment methods: time series, baseline, post to track the changes	Standardized measures /responsiveness	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C04: "clinical judgment and the degree of the sensitivity to change to target functional abilities in the community"	clinician	Priorities; EBP - clinical judgment, responsiveness, community-based	Clinical judgment Standardized measures	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C05: "objective evaluation it can also help us to highlight other deficits that the person has"	clinician	Mobility assessment: objective	Standardized measures	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C04: "use the scores and also the clinical judgment, I think it is a combination of both"	clinician	Score - as part of evidence-based practice	Clinical judgment Standardized measures	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C03: "it [objective tool] helps to be objective because we get invested in the person and we want them to get better, sometimes we have to take a step back and say no they did not change"	clinician	Score - as a means to be objective/professional	Clinical judgment Standardized measures	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C02: "I would say that the only time I go with score it is for driving because I cannot go and evaluate a driving by a mise en situation [i.e. simulation]"	clinician	Score - limits to using score when unable to assess directly	Standardized measures Driving	Environmental Factor Activity and Participation	e5 Services, systems and policies d4 Mobility	e580 Health services, systems and policies d475 Driving	e5808 Health services, systems and policies, other specified (guidelines) d4759 Driving, unspecified
C01: "the uses of the scores to help me when the client who doesn't see their deficits, so I use the objective tool as an argument to support my recommendation"	clinician	Score - as an educational tool for patient, support clinicians' recommendations	Standardized measures	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C03: "these numbers are more not what to treat but it is that they don't want treatment"	clinician	Score-tracking change, decision making	Clinical judgment Standardized measures	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C05: "for us the FIM is really important to do because it's made the recommendation"	clinician	Choose measures: best practices (decision making)	Clinical judgment Standardized measures	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C07: "That's it, often the coordinator will really do an initial meeting that gives us a	clinician	Initial assessment, comprehensive ax at	Self-reported	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems	e5808 Health services, systems and policies,

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
fairly global picture from the start"		referral				and policies	other specified (guidelines)
C05: Well, I don't know, PRO might highlight some areas that I'm going to want to go deeper into"	clinician	Types of assessment; patient-reported vs. clinicians-reported	Self-reported	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C06: "we based our interventions based on patients' objectives and our clinical judgments"	clinician	Blending client with goals with clinical assessment / judgement and expertise	Patient objective Clinical judgment	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C05: "It's rare, it's going to be more in terms of their perception of their energy level, their physical endurance, but otherwise it's pretty rare for me to use self-reported questionnaires"	clinician	Types of assessment; patient-reported vs. clinicians-reported; balance between patient-reported and clinical observation and assessment	Self-reported/limited	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C07: "using a questionnaire, it's still too much at the beginning if there is a bit of aphasia in there, comprehension problem, are not able to read, or you know they are able to just say simple answers"	clinician	Timing of when to use Ax tools; client deficits impact on usefulness/feasibility of assessment	Self-reported aphasia	Environmental Factor Body Function	e5 Services, systems and policies b1 Mental Functions	e580 Health services, systems and policies b167 Mental functions of language	e5808 Health services, systems and policies, other specified (guidelines) b1688 Mental functions of language, other specified (aphasia)
C05: "for example, people with hemianopsia, often they really need to be supervised to fill out the questionnaire"	clinician	Visual deficits may impact on functioning; need help with assessment	Self-reported Cognition	Environmental Factor Body Function	e5 Services, systems and policies b1 Mental Function	e580 Health services, systems and policies b144 Memory functions	e5808 Health services, systems and policies, other specified (guidelines) b1449 Memory functions, unspecified
C05: "Filling out a questionnaire alone is often difficult"	clinician	Limited functioning may impact on completing assessment; lack of support network	Self-reported/limited. Cognition	Environmental Factor Body Function	e5 Services, systems and policies b1 Mental Function	e580 Health services, systems and policies b144 Memory functions	e5808 Health services, systems and policies, other specified (guidelines) b1449 Memory functions, unspecified
C06: "the problem is that some patients don't see their deficits, so when we ask them what are the things that you cannot do? The answer is I can do everything, everything is fine"	clinician	Lack of awareness may impede completion of assessment	Self-reported/limited	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C06: "if we ask them about their goals, they answer to get back home as soon as	clinician	Lack of awareness may impede completion of	Self-reported/limited	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems	e5808 Health services, systems and policies,

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
possible, it is only because they don't see their deficit		assessment				and policies	other specified (guidelines)
C04: *"a member of family or a caregiver can fill the questionnaire for them"*	clinician	Using proxies to help with assessment	Proxy assessment Cognition	Environmental Factor Body Function Activity and Participation	e5 Services, systems and policies b1 Mental Function b7 Interpersonal interactions and relationships	e580 Health services, systems and policies b144 Memory functions d760 Family relationships	e5808 Health services, systems and policies, other specified (guidelines) b1449 Memory functions, unspecified d7608 Family relationships, other specified (family support)
C03: *"what are the red flags that require an intervention? Fear, problems with vision, pain, depression, fatigue, dizziness, headaches, if they mention any of these problems it may require other evaluations"*	clinician	Priorities; client-centred; assessment priorities; indicators that require interventions	Red flag indicators	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C05: *"take into account the red flags especially for older adults who have high risk of falling"*	clinician	Risks during community-based rehab impact on mobility	Red flag indicators	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C05: *"I think yes the objective tests are very valid but how the person is functioning is much important to decide the intervention"*	clinician	Combining objective ax tools with observation, situational, simulation, patient-reported outcomes	Standardized measures Situational assessment	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C01: *"We use a questionnaire to predict how the patient can get back to work considering the number of symptoms that they have when they began"*	clinician	Ax to predict recovery; planning for return to work, mobility	Self-reported	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C01: *"When the patient begins with us, he fills a number of questionnaires. One will be about self-efficacy, and then we re-do the questionnaire at the end of the process"*	clinician	Stages of assessment; pre-post; types of ax tools	Self-reported/first contact	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C02: *"if the inpatient and the acute outpatient and the chronic outpatient all use the same test, then we can track measures across the time, but everybody uses different things, so it is hard to see if there is been progress"*	clinician	System wide policy: use common assessment tools to enable comparison, tracking progress	Standardized measures /consistency	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C06: *"I find using the scores much more as a way to see the progression than to use it as a way to establish the plan as you know"*	clinician	Scores used to see responsiveness; scores to see change/progress;	Standardized measures /responsiveness	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C05: *"the objective tests help me to have a*	clinician	Objective assessment	Standardized	Environmental	e5 Services, systems	e580 Health	e5808 Health services,

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
global picture at the beginning and make recommendation to discharge the patient"		tools facilitate clear understanding of rehab treatment plan & discharge for client	measures /global and recommendation	Factor	and policies	services, systems and policies	systems and policies, other specified (guidelines)
C07: I think in rehab it's a lot of sharing between all the stakeholders in relation to each other"	clinician	Interdisciplinary approach to rehab; impact on mobility	Interdisciplinary shared decision making	Activity and Participation	d3 Communication	Conversation and use of communication devices and techniques (d350-d369)	Activity and Participation
C07: "I think the richness of teamwork is to exchange a lot of observations about the same patient"	clinician	Interdisciplinary approach to rehab; share info/data; impact on mobility	Interdisciplinary shared decision making	Activity and Participation	d3 Communication	Conversation and use of communication devices and techniques (d350-d369)	Activity and Participation
C06: "Yes, the interdisciplinary work is helping us a lot"	clinician	Interdisciplinary approach to rehab; impact on mobility	Interdisciplinary shared decision making	Activity and Participation	d3 Communication	Conversation and use of communication devices and techniques (d350-d369)	Activity and Participation
C07: "it's sure that we will have the objectives of the intervention plan. Also, it's true that we have our own objectives, you know, disciplinary objectives"	clinician	Discipline specific treatment plan integrated with interdisciplinary treatment plan	Interdisciplinary shared decision making	Activity and Participation	d3 Communication	Conversation and use of communication devices and techniques (d350-d369)	Activity and Participation
C07: "the intervention plan depends on if it's the disciplinary or interdisciplinary plan"	clinician	Treatment plan depends on resources, team, context; disciplinary vs. interdisciplinary	Interdisciplinary shared decision making	Activity and Participation	d3 Communication	Conversation and use of communication devices and techniques (d350-d369)	Activity and Participation
C05: "to see the contribution of the physio assessment plus the neuropsychological assessment plus the ergo assessment at the same level that's what will have the greatest impact on our intervention plan"	clinician	Discipline specific treatment plan integrated with interdisciplinary treatment plan	Interdisciplinary shared decision making	Activity and Participation	d3 Communication	Conversation and use of communication devices and techniques (d350-d369)	Activity and Participation
C05: "to have goals that are achievable across the team to meet patient's needs"	clinician	Client-centred, goal setting; Discipline specific treatment plan integrated with interdisciplinary treatment plan	Interdisciplinary shared decision making	Activity and Participation	d3 Communication	Conversation and use of communication devices and techniques (d350-d369)	Activity and Participation
C07: "It's good to be more specific in each discipline, it's important to be more	clinician	Treatment plan depends on resources, team,	Interdisciplinary shared decision	Activity and Participation	d3 Communication	Conversation and use of	Activity and Participation

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
specific in each discipline too"		context; disciplinary vs. interdisciplinary	making			communication devices and techniques (d350-d369)	
C07: *"There's a lot of exchange between the stakeholders"*	clinician	Communication between stakeholders	Interdisciplinary shared decision making	Activity and Participation	d3 Communication	Conversation and use of communication devices and techniques (d350-d369)	Activity and Participation
C07: *"When you see a decrease in physical capacity and then after that in ergo they see the impact of a lifestyle habit, lack of endurance or, lack of strength in one leg while going down the stairs of the supermarket that doesn't have ramp, you know, we're going to exchange the information a lot"*	clinician	Sharing info: key changes in behaviour and function communicated with team	Interdisciplinary shared decision making	Activity and Participation	d3 Communication	Conversation and use of communication devices and techniques (d350-d369)	Activity and Participation
T04: *"What are those steps and How to apply them, you really need a specialist to really get in there and focus and help you Improve on very specific things and how to do those things"*	TBI	Tailored rehab to specific deficits; need specialists to help recover	Uncertainty	Not defined			
C03: *"we have to understand the client's reality before we start doing basically anything and taking the time to ask them even before evaluating which is a part of the assessment? What are their difficulties? And what are their priorities"*	clinician	Priorities; client-centred	Patients objectives	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C07: *"the intervention is more functional based on the patient's goals"*	clinician	Treatment matched to client goals; client-centred	Patients objectives	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C07: *"for example, the person's objective will be to participate in a community café in their neighborhood, so it is necessary to work on his endurance and balance to go there"*	clinician	Client goals and tailoring intervention and treatment plan to client goals	Patients objectives	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C07: *"the goal at the end of the line is that he is able to meet his essential needs"*	clinician	Client-centred; start with basic needs and move up to work, leisure, relationships in treatment plan	Patients objectives	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
2.2. Challenges clinicians faced when they evaluate mobility							
C04: *"Berg is really good, but it took 30 minutes, the BESTest took 45 minutes to finish, I mean there is too many things to look at instead of using a tool"*	clinician	Assessment; complicated - no right answer; Limited time and resources	Standardized measures / limited	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)

366

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
C06: "yes, because some of these assessments are not transferable to real life"	clinician	Standard assessment along with situational / simulation assessment; observation ax to assess mobility	Standardized measures /limited	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C05: "sometimes in the community, it's hard to use a standardize measure to evaluate mobility because of different environment, so it is more functional"	clinician	Which mobility measure/tool to use varies with context/environment	Standardized measures /limited	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C03: "fatigue is another obstacle if you have to do the BORG over three visits"	clinician	Assessment: fatigue; limited resources; burden on patient	Standardized measures / limited	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C03: "we have got an hour and we have to choose one or two tests, hopefully do some treatments and teach them something"	clinician	Assessment treatment cycle limits of time	Standardized measures / limited	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C03: "there is a limit of how much because there is not enough time to assess [if] they can swallow, they can eat, they can dress, and they can walk themselves"	clinician	Limits to discharge planning; assess safety, mobility, activities of daily living	Standardized measures / limited	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C03: "what we need to know, and you know in terms of research questions, what are the top 5, top 10 tests that are going to be helpful"	clinician	Assessment methods; limited time and resources; limited choices in what tools to use	Standardized measures / top	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C03: "I think we have to get down to a short list of at least covering the different domains in physiotherapy"	clinician	Limited time: lack of guidelines, limited choice in what tool to use	Standardized measures / top	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C06: "there's no systematic way to choose the measures"	clinician	Choose measures: no systematic method	Standardized measures / limited	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
C01:"another barrier for sure is the client themselves in term of fear, do they trust you, or even if they trust you are they able to put themselves in a situation where they are challenged"	clinician	Assessment: self-awareness, avoidance/fear, trust in clinician/barriers to evaluate mobility	Trust	Body Function	b1 Mental Functions	b153 Emotional Functions	b1522 Range of emotion
C01: "[Clients were] basically home bound in winter because either they don't have the confidence or just very difficult to get out in wheelchair, probably a combination of the two?"	clinician	Fear and avoidance, no confidence in ability/access in winter (using the wheelchair)	Fear Confidence Weather	Environmental Factors	e2 Natural environment and human made changes to environment	e225 Climate b153 Emotional Functions	e 2255 Seasonal variation

367

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
				Body Function	b1 Mental Functions	b126 Temperament and personality functions	b1522 Range of emotion b1266 Confidence
C07: *"other people that it's really a lack of endurance, and then the use of walking aid in winter weather may results into falling"*	clinician	determining factor is physical; cognitive may be more serious; clinical judgment	Fatigue Weather	Body Function	b4 Functions of the cardiovascular, haematological, immunological and respiratory systems	b455 Exercise tolerance functions	b4552 Fatigability
				Environmental Factors	e2 Natural environment and humanmade changes to environment	e225 Climate	e 2255 Seasonal variation
C05: *"Another aspect which is a barrier to mobility is the use of alcohol or drugs"*	clinician	Mobility assessment challenges: alcohol or drug use	Alcohol/Drug	Body Function	b1 Mental Functions	b 110 Consciousness functions	b1102 Quality of consciousness
C05: *"We have clients with a problem of abusive consumption, when they return home and resume their consumption, they will have falls"*	clinician	Mobility assessment challenges: alcohol or drug use	Alcohol/Drug	Body Function	b1 Mental Functions	b 110 Consciousness functions	b1102 Quality of consciousness
C07: *"when we talk about cognitive versus physical, it depends on the clients, there are clients for whom the cognitive dominates, which make them unsafe to cross the street, they don't orient themselves in their neighbourhood"*	clinician	Determining factor is physical; cognitive may be more serious; clinical judgment	Cognitive Safety	Environmental Factor	e5 Services, systems and policies	e530 Utilities services, systems and policies	e5308 Utilities services, systems and policies, other specified (Safety standards for individuals with ABI)
				Body Function	b1 Mental Function	b144 Memory functions b164 Higher-level cognitive functions	
C03: *"the lack of fear and the lack of awareness often the patients with cognitive problems will they are not limited by fear"*	clinician	Executive dysfunction: poor perception, decision making, planning etc. impact on mobility, safety perception, awareness, lack of fear	Cognitive Safety	Environmental Factor	e5 Services, systems and policies	e530 Utilities services, systems and policies	e5308 Utilities services, systems and policies, other specified (Safety standards for individuals with ABI)
				Body Function	b1 Mental Function	b144 Memory functions b164 Higher-level cognitive functions	
C03: *"they overestimate their abilities"*	clinician	Executive dysfunction: poor perception, decision making, planning etc. impact on mobility, safety perception, awareness, lack of fear	Cognitive Safety	Environmental Factor	e5 Services, systems and policies	e530 Utilities services, systems and policies b144 Memory	e5308 Utilities services, systems and policies, other specified (Safety standards for individuals with ABI)

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
				Body Function	b1 Mental Function	functions	
						b164 Higher-level cognitive functions	
C08: "feeling safe in the environment"	clinician	Mobility assessment challenge in the community: safety issues	Safety	Environmental Factor	e5 Services, systems and policies	e530 Utilities services, systems and policies	e5308 Utilities services, systems and policies, other specified (Safety standards for individuals with ABI)
C03: "safety, awareness [and] being able to cross the street"	clinician	Executive dysfunction: poor perception, decision making, planning, self-awareness etc. impact on mobility, safety	Cognitive Safety	Environmental Factor	e5 Services, systems and policies	e530 Utilities services, systems and policies	e5308 Utilities services, systems and policies, other specified (Safety standards for individuals with ABI)
				Body Function	b1 Mental Function	b144 Memory functions	
						b164 Higher-level cognitive functions	
C03: "there is basic safety things that sometimes will people be more impulsive in lack of judgment and be attentive"	clinician	Executive dysfunction: poor perception, decision making, planning, self-awareness etc. impact on mobility, safety	Cognitive Safety	Environmental Factor	e5 Services, systems and policies	e530 Utilities services, systems and policies	e5308 Utilities services, systems and policies, other specified (Safety standards for individuals with ABI)
				Body Function	b1 Mental Function	b144 Memory functions	
						b164 Higher-level cognitive functions	
C13: "there is an issue of balance and coordination, and many of these patients have complex problems because it might go with vision problem"	clinician	Mobility assessment challenge in the community: balance, coordination, vision issues	Balance Vision	Body Function	b2 Sensory functions and pain	b235 Vestibular Functions	b2358 Vestibular functions, other specified (Balance, coordination)
						b210 Seeing Functions	b2101 Visual field functions
C14: "They [TBI] have difficulty to integrate what they feel and what they see"	clinician	Mobility assessment challenge in the community: integration between themselves and the environment	Cognitive Safety	Environmental Factor	e5 Services, systems and policies	e530 Utilities services, systems and policies	e5308 Utilities services, systems and policies, other specified (Safety standards for individuals with ABI)
				Body Function	b1 Mental Function	b144 Memory functions	
						b164 Higher-level cognitive functions	
C14: "It is more psychologist, so the	clinician	Mobility assessment	Cognitive	Environmental	e5 Services, systems	e530 Utilities	e5308 Utilities services,

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
person needs to regain confidence"		challenge in the community: regain confidence	Safety Confidence	Factor	and policies	services, systems and policies	systems and policies, other specified (Safety standards for individuals with ABI)
				Body Function	b1 Mental Function	b144 Memory functions	b1266 Confidence
						b164 Higher-level cognitive functions b126 Temperament and personality functions	
C13: "basically, there is a link between confidence and anxiety"	clinician	Mobility assessment challenge in the community: regain confidence	Confidence Anxiety	Body Function	b1 Mental Functions	b126 Temperament and personality functions	b1266 Confidence b1522 Range of emotion
						b152 Emotional functions	
2.3. Engaging the patient and considering their perspectives in their care							
S02: "I was asking why you are doing this test or whatever this function and what"	stroke	Patients are asking questions related to the purpose of the evaluation/patient centred care	Patient engagement	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
S02: "I would actually stop at the beginning and ask what do you want to gain out of this, like what's the purpose of it"	stroke	Patients are asking questions related to the purpose of the evaluation/patient centred care	Patient engagement	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
S02 "they have a protocol, and so basically I was applying that to everything that had to be done was like OK, stop what are we doing here?"	stroke	Patients are asking questions related to the purpose of the evaluation/strict protocol followed while ax and treatment/patient centred care	Patient engagement	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
S05: "I was a little more cautious and not just doing likely whatever they said like"	stroke	Patients are asking questions related to the purpose of the evaluation/strict protocol followed while ax and treatment/patient centred care	Patient engagement	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
S03: "I assumed that's what should happen because, you know this is how they going to treat me"	stroke	No questions are asked assuming that the healthcare provider knows exactly what to	Patient engagement	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
		do/patient centred care					
S03 *"I take it to mean you know what's best for me because you've seen this before, and you know how to handle it"*	stroke	No questions are asked assuming that the healthcare provider knows exactly what to do/patient centred care	Patient engagement	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
S05: *"I learned there to say no to certain things coz they would really bad decision"*	stroke	Patients learn how to say "no" for certain assessment and treatment/bad decisions are taken by the healthcare provider/patient-centred care/Allen Edwards hospital	Patient engagement	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (guidelines)
Theme 3. Support Network							
3.1. Caregiver support							
C06: *"a family member or a caregiver can help especially for patients with cognitive issues"*	clinician	Caregiver/family depends on deficits/cognition - may be better to ask caregivers/family	Cognition Family/Caregiver	Body Function Environmental Factors	b1 Mental Function e3 Support and relationships	b144 Memory functions e310 Immediate family	b1449 Memory functions, unspecified
C06: *"by some discussion with the patient's family, we can point into their deficits"*	clinician	Caregiver/family depends on deficits/cognition - may be better to ask caregivers/family	Cognition Family/Caregiver	Body Function Environmental Factors	b1 Mental Function e3 Support and relationships	b144 Memory functions e310 Immediate family	b1449 Memory functions, unspecified
C01: *"if the clients has cognitive issues, he might want to get the family members involved as well to validate what he is saying or maybe give extra information"*	clinician	Caregiver/family depends on deficits/cognition - may be better to ask caregivers/family	Cognition Family/Caregiver	Body Function Environmental Factors	b1 Mental Function e3 Support and relationships	b144 Memory functions e310 Immediate family	b1449 Memory functions, unspecified
C04: *"aphasia is a big topic; can we be able to talk to the person"*	clinician	Caregiver/family depends on deficits/aphasia - may be better to ask caregivers/family	Aphasia Family/Caregiver	Body Function Environmental Factors	b1 Mental Function e3 Support and relationships	b167 Mental functions of language e310 Immediate family	b1688 Mental functions of language, other specified (Aphasia)
C01: *"a lot of people maybe it is a new thing that their loved one is using a wheelchair"*	clinician	Adjustment to new life	Family/Caregiver	Environmental Factors	e3 Support and relationships	e310 Immediate family	Environmental Factors
T04: *"my husband is give me too much help for improve my mental stress"*	TBI	Family / spousal support helps with stress; difficult to navigate system - paperwork and files spread across many points	Family/Caregiver	Environmental Factors	e3 Support and relationships	e310 Immediate family	Environmental Factors

371

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
T04:"I think the psychologist and the support from your family is more effective"	TBI	Family support	Family/Caregiver	Environmental Factors	e3 Support and relationships	e310 Immediate family	Environmental Factors
T04:"my husband gave me a lot of time and discussion and relaxations"	TBI	Family/spousal support helps	Family support	Environmental Factors	e3 Support and relationships	e310 Immediate family	Environmental Factors
T04: "a family support is very, very healthy for me because I have two sons and my husband in my home, my son is 14 year old and then my son and my husband all the time is with me [to support me]"	TBI	Family / spousal support helps	Family support	Environmental Factors	e3 Support and relationships	e310 Immediate family	Environmental Factors
T04:"all the time my husband and my son give me a boost like going outside and met some family members over the phone"	TBI	Family support, spousal support help with mental health	Family support Mental health	Environmental Factors Body Function	e3 Support and relationships b1 Mental Functions	e310 Immediate family b199 Mental Functions, unspecified	
S02: "Luckily she had the day off [his caregiver], so she can help me out for certain things or would I can't get something"	stroke	Caregiver support useful and required for mobility and community participation	Family support	Environmental Factors	e3 Support and relationships	e310 Immediate family	
S03:"You know if you're lucky enough to have that for your own cognitive ability to advocate for yourself, that's one and then if you have people that you're surrounded by who can advocate for you as well, not everybody's that fortunate also"	stroke	Cognitive abilities and family support	Family support Cognition	Environmental Factors Body Function	e3 Support and relationships b1 Mental Functions	e310 Immediate family b144 Memory functions	
S02: "No that's for sure I go to the hospital I dropped my arms [to his wife] and just let her go, because she knows the system"	stroke	Caregiver/family support	Family support	Environmental Factors	e3 Support and relationships	e310 Immediate family	
3.2. Providers support							
T02:"I thought the team of the xxx was very good. They were on board, I felt finally really supported"	TBI	Institutional support; great services	Provider support	Environmental Factors	e3 Support and relationships	e325 Acquaintances, peers, colleagues, neighbours and community members	
T02:"I found everyone to be very kind and understanding because I've never had a concussion and I it's very confusing"	TBI	Institutional support; great services	Provider support	Environmental Factors	e3 Support and relationships	e325 Acquaintances, peers, colleagues, neighbours and community members	
T01:"So it's just having people believe you and support you and understand the difficulties that you're going through finding those health professionals, especially at the neuroscientist kind of level"	TBI	Support is important, listening, understanding is important	Provider support	Environmental Factors	e3 Support and relationships	e325 Acquaintances, peers, colleagues, neighbours and community members	
C13: "we work with the families, so it is important to get their point of view and	clinician	Working with family/caregivers to	Family/Caregiver Coping style	Environmental Factors	e3 Support and relationships	e310 Immediate family	

372

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
their input and to help them to cope into the situation to help the patient"		facilitate coping styles					
3.3. Community Support							
S06:"Like I was just saying, people at the hospital, homes, they think you are stupid, but the public in general, they pretty nice about it, they come and ask, can we help you?"	stroke	Perceptions of people at institutions vs. community and stigma associated with stroke; impacts mobility	Community support Stigma	Environmental Factors	e3 Support and relationships	e325 Acquaintances, peers, colleagues, neighbours and community members	
S06:"I find one thing quite annoying is that when you are put around in a wheelchair, people look at you, and some taxi drivers, they think your brain is gone, they think you stupid"	stroke	Stigma associated with stroke; visible disability and using a wheelchair; possible avoidance of use of services	Community support Stigma	Environmental Factors	e3 Support and relationships	e325 Acquaintances, peers, colleagues, neighbours and community members	
S04: "when I first get my cane, after I get out at Jean Coutu with my dad, purchase a cane. and standing in line trying to get out, the younger people, they get out of your way, they help you a lot"	stroke	Visible disability via a cane can be perceived positively by younger members community; they help with mobility	Community support	Environmental Factors	e3 Support and relationships	e325 Acquaintances, peers, colleagues, neighbours and community members	
S04: "the elder people didn't, they push you like they couldn't give a hood"	stroke	Visible disability via a cane can be perceived positively by younger members community; they help with mobility	Community support	Environmental Factors	e3 Support and relationships	e325 Acquaintances, peers, colleagues, neighbours and community members	
C05: "knowing what the best ways to accompany them to be mobile in community as possible when they can't resume driving for example"	clinician	Community supports to facilitate mobility	Community support	Environmental Factor	e5 Services, systems and policies	e575 General social support services, systems and policies	e 5758 General social support services, systems and policies, other specified (community)
C05: "[the support services are missing, especially when the patient] is not [obtaining] the necessary balance, the necessary endurance or because it is not well oriented and safe to cross the street"	clinician	Community-based - lack of support services; difficult to plan	Community support	Environmental Factor	e5 Services, systems and policies	e575 General social support services, systems and policies	e 5758 General social support services, systems and policies, other specified (community)
C06: "people who don't have caregivers around them who can't take the car, who are not independent to take public transit [also, have a problem to get access to the outpatient services]"	clinician	community-based - lack of support services; difficult to plan	Community support	Environmental Factor	e5 Services, systems and policies	e575 General social support services, systems and policies	e 5758 General social support services, systems and policies, other specified (community)
C06: "in stroke, there's no services, you know, they end up after that feeling like there's no one left, there is no services that can be provided for them"	clinician	Community-based - lack of services; difficult to plan	Community support	Environmental Factor	e5 Services, systems and policies	e575 General social support services, systems and policies	e 5758 General social support services, systems and policies, other specified (community)
Theme 4. Uncertainty about symptoms and recovery							
T02: "Will I ever get back to 'normal'? Are the changes to my cognitive	TBI	Uncertainty of deficits and recovery limits	Uncertainty Recovery	Not covered			

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
functioning permanent?"		mobility	Symptom				
T01: "It's like you just never know how long you're going to be well last; you know, it was tough"	TBI	Uncertainty about severity of deficits impact on participation	Uncertainty Symptom Recovery Psychological	Not covered Body Function	b1 Mental Functions	b199 Mental Functions, unspecified	
T01:"feel like I can kind of live with symptoms, little bit, but it's like, am I always going to have them"	TBI	Uncertainty of progress and recovery make it difficult;	Uncertainty Symptom Recovery	Not covered			
T01: "I'm mostly resolved from it, but there's still some little symptoms and you kind of wonder, is that going to last forever or if there are ways to kind of do right now, especially because of all COVID as we don't have any therapies really like accessible "	TBI	Uncertainty of progress and recovery make it difficult; lack of services due to COVID-19	Uncertainty Recovery	Not covered			
T03:"I simply write things down, like using notes in my phone or just like a notepad. So, I can remind myself, but sometimes I forgot"	TBI	Using compensatory strategies (notepad, phone) helpful for memory loss	Uncertainty Cognition Symptom management	Not covered Body Function	b1 Mental Functions	b144 Memory Functions	
T03: "I write things down. Basically, I write everything down. If it's something I need to remember I write it down"	TBI	Compensatory strategies like writing down info helps; memory deficits have an impact	Uncertainty Cognition Symptom management	Not covered Body Function	b1 Mental Functions	b144 Memory Functions	
T02: "I am watching my language so that my whole being part of myself self reflection has helped me easing myself talk. But I fail in doing that"	TBI	Meta-cognitive strategies, and self-talk, monitoring thoughts and words helpful	Uncertainty Cognition Symptom management	Not covered Body Function	b1 Mental Functions	b144 Memory Functions	
T01:"I did just slow reintegration that was really helpful and I felt like I could involve myself,...I would do more that way that like I could remind myself that I still was able to do things, and I still remembered my protocols and I still know how to do my job"	TBI	Slow, stepwise transition back to work was helpful	Uncertainty Symptom management	Not covered			
T01: "when I felt good. I was obviously able to perform better, and like socialize more and do more of my daily activities"	TBI	Uncertainty of impact of deficits; when doing well can participate, when doing poorly can participate less	Uncertainty Recovery	Not covered			
T01: "But in general, my progress has been very slow, and the main issue has been the slowness in getting back into my life"	TBI	Speed of recovery and progress impacts mobility	Uncertainty Recovery	Not covered			
T01: "I started going back in April, all the way, like I was progressive until November. It was a long journey back"	TBI	Progress with recovery, access to rehab services helps with mobility	Uncertainty Recovery	Not covered			
T05: "I ask myself if I would ever return	TBI	Uncertainty of deficits	Uncertainty	Not covered			

Quotes	Population	Formulated statements	Codes	ICF component	1st Level ICF category	2nd Level ICF category	3rd or higher Level ICF category
normal and would my symptoms last for a lifetime. They recently told me to at xxx that my physiotherapy sessions have ended"		and recovery limits mobility; lack of transition to community-based services	Symptoms Recovery				
T03: "will I get relief from the symptoms? Given that they're being caused by two different things like perhaps the brain injury will get better. But, well, I still have the symptoms as a result of the eye damage"	TBI	Uncertainty of deficits and recovery limits mobility	Uncertainty Symptoms Recovery	Not covered			
T03:"the symptoms are affecting me in a life changing way because I don't know how I'm going to do any kind of job Especially with the vertigo as well"	TBI	Combination of deficits; uncertainty of progress and return to vocation	Uncertainty Symptoms Recovery	Not covered			
T01: I'm not sure if this is what you mean but I found myself asking all my therapists (e.g. physio) how long will these symptoms last? no one could give a timeline"	TBI	Lack of timeline for recovery difficult	Uncertainty Recovery	Not covered			

C: clinician; S: stroke; T & TBI: traumatic brain injury

375

Appendix 2. Inventory list of mobility measures

Mobility measures	International Classification of Functioning, Disability and Health Component
Two-meter walking test	Activity and Participation
Five times sit to stand	Activity and Participation
Berg Balance Scale	Activity and Participation
Bilan articulaire + croix de Maligne	Activity and Participation
Community balance and mobility	Activity and Participation
Doigt-nez-, LEMOCOT, diadocokinésie	Body Function and structure
Equitest-Motor Control Test	Activity and Participation
Flexibilité musculaire	Body Function and structure
Fregly Ataxia Battery	Body Function and structure
Manual muscle testing	Activity and Participation
Sensation : toucher léger/discrimination pique-touche, vibration, proprioception, température	Body Function and structure
Tests de l'évaluation vestibulaire (inclus plusieurs tests)	Body Function and structure
Timed- Stairs	Activity and Participation
Vitesses de marche (10-meter walking test)	Activity and Participation
Assis à debout 5X	Activity and Participation
Autonomie fonctionnelle - Chedoke-McMaster Stroke Assessment-Inventaire d'activités (CMSA-IA)	Activity and Participation
Coordination: locomotion (Lower Extremity Motor Coordination Test)	Body Function and structure
Functional independence measure: Section locomotion	Activity and Participation
Force de préhension – dynamomètre manuel	Activity and Participation
Force musculaire – évaluation musculaire manuelle selon la méthode Daniels and Worthingham	Activity and Participation
Function in sitting test (FIST)	Activity and Participation
Grille d'évaluation des risques de chute en réadaptation, utilisée à l'interne, inspirée de la Morse Fall Scale.	Activity and Participation
Nottingham Sensory Assessment révisé (EmNSA)	Activity and Participation
Questionnaire sur la santé du patient (QSP-9)	Activity and Participation
Stade moteur du bras, de la main, de la jambe et du pied – Chedoke-McMaster Stroke Assessment-Inventaire des déficiences (CMSA-ID)	Activity and Participation
Step Test	Activity and Participation
Vitesse de marche : naturelle et rapide	Activity and Participation
BESTest (inclus le Mini-BESTest)	Activity and Participation
Capacité de marche fonctionnelle : Test de marche six minutes	Activity and Participation
Modified Ashworth Scale	Body Function and structure
Rating of perceived exertion (Borg scale)	Body Function and structure

Balance Master (Sensory Organization Test)	Body Function and structure
Four Square Step Test	Activity and Participation
Stade de douleur à l'épaule hémiparétique – Chedoke-McMaster Stroke Assessment (CMSA)	Activity and Participation
Timed up and go test	Activity and Participation
Visual analogue scale-douleur	Body Function and structure
Six-minute walking test	Activity and Participation
Disabilities of the Arm, Shoulder and Hand questionnaire	Activity and Participation
Dyspnoea handicap inventory	Body Function and structure
Minnesota manual dexterity test	Activity and Participation
Go outside and observation; real life, in authentic situation	Activity and Participation
Wheelchair skill assessment	Activity and Participation
Box and Block test	Activity and Participation
Functional independence measure	Activity and Participation
Capacity assessment	Activity and Participation
Energy expenditure	Activity and Participation
Useful Field of View (UFOV)	Body Function and structure
Smith hand function evaluation	Activity and Participation
Presence of pain; Pain intensity; Stability of the person's medical condition; Type of pain and Practice setting (PPSTP)	Body Function and structure

Appendix 3. Thematic content analysis based on the coding rating (the frequency of each code within each theme among all participants)

Codes	All participants (n=28) n (%)	Clinicians (n=17) n (%)	Patients (n=10) n (%)	Caregivers (n=1) n (%)
Theme 1: Considering mobility holistically and individuals needs, preferences, and unique experiences				
1.1. A comprehensive definition of mobility				
• Cognition	4 (14%)	2 (12%)	2 (20%)	
• Walking	4 (14%)		4 (40%)	
• Anxiety	3 (11%)	2 (12%)	1 (10%)	
• Safety	3 (11%)	3 (17%)		
• Work	2 (7%)	1 (6%)	1 (10%)	
• Fear	2 (7%)	2 (12%)		
• Leisure activities	2 (7%)	2 (12%)		
• Finances	1 (3%)		1 (10%)	
• Behaviour	1 (3%)	1 (6%)		
• Biking	1 (3%)	1 (6%)		
• Community re-integration	1 (3%)	1 (6%)		
• Driving	1 (3%)		1 (10%)	
• Motivation	1 (3%)	1 (6%)		
• Physical capacity	1 (3%)	1 (6%)		
• Psychological	1 (3%)		1 (10%)	
• Relationship with family	1 (3%)		1 (10%)	
• Self-confidence	1 (3%)	1 (6%)		
• Self-efficacy	1 (3%)	1 (6%)		
• Self-identity	1 (3%)		1 (10%)	
• Self-isolation	1 (3%)		1 (10%)	
• Social life	1 (3%)		1 (10%)	
• Travel	1 (3%)		1 (10%)	
1.2. Factors hindering mobility, participation and reintegration into the community				
• Cognition	5 (18%)	1 (6%)	4 (40%)	
• Fatigue	4 (14%)		4 (40%)	
• Headache	4 (14%)		4 (40%)	
• Self-identity	3 (11%)		3 (30%)	
• Dizziness	3 (11%)	1 (6%)	2 (20%)	
• Fear	3 (11%)	1 (6%)	2 (20%)	
• Emotions	2 (7%)		2 (20%)	
• Nausea	2 (7%)		2 (20%)	
• Balance	1 (3%)	1 (6%)		
• Confidence	1 (3%)	1 (6%)		
• Confusion	1 (3%)	1 (6%)		
• Depression	1 (3%)		1 (10%)	
• Double vision	1 (3%)		1 (10%)	
• Fall	1 (3%)	1 (6%)		
• Finding words/Speech	1 (3%)		1 (10%)	
• Hallucination	1 (3%)		1 (10%)	
• Independence	1 (3%)		1 (10%)	
• Physical	1 (3%)		1 (10%)	
• Psychological	1 (3%)		1 (10%)	
• Relationship with family	1 (3%)		1 (10%)	1 (100%)

• Safety	1 (3%)	1 (6%)		
• Sleep disturbance	1 (3%)		1 (10%)	
• Loss of driving license	1 (3%)		1 (10%)	
1.3. Impacts of bio-psychosocial factors on everyday life and mobility				
• Cognitive	8 (28%)		8 (80%)	
• Work	6 (21%)		6 (60%)	
• Social life	5 (18%)		5 (50%)	
• Reading/comprehension	4 (14%)		4 (40%)	
• Sensitivity to stimulation	4 (14%)		4 (40%)	
• Leisure activities	3 (11%)		3 (30%)	
• Auditory	2 (7%)		2 (20%)	
• Family relationship	2 (7%)		2 (20%)	
• Psychological	2 (7%)		2 (20%)	
• Self-isolation	2 (7%)		2 (20%)	
• Visual	2 (7%)		2 (20%)	
• Driving	2 (7%)		2 (20%)	
• Fear	1 (3%)		1 (10%)	
• Anxiety	1 (3%)		1 (10%)	
• Depression	1 (3%)		1 (10%)	
• Fatigue	1 (3%)		1 (10%)	
• Financial	1 (3%)		1 (10%)	
• Self-identity	1 (3%)		1 (10%)	
• Sport	1 (3%)		1 (10%)	
• Weather	1 (3%)		1 (10%)	
Theme 2: Assessment and intervention guidelines				
2.1 Finding common goals with patients				
• Clinical judgment Standardized measures	11 (39%)	11 (65%)		
• Interdisciplinary shared decision making	10 (36%)	10 (59%)		
• Self-reported Screening	10 (36%)	10 (59%)		
• Situational/Observation	9 (32%)	9 (53%)		
• Clinical judgement Expertise	8 (28%)	8 (47%)		
• Patient objective Clinical judgment	8 (28%)	8 (47%)		
• Cognition/Aphasia	6 (21%)	6 (35%)		
• Self-reported/limited	4 (14%)	4 (23%)		
• Screening Assessment	4 (14%)	4 (23%)		
• Standardized measures /responsiveness	2 (7%)	2 (12%)		
• Red flag indicators	2 (7%)	2 (12%)		
• Functional capacity	1 (3%)	1 (6%)		
• Standardized measures /consistency	1 (3%)	1 (6%)		
• Standardized measures /global and recommendation	1 (3%)	1 (6%)		
• Proxy assessment	1 (3%)	1 (6%)		
• Balance	1 (3%)	1 (6%)		

• Driving	1 (3%)	1 (6%)		
• Coordination	1 (3%)	1 (6%)		
• Pain	1 (3%)	1 (6%)		
• Endurance	1 (3%)	1 (6%)		
• Safety	1 (3%)	1 (6%)		
• Spasticity	1 (3%)	1 (6%)		
• Strength	1 (3%)	1 (6%)		
• Vision	1 (3%)	1 (6%)		
2.2. Challenges clinicians faced when they evaluate mobility				
• Standardized measures/ limited	9 (32%)	9 (53%)		
• Safety	8 (28%)	8 (47%)		
• Cognitive	7 (25%)	7 (41%)		
• Confidence	3 (11%)	3 (17%)		
• Guidelines	2 (7%)	2 (12%)		
• Alcohol/Drug	2 (7%)	2 (12%)		
• Weather	2 (7%)	2 (12%)		
• Anxiety	1 (3%)	1 (6%)		
• Balance	1 (3%)	1 (6%)		
• Fatigue	1 (3%)	1 (6%)		
• Fear	1 (3%)	1 (6%)		
• Trust	1 (3%)	1 (6%)		
• Vision	1 (3%)	1 (6%)		
2.3. Engaging the patient and considering their perspectives in their care				
• Patient engagement	7 (25%)		7 (70%)	
Theme 3: Support network				
3.1. Caregiver support				
• Caregiver	13 (46%)	5 (29%)	8 (80%)	
• Cognition	4 (14%)	3 (17%)	1 (10%)	
• Aphasia	1 (3%)	1 (6%)		
• Mental health	1 (3%)			
3.2. Provider support				
• Provider	3 (11%)		3 (30%)	
• Family support	1 (3%)	1 (6%)		
• Coping style	1 (3%)	1 (6%)		
3.3. Community support				
• Community	8 (28%)	4 (23%)	4 (40%)	
• Stigma	2 (7%)		2 (20%)	
Theme 4: Uncertainty about symptoms and recovery				
• Recovery	4 (14%)		4 (40%)	
• Symptom management strategies	4 (14%)		4 (40%)	
• Symptoms	3 (11%)		3 (30%)	
• Cognition	3 (11%)		3 (30%)	
• Psychological	1 (3%)		1 (10%)	

Appendices of Chapter 7

Appendix 1. Inductive and deductive thematic analysis

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
Theme 1: Enabling continuity of care							
1.1. Experiences with acute rehabilitation care							
Cs01: "it was just a nightmare going through there, and I wanted to get him transferred to xxx because it's a hospital, I mean well known there"	Caregiver	Some hospital services don't help	Accessibility to healthcare services Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
Cs01:"they put him [her husband] on some unit that it was like a geriatric floor with all people that were demented and confused and screaming at night, and I mean they are was just off"	Caregiver	Acute care services at some hospital don't help/mixing patients with different diagnosis	Accessibility to healthcare services Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
Cs01: "the services that he got other than the emergency you know when he had to get the further scans and set up with her neurologist there was fantastic"	Caregiver	Quality of services at some hospitals was excellent	Accessibility to healthcare services Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
S03: "the services I found the least helpful, I found the physiotherapist very helpful and the occupational therapist over the speech therapy"	Stroke	Physiotherapy and occupational therapy helpful and better than speech therapy	Specialized Services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (Specialized services)
S02: "I was taken by ambulance to the xxx and you're right the service there is like amazing and then that night I got transferred to the neuro because they didn't have a bed for me at the general which is also kind of a blessing in disguise"	Stroke	Quality of services at some hospitals was excellent	Accessibility to healthcare Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
S03: "the service I found at this hospital xxx was the least helpful"	Stroke	Some services don't help	Specialized Services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (Specialized services)
S03: "Sometimes it doesn't connect. Exactly she just was not just my thing [the occupational therapist]"	Stroke	Occupational therapy not helpful	Specialized Services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (Specialized services)
S04: "Others are terrible. Starting off with the doctor, you go see neurologist for 5 or 10	Stroke	Physicians don't help	Specialized Services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
minutes while he's on the phone talking that's the first problem, they [the neurologist] don't care"							(Specialized services)
S05: "I wasn't able to work full time before the stroke, I had a serious injury, but 10 minutes with the neurologist, after the stroke, Oh now you're good to work full time!"	Stroke	Physicians don't help/ Beside manners	Specialized Services Accessibility to healthcare services Beside manners	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (Specialized services)
Cs01: "so he was in the French system you know; this hospital is the very French system and then nobody spoke English to us so that's another disappointing thing"	Caregiver	Healthcare system/not helping the patients with other language than French	Accessibility to healthcare services Language barriers	Environmental Factor Activity and Participation	e5 Services, systems and policies d3 Communication	e580 Health services, systems and policies d310 Communicating with - receiving - spoken messages	e5809 Health services, systems and policies, other unspecified
S04: "I said why seem to be having problems with my memory, I will go see my neurologist, and she [the speech therapist] said no neurologist can't help you, she discouraged me"	Stroke	Speech therapy not helpful/ Respecting patients needs and preferences/ Memory problem	Specialized Services Individualized focus Deficits	Environmental Factor Body Function	e5 Services, systems and policies b1 Mental Functions	e580 Health services, systems and policies b144 Memory functions	e5808 Health services, systems and policies, other specified (Specialized services) b1449 Memory functions, unspecified
S04: "I couldn't care less, so I contact neurologist, and consequently maybe it's not really related to strokes"	Stroke	Decisions made by patients without consulting the healthcare provider	Individualized focus	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
S04: "the OT there she noticed, and gave you a quick memory test, and I got she goes wow! you do have a memory problem"	Stroke	Occupational therapy was helpful/ Memory problem	Individualized focus Deficits	Environmental Factor Body Function	e5 Services, systems and policies b1 Mental Functions	e580 Health services, systems and policies b144 Memory functions	e5808 Health services, systems and policies, other specified (Specialized services) b1449 Memory functions, unspecified
S04: "because of her [the OT], getting hooked up with a neuropsychologist that does like 12 hours of testing and they found stuff"	Stroke	Occupational therapy was helpful/ Memory problem	Individualized focus Deficits	Environmental Factor Body Function	e5 Services, systems and policies b1 Mental Functions	e580 Health services, systems and policies b144 Memory functions	e5808 Health services, systems and policies, other specified (Specialized services)
Cs01: "there is no consideration on what your needs, and so that was just disappointing for me"	Caregiver	Respecting patients needs and preferences	Individualized focus	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T03:"So it's just having people believe you and support you and understand the difficulties that you're going through finding those health professionals, especially at the neuroscientist	TBI	Support is important, listening, understanding is important	Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
kind of level "							
T03:"Who You would think would be extremely helpful, but I found that neuro physician. The most dismissive of all"	TBI	Neurologist is dismissive; bedside manner is poor	Quality of services Beside manner	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T04:"I found a lot of they [the doctors] weren't taking me seriously"	TBI	Malingering diagnosis leads to anxiety; Invisible disability	Quality of services Beside manner	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T02: "So I was following actually all of the recommendations and I wasn't getting better, no one considered my needs"	TBI	Rehabilitation wasn't working; No progress	Individualized focus	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
C04: "we educate [clinicians working at acute setting] our patients with time management, because that has an impact into mobility, when to stop, when to start"	Clinician	Providing education; strategies - time management that impact on mobility	Education services to patients Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (education services)
C010: "just doing a lot of teaching, the management, what is TBI and get a feel of how severe these symptoms are affecting them [at acute setting]"	Clinician	Education as part of treatment planning	Education services to patients Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (education services)
1.2. Transition from acute to rehabilitation settings							
S03: "Everybody wants to get better. Everybody wants access to; we need access to health services"	Stroke	Access to services important, motivated to get better	Accessibility to healthcare services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
S01: "the occupational therapist at the xxx was very good and helpful"	Stroke	Occupational therapy services help	Specialized services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (Specialized services)
S03: "I found the physiotherapist very helpful and the occupational therapist over the speech therapy"	Stroke	Physiotherapy and occupational therapy helpful and better than speech therapy	Specialized services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (Specialized services)
S04: "For the next chunk of my experience, is the rehab places I went to xxx, everybody there was fantastic except for the speech therapist"	Stroke	Some outpatient rehabilitation services are helpful	Accessibility to healthcare services Specialized services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (Specialized services)
S04: "[the services] at xxx [rehabilitation centre] it was incredible, you talk about personalize service, it's incredible here"	Stroke	Some outpatient rehabilitation services are lack of services, difficult to pl. helpful	Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
S02: "the whole general system,	Stroke	Wait times for services	Accessibility to	Environmental Factor	e5 Services, systems	e580 Health services,	e5809 Health services,

383

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
it's the waiting to get to [rehabilitation], so you don't progress"		difficult; no progress while waiting	healthcare services Wait times		and policies	systems and policies	systems and policies, other unspecified
S02: *"then you find yourself with a 2 month wait period and that's like okay"*	Stroke	Wait times for services difficult; no progress while waiting	Accessibility to healthcare services Wait times	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
S03: *"as I probably speak mine, honestly unless you have like access to private"*	Stroke	Access to services/limited/ access to private	Accessibility to private healthcare services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (private services)
S03: *"reduce Wait times! I mean get people their needs and the proper treatments"*	Stroke	Wait times for services difficult; no progress while waiting	Accessibility to healthcare services Wait times	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
Cs01: *"they don't put that into consideration it's just like when after the hospitalization, they just put you where they find a spot"*	Caregiver	Availability of spot at outpatient rehabilitation is limited	Accessibility to healthcare services Wait times	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
Cs01: *"They don't tell you like OK, well it [i.e. the transition] will be approximately three weeks, we don't know"*	Caregiver	Transition from previous life to new life; from acute services to community; wait times difficult/limited information services	Accessibility to healthcare services Wait times Information services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
C06: *"if the [patient] have a family support, to compensate, patients will be discharged faster, versus the person who is alone"*	Clinician	Discharge factors to community/family	Discharge factors Family support	Environmental Factor	e3 Support and relationships	e325 Acquaintances, peers, colleagues, neighbours and community members	
Cs01: *"When you're already dealing emotionally for what's happening"*	Caregiver	Emotional support/limited	Caregiver support services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (caregiver support services)
Cs01: *"I just found like it was I mean he did get good service with the occupational therapist, but he also had the physiotherapist"*	Caregiver	Occupational therapy and physiotherapy helpful	Specialized services Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (Specialized services)
Cs01: *""[the physiotherapist] was like how come your wife can't pick up in here you know, like in which I didn't appreciate"; "it was just upsetting"*	Caregiver	Physiotherapy not helpful/blaming caregivers	Specialized services Caregiver support services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (Specialized services & caregiver support services)
C03: *" we've got a huge waiting list"*	Clinician	Wait times impact on rehabilitation	Wait times	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
C04: *"there is a gap between acute care and rehab"*	Clinician	Service Pathways from acute care to rehabilitation/limited	Service Pathways	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
C03: *"one of the challenges in outpatient rehab is we have to know when we stop treatment? And when they need to go to the next phase?"*	Clinician	Discharge guidelines from rehabilitation care to community Barriers: limited resources	Uncertainty	Not covered			
C03:*" the thing to bring in the table is in getting the discharge summaries, I mean that is not even knowledge transfer that's only information transfer"*	Clinician	Limits to discharge summaries; information vs. knowledge/Service Pathways from acute care to rehabilitation/limited	Service Pathways Workflow design	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (workflow design)
C01: *"there is also another lack in the system is you know that the client either who never referred at all or the client who ends been through the continuum and never been discharge and there is no link"*	Clinician	Service Pathways from acute care to rehabilitation/limited	Service Pathways Workflow design	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (workflow design)
C03: *"sometimes it takes a month to get the discharge summaries from outpatient to outpatient here even though it is written it is because they are Shortens archives"*	Clinician	Integration and infrastructure; limited resources; takes too long for information to move through system/Service Pathways from acute care to rehabilitation/limited	Service Pathways Workflow design	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (workflow design)
C06*"sometimes the referral gave us the wrong information by saying everything is good about the patient with moderate or severe TBI, and a month later everything is going badly or it's really difficult for them to do the same tasks"*	Clinician	Barriers- some referrals give the wrong information/Service Pathways from acute care to rehabilitation/limited	Service Pathways Workflow design	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (workflow design)
C04:*" the young clients are mostly lost in the system and get no service [when] they are the ones who they have the most potential to go back to work"*	Clinician	Service Pathways from acute care to rehabilitation/limited to young clients	Service Pathways Young patients with impairments	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
C03: *"talking about having you know informatics electronic*	Clinician	Using electronic health records; saves time -	Electronic health records	Environmental Factor	e1 Products and technology	e198 Products and technology, other	

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
health records, so if it there it is saves time"		mitigates limited resources				specified (EHRs)	
C03: "so they have not been able to put together the file and sending them by fax, but if it was electronic, [it] would be quick"	Clinician	Electronic health records would improve flow and speed of information	Electronic health records	Environmental Factor	e1 Products and technology	e198 Products and technology, other specified (EHRs)	
C01: "if we would be able to cut down on the paperwork, we will have a whole of time transferring the information"	Clinician	Better workflow; minimize paperwork	Electronic health records	Environmental Factor	e1 Products and technology	e198 Products and technology, other specified (EHRs)	
C03: "but when people in a rehab bed if they only have mobility issue or if they have mobility issues and other things they are get into rehab"	Clinician	Systemic challenges in service pathway from acute care to rehabilitation/ what deficit is priority	Service Pathways Deficits Discharge Factors	Environmental Factor not covered Activity and Participation	e5 Services, systems and policies d4 Mobility	e580 Health services, systems and policies d499 Mobility, unspecified	e5809 Health services, systems and policies, other unspecified
C03: "but when they have visual or cognitive it can be pretty settle; they go home, and they are not necessarily picked up until they have a serious physical problem"	Clinician	Systemic challenges in service pathway from acute care to rehabilitation/ what deficit is priority	Service Pathways Deficits Discharge Factors	Environmental Factor Not covered Body Function	e5 Services, systems and policies b2 Sensory functions and pain b1 Mental Functions	e580 Health services, systems and policies b210 Seeing functions b144 Memory functions	e5809 Health services, systems and policies, other unspecified b2101 Visual field functions b1449 Memory functions, unspecified
C04: "is the OT and inpatient going to evaluate if the person can read, no, can they see, can they navigate around or they are safe"	Clinician	Systemic challenges in service pathway from acute care to rehabilitation/ what deficit is priority	Service Pathways Deficits Discharge Factors	Environmental Factor Not covered Activity and Participation	e5 Services, systems and policies d1 Learning and applying knowledge	e580 Health services, systems and policies Applying knowledge (d160-d179)	e5809 Health services, systems and policies, other unspecified
C03: "when they go to inpatient how long they do need to stay inpatient before they discharged home"	Clinician	Systemic challenges in service pathway from acute care to rehabilitation/uncertainty	Service Pathways Uncertainty Discharge Factors	Environmental Factor Not covered	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
C03: "the indicators of getting people to discharge as soon as somebody is able to be mobile and is able get to the bathroom and can do their ADLs they go home because they cannot keep staying there because otherwise they are going to block a bed and has repercussions"	Clinician	Service Pathways from acute care to rehabilitation/Discharge Factors	Service Pathways Deficits Discharge Factors	Environmental Factor Not covered Activity and Participation	e5 Services, systems and policies d5 Self-Care	e580 Health services, systems and policies d599 Self-care, unspecified	e5809 Health services, systems and policies, other unspecified
C02: "physically you say you need exercise to get better but cognitively well time well does the job, even for vision time will	Clinician	Service Pathways from acute care to rehabilitation/Discharge Factors	Service Pathways Deficits Discharge Factors	Environmental Factor Not covered Activity and Participation	e5 Services, systems and policies d4 Mobility b1 Mental Functions	e580 Health services, systems and policies d499 Mobility, unspecified	e5809 Health services, systems and policies, other unspecified b1449 Memory

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
do the job no exercise, nothing"				Body Function		b144 Memory functions	functions, unspecified
C04: "if the [clients] had vision issues, vestibular issues, cognitive issues, or speech issues but physically they are fine, they will discharge with no service"	Clinician	Service Pathways from acute care to rehabilitation/Discharge Factors	Service Pathways Deficits Discharge Factors	Environmental Factor Not covered	e5 Services, systems and policies b2 Sensory functions and pain b3 Voice and speech functions b1 Mental Functions	e580 Health services, systems and policies b210 Seeing Functions b330 Fluency and rhythm of speech functions b144 Memory functions	e5809 Health services, systems and policies, other unspecified b2101 Visual field functions b3309 Fluency and rhythm of speech functions, unspecified b1449 Memory functions, unspecified
C01: "so that we are going really back into acute care centers and [are] they doing proper triage"	Clinician	Service Pathways from acute care to rehabilitation/Discharge Factors	Service Pathways Discharge Factors	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
C01: "the education has to go back to the acute care teams in terms of rehabilitation"	Clinician	Service pathways from acute care to rehabilitation limitation; education can be one strategy to improve care at acute level of care	Service Pathways Education services to providers	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (education services)
1.3. Access to rehabilitation in the community setting							
C05: "when they are discharged, they can't go to the outpatient department because they are not independent to move around"	Clinician	Discharge Factors/Deficits	Deficits Discharge Factors	Not covered			
C05: "it's like a grey area where that person would have had the potential to develop independence but it's not enough to keep it"	Clinician	Limits to restoring independent functioning in community; limits to independency	Deficits Discharge Factors	Not covered			
C07: "To have the same services so you know to continue the rehabilitation outside of community, we need to have special services that can help them to function well at home"	Clinician	Transition to community-based rehabilitation; limited resources impact on long-term functioning, mobility	Specialized services Accessibility to healthcare services Resources	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies e590 Labour and employment services, systems and policies	e5808 Health services, systems and policies, other specified (specialized services) e 5908 Labour and employment services, systems and policies, other specified (resources)
C06: "Even for the stroke clientele, some patients don't have access to the CPA program after discharge"	Clinician	Lack of services; difficult to plan	Specialized services Accessibility to healthcare services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (specialized services)
S03: "I watched CLSC come to their house [disabled friend] and	Stroke	Quality community-based services are	Specialized services Accessibility to	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies,

387

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
they don't show up on time"		lacking; not showing up on time	healthcare services				other specified (specialized services)
C05: "I find it's the difficult area when our patients are discharged, when we know that he would have the potential to become independent but it's as if the services don't exist in a certain way or at least not in an optimal way to continue that with him"	Clinician	Community-based - lack of health care services; difficult to plan	Specialized services Resources Deficits Discharge Factors	Environmental Factor Not covered	e5 Services, systems and policies	e580 Health services, systems and policies e590 Labour and employment services, systems and policies	e5808 Health services, systems and policies, other specified (specialized services) e 5908 Labour and employment services, systems and policies, other specified (resources)
1.4. Re-integration into the community							
C05: "we can do training [for people with cognitive impairments at the clinic] but they will have difficulty making the connections in their real environment"	Clinician	Care pathway: community-based - lack of services; difficult to plan	Re-integration Cognition	Environmental Factor Body Function	e5 Services, systems and policies b1 Mental Functions	e580 Health services, systems and policies b144 Memory functions	e5809 Health services, systems and policies, other unspecified
T01:"my first occupational therapist wasn't really like telling me how to integrate myself really into regular life, like they were kind of just giving me some activities to do while I was there. And then we'd have a little talk, but I didn't like it I didn't connect with them very much"	TBI	Rapport with occupational therapy was difficult; There was a lack of integration of therapy into real life	Re-integration Specialized services Individualized focus	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (specialized services)
T01:"the second one I had he really focuses on each person well and he really gave us a schedule and he was the one who was like, okay, you need to push yourself. And I know it's not going to feel good and it's scary and everything"	TBI	Rapport with 2nd professional was good; Scheduled, provided guidance and support and honest hard truths about path of recovery	Re-integration Specialized services Individualized focus	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (specialized services)
T01:"He [OT] was pushed me to go further than I thought I could which was reassuring telling you is okay like to do. I wasn't feeling like I was scared that I was like, doing something shouldn't be doing"	TBI	Occupational therapy services were good; Pushed hard, progressed further that thought possible	Re-integration Specialized services Individualized focus	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (specialized services)
C06: "we try to put [the patients who are alone] in places [that offer] services to compensate for their safety"	Clinician	Discharge planning; safety as priority; determining factors include support system (living alone)	Re-integration Support services Safety	Environmental Factor	e5 Services, systems and policies e5 Services, systems and policies	e580 Health services, systems and policies e530 Utilities services, systems and policies	e5808 Health services, systems and policies, other specified (support services) e5308 Utilities services, systems and

388

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
							policies, other specified (Safety standards for individuals with ABI)
C06: *"the person can be functional at home, but obviously [it is difficult to them] to be functional when they are going outdoors"*	Clinician	Discharge planning; safety as priority; determining factors include support system (living alone)	Re-integration Support services Safety	Environmental Factor	e5 Services, systems and policies e5 Services, systems and policies	e580 Health services, systems and policies e530 Utilities services, systems and policies	e5808 Health services, systems and policies, other specified (support services) e5308 Utilities services, systems and policies, other specified (Safety standards for individuals with ABI)
C05: *"it is important to leave the patient with all the needed services when they are in community"*	Clinician	Transition to community-based rehab; limited resources impact on long-term functioning, mobility	Re-integration Support services Safety	Environmental Factor	e5 Services, systems and policies e5 Services, systems and policies	e580 Health services, systems and policies e530 Utilities services, systems and policies	e5808 Health services, systems and policies, other specified (support services) e5308 Utilities services, systems and policies, other specified (Safety standards for individuals with ABI)
S04: *"Like I remember one of the classes, they are talking occupation, like if you got to fold clothes, don't stand over the table and do it, sit down and do it"*	Stroke	Structuring activities to be simple and take less energy facilitates participation and mobility	Re-integration Education services to patients	Environmental Factor	e5 Services, systems and policies e5 Services, systems and policies	e580 Health services, systems and policies e530 Utilities services, systems and policies	e5809 Health services, systems and policies, other unspecified e5308 Utilities services, systems and policies, other specified (Education services)
S04: *"the lady said well for your cooking, move your dishes that you used to this shower, if you tell me there's a normal person, I'd go what's the point, but you don't have the small battery"*	Stroke	Structuring activities to be simple facilitates participation and mobility	Re-integration Education services to patients	Environmental Factor	e5 Services, systems and policies e5 Services, systems and policies	e580 Health services, systems and policies e530 Utilities services, systems and policies	e5809 Health services, systems and policies, other unspecified e5308 Utilities services, systems and policies, other specified (Education services)
T02:*"there was a six-week program and meditation and part of xxx education that I found very, very, very helpful. I really found it made the biggest shift in my education part"*	TBI	Meditation program was helpful	Re-integration Education services to patients	Environmental Factor	e5 Services, systems and policies e5 Services, systems and policies	e580 Health services, systems and policies e530 Utilities services, systems and policies	e5809 Health services, systems and policies, other unspecified e5308 Utilities services, systems and policies, other specified (Education services)

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
C06: "[for persons who lives alone], it is important to make sure that they are safe, so it's always a must to have the notion of safety at home"	Clinician	Discharge planning; safety as priority; determining factors include support system (living alone)	Support services Safety	Environmental Factor	e5 Services, systems and policies e5 Services, systems and policies	e580 Health services, systems and policies e530 Utilities services, systems and policies	e5808 Health services, systems and policies, other specified (support services) e5308 Utilities services, systems and policies, other specified (Safety standards for individuals with ABI)
1.5. Follow-up in the community							
C03: "if they got a survey monkey of something to say are there any problems, how are you doing? Would help"	Clinician	Follow up patients in the community using technology	Survey Follow-up	Environmental Factor	e1 Products and technology	e198 Products and technology, other specified (survey)	
C07: "We're not the team that can do the training at their environment, [and the service] may take six months, we don't have the recourses and service to train our patients at their home. I think that's one of our big problems"	Clinician	Community-based - lack of services; difficult to plan	Support services Recourses Follow-up	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies e590 Labour and employment services, systems and policies	e5808 Health services, systems and policies, other specified (support services) e 5908 Labour and employment services, systems and policies, other specified (resources)
C06: "in rehabilitation phase 2, the patient can go home once he is safe, and able to meet basic needs"	Clinician	Alludes to some discharge planning standards (safety and basic needs)	Support services Safety	Environmental Factor	e5 Services, systems and policies e5 Services, systems and policies	e580 Health services, systems and policies e530 Utilities services, systems and policies	e5808 Health services, systems and policies, other specified (support services) e5308 Utilities services, systems and policies, other specified (Safety standards for individuals with ABI)
C05: "we do follow-ups, which last between 6 months to sometimes 2 years"	Clinician	Follow up patients in the community using phone	Follow-up	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
C06: "We do [the follow-up] more often by phone call, that would be useful for a certain category of people"	Clinician	Follow up patients in the community using phone	Follow-up	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
C05: "we do the follow up for our clients"	Clinician	Follow up: varies	Follow-up	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
C05: "sometimes we do the follow up for other clients who came directly from the community and they are mobile"	Clinician	Follow up: varies - source of referral	Follow-up	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
C05: "sometimes, we see improvements in our patients after a year and a half of follow up. Most of the time it is physically not cognitively"	Clinician	Follow up: timing and duration varies; as does improvement with patients	Follow-up Deficits	Environmental Factor Not covered	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
C05: "It's not enough to provide, sometimes a guardianship, but that's it, it's just to have a little guidance that could help them, just to guide them"	Clinician	Cognitive deficits may require guardianship; or supervision; or assistance	Support services Safety Deficits	Environmental Factor not covered	e5 Services, systems and policies e5 Services, systems and policies	e580 Health services, systems and policies e530 Utilities services, systems and policies	e5808 Health services, systems and policies, other specified (support services) e5308 Utilities services, systems and policies, other specified (Safety standards for individuals with ABI)
C05: "to have immediate and intensive follow-up [to our patients who are discharged] and make transition between outpatient and home very smooth and accomplish patients needs at his own environment"	Clinician	Transition btw stages of rehab; acute to community; what resources available	Follow-up	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
C06: "to take care of our patients in the long term especially for people who don't have the capacity to go back to work, how to keep them active?"	Clinician	Long-term planning for activity/mobility; community-based treatment	Follow-up Support services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (support services)
C06: "to keep them as active as possible after discharge"	Clinician	Long-term planning for activity/mobility; community-based treatment	Follow-up	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
C06: "the problem is who is going to do the follow up during the transition from phase 2 to 3"	Clinician	Transition to community-based rehab; limited resources impact on long-term functioning, mobility	Follow-up	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
C06: "if we take charge to do the follow up and do the training	Clinician	Transition to community-based rehab;	Follow-up Support services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies,

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
immediately at their home after discharge, we will save time but the reality is that other clinician will take the responsibility and this will take a very long time"		limited resources impact on long-term functioning, mobility	Resources			e590 Labour and employment services, systems and policies	other specified (support services) e 5908 Labour and employment services, systems and policies, other specified (resources)
C01: "offering tele-rehab to those clients during wintertime"	Clinician	Shifting services; secondary effect different mode of service delivery- adapting tele-rehabilitation to be able to maintain as much of in person as possible	Follow-up Tele-health	Environmental Factor	e5 Services, systems and policies e1 Products and technology	e580 Health services, systems and policies e198 Products and technology, other specified (tele-rehabilitation)	e5809 Health services, systems and policies, other unspecified
C01: "it would be a limited session, a different type of session maybe but at least it is maintaining some contacts"	Clinician	Shifting services; secondary effect different mode of service delivery- adapting tele-rehabilitation to be able to maintain as much of in person as possible	Follow-up Tele-health	Environmental Factor	e5 Services, systems and policies e1 Products and technology	e580 Health services, systems and policies e198 Products and technology, other specified (tele-rehabilitation)	e5809 Health services, systems and policies, other unspecified
C05: "I always think that [tele-rehab is good] for patients that they just need supervision from time to time"	Clinician	Tele-health; depends on deficit/task; Access to tele-health resources	Follow-up Tele-health	Environmental Factor	e5 Services, systems and policies e1 Products and technology	e580 Health services, systems and policies e198 Products and technology, other specified (tele-rehabilitation)	e5809 Health services, systems and policies, other unspecified
C03: "Technology is more to follow up the patient to have data, but the patient doesn't know"	Clinician	Technology to help with transition to community-based care	Follow-up Technology	Environmental Factor	e5 Services, systems and policies e1 Products and technology	e580 Health services, systems and policies e199 Products and technology, other unspecified	e5809 Health services, systems and policies, other unspecified
C03: "so if the patient has a smart watch that would help"	Clinician	Wearable (smart watch) for rehab	Follow-up Technology	Environmental Factor	e5 Services, systems and policies e1 Products and	e580 Health services, systems and policies e198 Products and technology, other	e5809 Health services, systems and policies, other unspecified

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
					technology	specified (smart watch)	
C05: "it would be interesting to have, you know, a little chip that would allow us to see what route he took when he was really on his own"	Clinician	Community-based assessment: use technology (RFI chip)	Follow-up Technology	Environmental Factor	e5 Services, systems and policies e1 Products and technology	e580 Health services, systems and policies e198 Products and technology, other specified (RFI chip)	e5809 Health services, systems and policies, other unspecified
C02: "it could be virtual reality, kind of thing"	Clinician	Virtual reality can be proper solution to treat patients during winter seasons	Follow-up Technology	Environmental Factor	e5 Services, systems and policies e1 Products and technology	e580 Health services, systems and policies e198 Products and technology, other specified (virtual reality)	e5809 Health services, systems and policies, other unspecified
C06: "it's usually hard for older people to deal with a cell phone or a tablet or with a computer"	Clinician	Age may impact usability, feasibility of using technology	Follow-up Technology	Environmental Factor	e5 Services, systems and policies e1 Products and technology	e580 Health services, systems and policies e199 Products and technology, other unspecified	e5809 Health services, systems and policies, other unspecified
C06: "[using a tele-rehab] is not safe to cross the streets. Maybe it's to organize routines and things like that, in the house, but you know, to go outside for training, when you ask for supervision, it takes someone there, physically present"	Clinician	Tele-health; depends on deficit/task; Limits to using tele-health - need to use in concert with in-person	Follow-up Safety Tele-health	Environmental Factor	e5 Services, systems and policies e1 Products and technology	e580 Health services, systems and policies e530 Utilities services, systems and policies e198 Products and technology, other specified (tele-rehabilitation)	e5809 Health services, systems and policies, other unspecified e5308 Utilities services, systems and policies, other specified (Safety standards for individuals with ABI)
C05: "but for patients who are not completely safe, who are at risk of falling at home, tele-rehab would not work because I think it	Clinician	Tele-health; depends on deficit/task; limits to telehealth; need for multi-modal treatment	Follow-up Safety Tele-health	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies e530 Utilities services, systems and	e5809 Health services, systems and policies, other unspecified e5308 Utilities

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
is only important to do the follow-up interventions"					e1 Products and technology	policies e198 Products and technology, other specified (tele-rehabilitation)	services, systems and policies, other specified (Safety standards for individuals with ABI)
C05: *"I honestly don't think so that virtual reality would work because the generalization point of view you know to do that in the lab is not same as real life, it doesn't transpose in the same way"*	Clinician	Virtual reality - does it generalize to real life; Need to use multi-modal approach to treatment	Follow-up Safety Technology	Environmental Factor	e5 Services, systems and policies e1 Products and technology	e580 Health services, systems and policies e530 Utilities services, systems and policies e198 Products and technology, other specified (virtual reality)	e5809 Health services, systems and policies, other unspecified e5308 Utilities services, systems and policies, other specified (Safety standards for individuals with ABI)
C06: *"Perhaps it works with the clientele with little deficit, which is a good way to stimulate or to see, but I am certain that, as such, the clientele that is a little more cognitively affected, and the clientele that is a little more rigid, that would be a little harder"*	Clinician	Virtual reality - limits to applicability for all patients; Need to use multi-modal approach to treatment	Follow-up Safety Technology	Environmental Factor	e5 Services, systems and policies e1 Products and technology	e580 Health services, systems and policies e530 Utilities services, systems and policies e198 Products and technology, other specified (virtual reality)	e5809 Health services, systems and policies, other unspecified e5308 Utilities services, systems and policies, other specified (Safety standards for individuals with ABI)
C05: *"it's over 60% of our entire clientele, older people with mild TBI and we have hard time following them up"*	Clinician	Follow up: varies - by age	Follow-up	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
C06: *"We don't usually follow up young adults with mild TBI who are either going back to work or who have a family"*	Clinician	Follow up: varies - by age and function	Follow-up	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
C05: "30% with moderate to severe TBI may be better to have them here than they leave to their home"	Clinician	Follow up: varies - by age and function	Follow-up	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
C06: "I still have a gentleman who has just had a leave of absence and we're a bit uncertain, even if this gentleman can pick up the phone and talk and remember exactly who I am and why, it's not as simple as that"	Clinician	Follow-up: but serious deficits and other factors may not be overcome by technology	Follow-up Safety Deficits	Environmental Factor not covered	e5 Services, systems and policies	e580 Health services, systems and policies e530 Utilities services, systems and policies	e5809 Health services, systems and policies, other unspecified e5308 Utilities services, systems and policies, other specified (Safety standards for individuals with ABI)
				Theme 2: System Design			
				2.1. Quality of care			
T01: I felt like the doctors that I saw didn't really know, like they didn't have very good suggestions of what to do and how to help"	TBI	Lack of quality doctor services	Knowledge acquisition Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T01: "I think they [doctors] Kind of didn't really understand how it was really affecting [i.e. TBI] my life and didn't really kind of know how to guide me where to go"	TBI	Lack of quality services; lack of knowledge of impact of traumatic brain injury; Lack of guidance	Knowledge acquisition Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T01: "They kind of said go to physio, go to occupational therapy and like, that's kind of it, and it caused me a lot of anxiety and then he [the doctor] just was like, here's some anxiety meds!"	TBI	Bedside manner poor; Just access services with lack of explanation and guidance; Medical model	Knowledge acquisition Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T02: "family doctor didn't know much; he was giving me a medication that wasn't working."	TBI	Lack of traumatic brain injury knowledge; quality of services; Medical Model	Knowledge acquisition Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T01:"And I think like in terms of the doctor didn't really know how to handle that and like it's hard because like all these professionals like there. This is their job"	TBI	Lack of traumatic brain injury knowledge, Quality of services	Knowledge acquisition Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T01: "At the same time, if they haven't experienced it like it's	TBI	Lack of traumatic brain injury knowledge,	Knowledge acquisition	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies,

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
also hard to help you"		Quality of services	Quality of services				other unspecified
T03:"I guess I just wish in some way that when they sort of discovered that you have a mild concussion that they understand that it's still as debilitating as maybe what they would consider a more serious concussion"	TBI	Uncertainty of impact of deficits; perception of a diagnosis; education of healthcare professionals	Knowledge acquisition Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T01:"but I feel like nobody could really give you good education or like information about what was going on, they kind of just, you know, give you short answers that kind of thing"	TBI	Guidelines for treatment; Education and information for patients; Staying up to date is difficult	Knowledge acquisition Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T01:"they definitely help [the healthcare providers] with like symptom management so symptom management was obviously like one of the biggest things"	TBI	Symptom management useful in rehabilitation	Symptom management Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (symptom management)
T01:"my Osteo and the Cairo are the ones that really like actually helped a lot with my symptoms"	TBI	Osteopath, Chiropractor useful in rehabilitation	Symptom management Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (symptom management)
S03: "because she said there's only so much she can do for me and I had to do it on my own [the speech therapist], I was discouraged actually to hear when she said that to me, I don't know, I could have wanted more"	Stroke	Bedside manner of speech therapy discouraging; I wanted to improve; Loss of hope	Specialized Therapy Individualized focus Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (specialized services)
T03:"What are those steps and How to apply them, you really need a specialist to really get in there and focus and help you improve on very specific things and how to do those things"	TBI	Specialized professionals: Individualized treatment would be useful	Specialized Therapy Individualized focus Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (specialized services)
T02:"They told me I finished the rehab at xxx and I feel really left in the cold, I do not feel ready to be in the world at all, so what is next for me?"	TBI	Lack of shared decision making	Specialized Therapy Individualized focus Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (specialized services)
T02: "So we set some goals they never said after you finish those goals or you're going to be	TBI	Lack of education about transition to end of services	Individualized focus Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified

396

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
finished"							
T04: "I was there [at rehabilitation centre] for the stroke not for the pain right, so they didn't take the pain into consideration at all"	TBI	Lack of individualized focus	Specialized Therapy Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (specialized services)
T05: "so for me personally I think that xxx should not be a place for rehabilitation for those with a TBI"	TBI	Some institutions are better for specific injuries and healthcare	Specialized Therapy	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (specialized services)
S03: "I was considered high functioning when I got here at xxx"	Stroke	Impact of status and diagnosis on access to services	Specialized Therapy	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5808 Health services, systems and policies, other specified (specialized services)
C01: "I have some real concerns about [the health system] down the road even getting like worse with like the elderly you know, like it should have been more of a demand"	Clinician	System of care not good enough for the patient; particularly the elderly	Healthcare services Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
S04: "It's good though, I found that the rehab centers are good, the doctors well good luck with that one! And then, it's actually service that are missed still"	Stroke	Services range from bad to good; Also, some services are missing	Healthcare services Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
S03: "We have a very broken system. I have to tell you, none of the people sitting here don't not want to get better"	Stroke	System of care not good enough for the patient	Healthcare services Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
S03: "the system is very broken, it's very broken, and it's very sad, and it's very discouraging"	Stroke	System of care not good enough for the patient	Healthcare services Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
Cs01: "I know how the system works, but I see the problems a lot"	Caregiver	System of care not good enough for the patient	Healthcare services Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
2.2. Information services							
T01: "I don't know, it's kind of hard to navigate what to do because you didn't really know who to listen to for where to turn"	TBI	Navigate system; Lack of case management service; System	Navigate system Case management services Information services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T01: But so I really had to do a lot like on my own to try and find therapists and I went through everything you know like physio, occupational therapy,	TBI	Navigate system; Lack of case management service; System	Navigate system Case management services Information services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
acupuncture, osteo, chiropractic"							
T01:""I did everything, you know, so I had to really find all these people on my own, and so it was hard to navigate, it takes time"	TBI	Navigate system; Lack of case management service; System	Navigate system Case management services Information services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
S04: "Accountability and oversight! Who is he going to complain to? The manager?"	Stroke	Oversight and accountability needed	Case management services Accountability	Environmental Factor	e5 Services, systems and policies e1 Products and Technology	e580 Health services, systems and policies e165 Assets	e5809 Health services, systems and policies, other unspecified e198 Products and technology, other specified (accountability)
S04: "there is no bigger oversight. First one was a stroke, here is neurologist, here is a test, here is this place, the paratransit, there is nobody taking care of it all"	Stroke	Oversight and accountability needed; Case management services would be useful	Case management services Accountability Information services	Environmental Factor	e5 Services, systems and policies e1 Products and Technology	e580 Health services, systems and policies e165 Assets	e5809 Health services, systems and policies, other unspecified e198 Products and technology, other specified (accountability)
S01: "where do I get that information or How do I get, you know this or like, anticipatory guidance"	Stroke	Lack of data infrastructure; Processes are lacking	Information services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T03: "my concussion was considered mild, but my therapist at xxx said sometimes there's a small percentage of cases with mild that just go on a very long time" "And that's why I've been sent there for them to work on some long term solutions"	TBI	Mild may not be so mild as it may last a long time; Service provided difficult but useful information	Information services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T03:"I joined a group at xxx that was like it was in the Information Group about how concussions are different from traumatic brain injuries"	TBI	Support group/ information group useful	Information services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
2.3. Oriented teamwork approach							
S03: "Some are really stressed out, in the health care system , they may start off with more ideal vision of what they like, and then in the end they end up being you know, overworked"	Stroke	Overworked healthcare professionals make it difficult	Overworked Professionals Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
S02: "Forced overtime, and too many patients on one nurse and	Stroke	Overworked healthcare professionals make it	Overworked Professionals	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies,

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
the nurses doing the doctors job"		difficult	Quality of services				other unspecified
S04: *"the Healthcare in Canada is great, but the disconnect with the doctor and the others is the problem"*	Stroke	Disconnect between doctors and other professionals makes it difficult	Team-Oriented Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
S04: *"And you have the doctors, everybody is broken up the little parts and they don't talk to each other really"*	Stroke	Lack of quality team service	Team-Oriented Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T01: *"when I do more therapy like everyone kind of has their own suggestions and each different field has their own suggestions"*	TBI	Lack of team-oriented approach	Team-Oriented Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T01:*"I mean, it depended like some of them [i.e. healthcare provider] said like you should do more therapy"; "some of them said you should do less like the doctors just kind of, I don't know"*	TBI	Lack of team-oriented approach	Team-Oriented Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T04: *"everyone [healthcare providers] just kind of give their own opinions"*	TBI	Lack of team-oriented approach	Team-Oriented Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T01: *"I didn't really feel that anybody really has a good guide of what you should really do"*	TBI	Lack of team-oriented approach	Team-Oriented Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T03: *"It was just not super contradicting but difference of opinions and you kind of don't really know exactly what to listen to"*	TBI	Lack of team-oriented approach	Team-Oriented Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T02: *"I was told I had a concussion. and shouldn't do any exercise for two weeks, which I did"*	TBI	Guidelines for treatment inconsistent; no exercise for 2 weeks	Team-Oriented Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T02: *"And then I was told to stay in a dark room for five days which I did"*	TBI	Guidelines for treatment inconsistent; stay in dark for 5 days	Team-Oriented Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T02: *"And then I saw my family doctor and he say, Okay, you should be off of work for a month in which I did"*	TBI	Guidelines for treatment inconsistent; no work for a month	Team-Oriented Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
S06: *"Proper training for the provider and teach them how to take care of the old man"*	Stroke	Quality healthcare: education needed for providers	Education to providers Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T01: *"I think maybe like*	TBI	Guidelines for treatment;	Education to providers	Environmental Factor	e5 Services, systems	e580 Health services,	e5809 Health services,

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
education [to the healthcare providers] about what exactly is going on and how they like see them like evolution like recovery"		Education and information for patients; Staying up to date is difficult	Quality of services		and policies	systems and policies	systems and policies, other unspecified
T01:"Maybe this is kind of what we think will happen, or how we can think get better, or how to Personalized the different kinds of therapies to each situation instead of just saying go try this"	TBI	Guidelines for treatment; Education and information for patients; Staying up to date is difficult	Education to providers Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T01: "there's so many different information and everything changes a lot. The view of how to treat concussions and how they really like impact you have changed a lot over the last few years"	TBI	Guidelines for treatment; Education and information for patients; Staying up to date is difficult	Education to providers Team-Oriented Quality of services	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
2.4. Self-management							
T01:"Maybe just like self-management at home with the link residual effects"	TBI	Self-education about TBI; self-management of symptoms	Self-therapy	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
S03: "[the work] fell on me as well to make sure that I continue everything that I learned, you know and practicing it"; "and I really push through that to bridge my gap"	Stroke	Therapy left to patient to maintain, makes it difficult	Self-therapy	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
S03: "it's hard because if it falls so much on yourself, you're looking for help"	Stroke	Therapy left to patient to maintain, makes it difficult	Self-therapy	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
S02: "I was lucky I had this therapist [speech therapist], I would have homework"	Stroke	Speech therapy services provide homework and it's helpful	Self-therapy	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
S03: "I was just happy to get the help and to be told what to do a little bit you know, to know what to practice, to know how to stand, or walk"	Stroke	Grateful for services and self-therapy	Self-therapy	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T03:"And I've done a lot of research on my own, but how to deal with the day to day life stuff. That perhaps you can improve your symptoms during this day to day stuff"	TBI	Self-education about TBI; Improve symptoms and their impact on ADLs	Self-therapy	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T02: "[self-management and writing] helped me to work with my symptoms like you know	TBI	Self-management: writing, pacing, scheduling all helped	Self-therapy	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
pacing, managing symptoms, and it also helps with the scheduling"							
T02: "And my daily activities, whether it was my internet, shopping center, going into anywhere that reveals noise and very sensitive to all of the music fleeing blast in every single store every single shopping center I go around with headphones now"	TBI	Noise-cancelling headphones are helpful in these environments	Self-therapy	Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
Theme 3. Accessibility and services in the community							
S04: "So, you have the street, cement barrier, and the bicycle path and then the sidewalks, so, I am very curious, how does a handicap transfer"	Stroke	Environmental barriers in the city limit mobility	Accessibility design Policy	Environmental Factor	e1 Products and technology e5 Services, systems and policies	e150 Design, construction and building products and technology of buildings for public use e515 Architecture and construction services, systems and policies	e 1500 Design, construction and building products and technology for entering and exiting buildings for public use e 5152 Architecture and construction policies
S04: "I find the city of Montreal, during the snowstorm, they don't care if you are a handicap person, that's it, you are stuck inside"	Stroke	Weather (snow) and lack of services to keep pathways clean and accessible impact mobility	Accessibility design Policy	Environmental Factor	e1 Products and technology e5 Services, systems and policies	e150 Design, construction and building products and technology of buildings for public use e515 Architecture and construction services, systems and policies	e 1500 Design, construction and building products and technology for entering and exiting buildings for public use e 5152 Architecture and construction policies
S01: "[in the metro station] there is no escalators right, so it's like stairs, so how are you supposed to get down there, if like we do have a walker, you know. So, there's a limitation"	Stroke	Lack of escalators in metro; impact on mobility	Accessibility design Policy	Environmental Factor	e1 Products and technology e5 Services, systems and policies	e150 Design, construction and building products and technology of buildings for public use e515 Architecture and construction services, systems and policies	e 1500 Design, construction and building products and technology for entering and exiting buildings for public use e 5152 Architecture and construction policies
S04: "I think the laws about handicap service is disabled"	Stroke	Challenges with knowing the law; how to access services with appropriate diagnoses	Policy	Environmental Factors	e5 Services, systems and policies	e575 General social support services, systems and policies e515 Architecture and construction services, systems and policies	e 5758 General social support services, systems and policies, other specified (handicap services) e 5152 Architecture

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
							and construction policies
C03: "construction is a big thing and navigating, especially if you have clients have cognition issue on top of that, they have hard time figuring out how to do it"	Clinician	Barriers; construction sites (uneven ground, safety issues); limited access due to environment	Accessibility design Policy	Environmental Factor	e1 Products and technology

e5 Services, systems and policies | e150 Design, construction and building products and technology of buildings for public use
e515 Architecture and construction services, systems and policies | e 1500 Design, construction and building products and technology for entering and exiting buildings for public use
e 5152 Architecture and construction policies |
| C04: "the street is clear but the sidewalks were not [because of the snow], so that's make it hard for the clients" | Clinician | Community barriers cause a shift in mobility (wailing aid to wheelchair) | Accessibility design Policy | Environmental Factor | e1 Products and technology

e5 Services, systems and policies | e150 Design, construction and building products and technology of buildings for public use
e515 Architecture and construction services, systems and policies | e 1500 Design, construction and building products and technology for entering and exiting buildings for public use
e 5152 Architecture and construction policies |
| S05: "I have bars in my house, so I don't use a cane inside; I got bars in the shower, now I don't have to use a bench anymore" | Stroke | Accessible design features in the home (bars) help with mobility within the home | Accessibility design Policy | Environmental Factor | e1 Products and technology

e5 Services, systems and policies | e150 Design, construction and building products and technology of buildings for public use
e515 Architecture and construction services, systems and policies | e 1500 Design, construction and building products and technology for entering and exiting buildings for public use
e 5152 Architecture and construction policies |
| S05: "they would not let me do it [the shower] without a bench. and they would not let me home [the hospital] until I promise that I would put a bench" | Stroke | Accessible design features in the home (shower) help with mobility within the home | Accessibility design Policy | Environmental Factor | e1 Products and technology

e5 Services, systems and policies | e150 Design, construction and building products and technology of buildings for public use
e515 Architecture and construction services, systems and policies | e 1500 Design, construction and building products and technology for entering and exiting buildings for public use
e 5152 Architecture and construction policies |
| T02"Well they close the gym [because of COVID]. So, I had just started, I started just walking on the treadmill. I was a runner before so I can run" | TBI | Disruptions in community services makes it hard to maintain progress | Recreational services | Environmental Factors | e5 Services, systems and policies | e575 General social support services, systems and policies | e 5758 General social support services, systems and policies, other specified (recreation services) |
| T02: "it will be difficult [to | TBI | Difficult to work on | Accessibility design | Environmental Factor | e1 Products and | e150 Design, | e 1500 Design, |

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
access to community services] because they were asking [the healthcare providers] you to do biking, hiking as a means to build up my cardio little bit"		rehab goals on your own	Policy		technology e5 Services, systems and policies	construction and building products and technology of buildings for public use e515 Architecture and construction services, systems and policies	construction and building products and technology for entering and exiting buildings for public use e 5152 Architecture and construction policies
C02:" I think that the intervention doesn't need to be with clients in itself, but with the city and the community"	Clinician	Policy strategies at the community level; systems thinking lens transport (parking) & access to places (malls…); built environment; policy	Accessibility design Policy	Environmental Factor	e1 Products and technology e5 Services, systems and policies	e150 Design, construction and building products and technology of buildings for public use e515 Architecture and construction services, systems and policies	e 1500 Design, construction and building products and technology for entering and exiting buildings for public use e 5152 Architecture and construction policies
C02: "can the city of Montreal know a bit more the places where is a parking lot for a handicap person can be a priority?"	Clinician	Policy strategies at the community level; systems thinking lens transport (parking) & access to places (malls…); built environment; policy	Accessibility design Policy	Environmental Factor	e1 Products and technology e5 Services, systems and policies	e150 Design, construction and building products and technology of buildings for public use e515 Architecture and construction services, systems and policies	e 1500 Design, construction and building products and technology for entering and exiting buildings for public use e 5152 Architecture and construction policies
Theme 4: Transportation services							
S05:"I couldn't put a seat belt, it was impossible, you couldn't put it up, nobody in the back seat could put it up, [while using transport adapted]"	Stroke	Adapted transport / poor service/ there is no differentiation between mental and physical handicaps/long ride/many people at the back seat/Physical limitations, not being able to put on a seatbelt; lack of services to help	Adapted transport services	Environmental Factors	e5 Services, systems and policies	e540 Transportation services, systems and policies	e 5408 Transportation services, systems and policies, other specified (transport adapted)
S05: "At first I couldn't handle buses or metro, I'd get overwhelmed with all the simulation and be sick"	Stroke	Sensitivity to stimulation, information, noise, light impact on mobility	Public transportation services	Environmental Factor	e5 Services, systems and policies	e540 Transportation services, systems and policies	e 5408 Transportation services, systems and policies, other specified (Public transportation)
S05: "I can do the buses for a decent amount now, as long as it's not in rush hour or	Stroke	Tolerance to crowds, with community transit can be a barrier	Public transportation services	Environmental Factor	e5 Services, systems and policies	e540 Transportation services, systems and policies	e 5408 Transportation services, systems and policies, other

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
something"							specified (Public transportation)
S05: "and I know they, just to come here for an appointment of 11:00 o'clock, I should be ready at 8:15, they drive you around for 2 hours, like crammed in the back of a hatchback with two other people, [while using transport adapted]"	Stroke	Challenges with adapting to using services; requires pre-planning, spending more time, being uncomfortable while in transport	Adapted transport services Training	Environmental Factors	e5 Services, systems and policies	e540 Transportation services, systems and policies	e 5408 Transportation services, systems and policies, other specified (transport adapted)
S05: "And you have an autistic person screaming the whole time. I can't handle noises, and it was unbelievable, [while using transport adapted]"	Stroke	Impact of noise while using services; limiting future participation	Adapted transport services	Environmental Factors	e5 Services, systems and policies	e540 Transportation services, systems and policies	e 5408 Transportation services, systems and policies, other specified (transport adapted)
S04:"Exactly, but the thing about the para transit is yeah you have this para transit service when you call and they are good, if they hire the taxis, and or they put them on the training course"	Stroke	Some services (transit) are beneficial as long as they have appropriate training	Adapted transport services Training	Environmental Factors	e5 Services, systems and policies	e540 Transportation services, systems and policies	e 5408 Transportation services, systems and policies, other specified (transport adapted)
S05: "Well, um I stopped with the transport adapted about a year ago probably, I use Uber, taxis, and the bus once in a while"	Stroke	Option for community transit helps with mobility (transport, uber, taxi); Choices can facilitate participation	Public transportation services	Environmental Factor	e5 Services, systems and policies	e540 Transportation services, systems and policies	e 5408 Transportation services, systems and policies, other specified (Public transportation)
S05: "usually, I'll go to an appointment, like actually when I was coming here, I'd take the bus here and then I would take an Uber home"	Stroke	Option for community transit helps with mobility (transport, uber, taxi); Choices can facilitate participation	Public transportation services	Environmental Factor	e5 Services, systems and policies	e540 Transportation services, systems and policies	e 5408 Transportation services, systems and policies, other specified (Public transportation)
C07: "sometimes, when we see [the patient], we can ask for transport adapted early enough when they are off work, but in any case, there is a [long] delay"	Clinician	Limited access to (transportation) services	Adapted transport services	Environmental Factors	e5 Services, systems and policies	e540 Transportation services, systems and policies	e 5408 Transportation services, systems and policies, other specified (transport adapted)
C05: "the transport adapted is not easy to use for patients with too much cognitive impairment"	Clinician	Adapted transport / poor service for people with cognitive impairment	Adapted transport services	Environmental Factors	e5 Services, systems and policies	e540 Transportation services, systems and policies	e 5408 Transportation services, systems and policies, other specified (transport adapted)
C05: "it's too difficult to manage, they're not able to call, they're not able to give all the information"	Clinician	Adapted transport / poor service for people with cognitive impairment	Adapted transport services	Environmental Factors	e5 Services, systems and policies	e540 Transportation services, systems and policies	e 5408 Transportation services, systems and policies, other specified (transport adapted)
C06: "[patient who are not	Clinician	Accessibility to	Adapted transport	Environmental	e5 Services, systems	e540 Transportation	e 5408 Transportation

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
assigned for transport adapted] have a problem to get an access to outpatient services and have no way to get there		outpatient rehabilitation, transportation services	services	Factors	and policies	services, systems and policies	services, systems and policies, other specified (transport adapted)
Cs01: "I would say after 2 months we've got the transport adapted, and he was able to book him more often"	Caregiver	Getting the transport adapted service/late	Adapted transport services	Environmental Factors	e5 Services, systems and policies	e540 Transportation services, systems and policies	e 5408 Transportation services, systems and policies, other specified (transport adapted)
C01: "[when] there is a snowstorm, transport adapted becomes very difficult to use"	Clinician	Weather, access to transport service (timing, location)	Adapted transport services Weather	Environmental Factor	e1 Products and technology e5 Services, systems and policies	e150 Design, construction and building products and technology of buildings for public use e540 Transportation services, systems and policies	e 1500 Design, construction and building products and technology for entering and exiting buildings for public use e 5408 Transportation services, systems and policies, other specified (transport adapted)
C01: "the reality is just they often they cannot come"	Clinician	Weather, access to transport service (timing, location)	Adapted transport services Weather	Environmental Factors	e1 Products and technology e5 Services, systems and policies	e150 Design, construction and building products and technology of buildings for public use e540 Transportation services, systems and policies	e 1500 Design, construction and building products and technology for entering and exiting buildings for public use e 5408 Transportation services, systems and policies, other specified (transport adapted)
C04: "if there is a snowstorm, just forget it [because] the transportation is very late, or transport adapted doesn't park close to them"	Clinician	Weather, access to transport service (timing, location)	Adapted transport services Weather	Environmental Factors	e1 Products and technology e5 Services, systems and policies	e150 Design, construction and building products and technology of buildings for public use e540 Transportation services, systems and policies	e 1500 Design, construction and building products and technology for entering and exiting buildings for public use e 5408 Transportation services, systems and policies, other specified (transport adapted)
C03: "there is also a financial issue that limit client's mobility"	Clinician	Limits of public (transportation) services and limits of out-of-	Public transportation services Financial limitation	Environmental Factor	e5 Services, systems and policies e1 Products and	e540 Transportation services, systems and policies	e 5408 Transportation services, systems and policies, other

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
		pocket access due to limited funds			technology	e165 Assets	specified (Public transportation) e1650 Financial assets
C06: *"they don't have the money to pay for a taxi every time, and transport adapted takes 2 months before they are accepted"*	Clinician	Getting the transport adapted service/late	Adapted transport services	Environmental Factors	e5 Services, systems and policies	e540 Transportation services, systems and policies	e 5408 Transportation services, systems and policies, other specified (transport adapted)
S05: *"people really do not give us those handicap seats, if you have a cane they do not care, oh my goodness, I guess I'm too young or something"*	Stroke	Lack of social norms for accessible seating on community transport	Public transportation services Social norms	Environmental Factor	e5 Services, systems and policies e1 Products and technology	e540 Transportation services, systems and policies e150 Design, construction and building products and technology of buildings for public use	e 5408 Transportation services, systems and policies, other specified (Public transportation) e 1500 Design, construction and building products and technology for entering and exiting buildings for public use
S06: *"I was taking the bus to the general [hospital] I think and I had my cane, when we got there, the bus driver stopped, looked up and said, hold on I will help you cross the street"*	Stroke	Helpful social norms on community transport helps with mobility	Public transportation services Social norms	Environmental Factor	e5 Services, systems and policies e1 Products and technology	e540 Transportation services, systems and policies e150 Design, construction and building products and technology of buildings for public use	e 5408 Transportation services, systems and policies, other specified (Public transportation) e 1500 Design, construction and building products and technology for entering and exiting buildings for public use
S06: *"that was exceptional, I was shocked, and I said, No, it's okay, relax. But that's one of how many?"*	Stroke	Helpful social norms on community transport helps with mobility	Public transportation services Social norms	Environmental Factor	e5 Services, systems and policies e1 Products and technology	e540 Transportation services, systems and policies e150 Design, construction and building products and technology of buildings for public use	e 5408 Transportation services, systems and policies, other specified (Public transportation) e 1500 Design, construction and building products and technology for entering and exiting buildings for public use
S05: *"I've actually had a bus driver that the bus was full, and nobody was giving up the handicap seats, and he actually*	Stroke	Helpful social norms on community transport helps with mobility	Public transportation services Social norms	Environmental Factor	e5 Services, systems and policies e1 Products and technology	e540 Transportation services, systems and policies e150 Design,	e 5408 Transportation services, systems and policies, other specified (Public

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
stopped the bus and screamed at them, Get up and give in your seats. I was like woo, thank you!"						construction and building products and technology of buildings for public use	transportation) e 1500 Design, construction and building products and technology for entering and exiting buildings for public use
S02: "But if it is a handicap seat, they should always have to be blank, for disabled person"	Stroke	Helpful social norms on community transport helps with mobility	Public transportation services Social norms	Environmental Factor	e5 Services, systems and policies e1 Products and technology	e540 Transportation services, systems and policies e150 Design, construction and building products and technology of buildings for public use	e 5408 Transportation services, systems and policies, other specified (Public transportation) e 1500 Design, construction and building products and technology for entering and exiting buildings for public use
Theme 5: Uncertainty about the provided services							
S04: "I asked myself if I would ever return normal and would my symptoms last for a lifetime. They recently told me at xxx that my physiotherapy sessions have ended"	Stroke	Uncertainty of deficits and recovery limits mobility; lack of transition to community-based services	Uncertainty Healthcare services	Not defined Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T01:"nobody can give you like a timeline or you're never going to really be able to give a timeline, but more kind of an evolution symptoms, or maybe what to kind of expect based on your initial symptoms"	TBI	Lack of timeline of recovery; education about individualized symptoms and recovery path	Uncertainty Healthcare services	Not defined Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T03:"So once they categorize them as symptoms [clinicians] they explained to me what I should expect as a result from those symptoms sort of explained how those things are going to affect me"	TBI	Knowledge of symptoms; individualized therapy and recovery path was useful	Uncertainty Healthcare services	Not defined Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T03:"And how long it's going to take to recover and they didn't give me a timeframe, just that they said, oh, well, this is something that might take a while"	TBI	Uncertainty about timeline; recovery path, navigating difficult	Uncertainty Healthcare services	Not defined Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T03:"And now, because there's	TBI	Transition of services	Uncertainty	Not defined	e5 Services, systems	e580 Health services,	e5809 Health services,

407

Quotes	Population	Formulated statements	Codes	ICF domain	1st Level ICF classification	2nd Level ICF category	3rd or higher Level ICF category
been a break and physiotherapy at xxx have stopped. I don't really know what to do?"		with COVID; lack of services; Uncertainty	Healthcare services	Environmental Factor	and policies	systems and policies	systems and policies, other unspecified
T03: "But I just started my therapy when all this, when the COVID19 started so I really haven't made any progress and I have no idea how to make progress at this point"	TBI	Transition of services with COVID; lack of services; Uncertainty	Uncertainty Healthcare services	Not defined Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T03: "I'm mostly resolved from it, but there's still some little symptoms and you kind of wonder, is that going to last forever or if there are ways to kind of do right now, especially because of all COVID as we don't have any therapies really like accessible"	TBI	Uncertainty about lingering symptoms; uncertainty about transition of services during COVID	Uncertainty Healthcare services	Not defined Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified
T03:"And apart from having all the symptoms, I have this vision problem, I have double vision. For which I still do not have my corrective lenses for it's been over a year and waiting for the glasses"	TBI	Comorbidities of symptoms; Vision symptoms an issue; Wait times for vision services a problem	Uncertainty Healthcare services	Not defined Environmental Factor	e5 Services, systems and policies	e580 Health services, systems and policies	e5809 Health services, systems and policies, other unspecified

C: clinician perspective; Cs: caregiver perspective; S: stroke perspective; T: traumatic brain injury perspective

Appendix 2. Thematic content analysis based on the coding rating (the frequency of each code within each theme among all participants)

Codes	All participants (n=28) n (%)	Clinicians (n=17) n (%)	Patients (n=10) n (%)	Caregivers (n=1) n (%)
Theme 1: Enabling continuity of care				
1.1. Experiences with acute rehabilitation care				
• Quality of services	7 (25%)	2 (12%)	4 (40%)	1 (100%)
• Individualized focus	6 (21%)		5 (50%)	1 (100%)
• Specialized Services	6 (21%)		6 (60%)	
• Accessibility to healthcare services	3 (11%)		2 (20%)	1 (100%)
• Deficits	3 (11%)		3 (30%)	
• Beside manner	3 (11%)		3 (30%)	
• Education services to patients	2 (7%)	2 (12%)		
• Language barrier	1 (3%)			1 (100%)
1.2. Transition from acute to rehabilitation settings				
• Service Pathways	15 (53%)	15 (88%)		
• Discharge factors	9 (32%)	9 (53%)		
• Accessibility to healthcare services	7 (25%)		6 (60%)	1 (100%)
• Deficits	6 (21%)	6 (35%)		
• Wait times	5 (18%)	1 (6%)	3 (30%)	1 (100%)
• Workflow design	4 (14%)	4 (23%)		
• Specialized services	4 (14%)		3 (30%)	1 (100%)
• Electronic health records	3 (11%)	3 (17%)		
• Uncertainty	2 (7%)	2 (12%)		
• Quality of services	2 (7%)		1 (10%)	1 (100%)
• Young patients with impairments	1 (3%)	1 (6%)		
• Education services to providers	1 (3%)	1 (6%)		
• Caregiver support services	1 (3%)			1 (100%)
• Information services	1 (3%)			1 (100%)
• Family Support	1 (3%)	1 (6%)		
1.3. Access to rehabilitation in the community setting				
• Specialized services	4 (14%)	3 (17%)	1 (10%)	
• Deficits	3 (11%)	3 (17%)		
• Discharge factors	3 (11%)	3 (17%)		
• Accessibility to healthcare services	3 (11%)	2 (12%)	1 (10%)	
• Resources	2 (7%)	2 (12%)		
1.4. Re-integration into the community				
• Re-integration	10 (36%)	4 (23%)	6 (60%)	
• Education services to patients	3 (11%)		3 (30%)	
• Individualized focus	3 (11%)		3 (30%)	
• Support services	3 (11%)	3 (17%)		
• Safety	3 (11%)	3 (17%)		
• Specialized services	3 (11%)		3 (30%)	
• Deficits	1 (3%)	1 (6%)		
1.5. Follow-up in the community				
• Follow-up	15 (53%)	15 (88%)		

Codes	All participants (n=28) n (%)	Clinicians (n=17) n (%)	Patients (n=10) n (%)	Caregivers (n=1) n (%)
• Technology/Tele-health	12 (42%)	12 (70%)		
• Safety	8 (28%)	8 (47%)		
• Support services	6 (21%)	6 (35%)		
• Deficits	3 (11%)	3 (17%)		
• Resources	2 (7%)	2 (12%)		
• Survey	1 (3%)	1 (6%)		
Theme 2: System Design				
2.1. Quality of care				
• Quality of services	10 (36%)	1 (6%)	8 (80%)	1 (100%)
• Knowledge acquisition	8 (28%)		8 (80%)	
• Specialized therapy	6 (21%)		6 (60%)	
• Healthcare services	5 (18%)	1 (6%)	3 (30%)	1 (100%)
• Individualized focus	4 (14%)		4 (40%)	
• Symptom management	2 (7%)		2 (20%)	
2.2. Information services				
• Information services	7 (25%)		7 (70%)	
• Case management services	5 (18%)		5 (50%)	
• Navigate system	3 (11%)		3 (30%)	
• Accountability	2 (7%)		2 (20%)	
2.3. Oriented teamwork approach				
• Quality of services	9 (32%)		9 (90%)	
• Team-oriented	7 (25%)		7 (70%)	
• Education to providers	4 (14%)		4 (40%)	
• Overworked professionals	2 (7%)		2 (20%)	
2.4. Self-management				
• Self-therapy	8 (28%)		8 (80%)	
Theme 3: Accessibility and system in the community				
• Policy	11 (39%)	4 (23%)	7 (70%)	
• Accessibility design	10 (36%)	4 (23%)	6 (60%)	
• Recreational services	1 (3%)		1 (10%)	
Theme 4: Transportation services				
• Adapted transport services	13 (46%)	8 (47%)	4 (40%)	1 (100%)
• Public transportation services	10 (36%)	1 (6%)	9 (90%)	
• Social norms	5 (18%)		5 (50%)	
• Weather	3 (11%)	3 (17%)		
• Training	2 (7%)		2 (20%)	
• Financial limitation	1 (3%)	1 (6%)		
Theme 5: Uncertainty about the provided services				
• Uncertainty	5 (18%)		5 (50%)	

Appendices of Chapter 9

Appendix 1. The Microsoft office Excel 2010 functionalities

Task	Functionalities
2.1. Export to .CSV file	All columns and rows were visible, and no blank rows appeared within the range. Create a backup copy of the original data in a separate workbook.
2.2. Remove duplicate rows	Removing duplicate rows function.
2.3. Correct spelling mistakes	Spell-check and grammar functions.
2.4. Changing the case	The "LOWER" functions in Excel that converts all uppercase letters in a text string to lowercase letters.
2.5. Extend acronyms and abbreviations to their full form	Excel functions "FIND, SEARCH, REPLACE, SUBSTITUTE, LEFT, RIGHT" that can perform various string manipulation tasks, such as finding and replacing a sub-string within a string, extracting portions of a string, or determining the length of a string.
2.6. Fixing numbers and number signs	The "VALUE, TEXT, VALUE" functions in Excel to convert a text string that representing a number to a number format.
2.7. Remove white spaces, non-printing characters, typos, punctuations from the sentence	The "SUBSTITUTE, TRIM, CLEAN" functions to replace one character in a text string with a different character.

Appendix 2. Mobility banks of items

The following tables present all the found clusters, listing all items and their relative distance to the cluster's center.

For outlier items, we report not applicable (NA)

1. Upper Extremity Mobility bank of items

Items	Silhouette score (distance to cluster center)
1) how difficult are the following activities sharpening a pencil	1.41E-06
2) i have no difficulty in turning a key	3.30E-06
3) i use my weaker arm to open a door by turning a door knob handle	4.05E-06
4) in the past 2 weeks how difficult was it to use your hand that was most affected by your stroke to pick up a dime	5.03E-06
5) how difficult are the following activities peeling potatoes with a knife	5.34E-06
6) turn screw with screwdriver	5.37E-06
7) partly unscrewing a screw-top lid	7.51E-06
8) carry a shopping bag or briefcase	8.65E-06
9) i always hold on to something when i sit down on the toilet such as the door post the washbasin a handle or an arm support	8.68E-06
10) carry a heavy object over 10 lbs 5 kgs	1.03E-05
11) carrying a heavy load of groceries	1.38E-05
12) how difficult are the following activities opening mail	1.56E-05
13) can you open and close a zipper	1.74E-05
14) carrying a small suitcase with your affected limb	1.77E-05
15) can you unscrew the lid from a jar opened before	1.98E-05
16) did you have trouble buttoning buttons	2.04E-05
17) unscrew lid of jars	2.14E-05
18) how difficult are the following activities peeling onions	2.15E-05
19) i use my weaker arm to open drawer	2.29E-05
20) i use my weaker arm to use a fork or spoon for eating refers to the action of bringing food to the mouth with fork or spoon	2.46E-05
21) are you able to open car doors	2.51E-05
22) i need assistance in cutting up food	2.56E-05
23) carrying a light load of groceries	2.64E-05
24) i use my weaker arm to put on your socks	3.45E-05
25) grasp fork spoon	3.54E-05
26) holds zipper pull	4.05E-05
27) i use my weaker arm in picking up a glass bottle drinking cup or can does not need to include drinking	4.09E-05
28) during a typical day does your health now limit you in these activities if so how much lifting or carrying groceries	4.16E-05
29) can you turn a key in a lock	4.19E-05
30) i normally adjusting a home or hotel air conditioner or heater only with my dominant hand before the stroke and continue to do with my dominant hand now	4.24E-05
31) i use my weaker arm to pick up a cup by a handle	4.29E-05
32) patient is unable to remove rubber band	4.46E-05
33) reaches forward but needs supervision	4.93E-05
34) are you able to open a new milk carton	5.00E-05
35) i use my weaker arm to wipe off a kitchen counter or other surface	5.11E-05
36) clamping an object between torso and upper arm	5.17E-05

Items	Silhouette score (distance to cluster center)
37) can you cut a piece of paper with scissors	5.27E-05
38) pincer grasp with pen	5.32E-05
39) patient is unable to put a box on a shelf	5.50E-05
40) places hand on sacrum	5.53E-05
41) lateral elevation of the arm	5.65E-05
42) i use my weaker arm to buckling a belt	5.84E-05
43) touch opposite shoulder	5.95E-05
44) patient is unable to hold a pan lid	5.96E-05
45) put arm through clothing	6.03E-05
46) i use my weaker arm to putting on glasses	6.06E-05
47) i normally button a shirt only with my dominant hand before the stroke and continue to do with my dominant hand now	6.36E-05
48) patient is unable to hook and zip a zipper	6.36E-05
49) i use my weaker arm to pull chair away from table before sitting down	6.42E-05
50) i normally pumping a soap dispenser only with my dominant hand before the stroke and continue to do with my dominant hand now	6.46E-05
51) do up buttons	6.48E-05
52) i use my weaker arm to open refrigerator	6.49E-05
53) forward elevation of the arm	6.56E-05
54) i use my weaker arm in using a zipper pull	6.59E-05
55) patient is unable to put coin in coin gauge	6.71E-05
56) patient is unable to wringing a rag	6.73E-05
57) are you able to turn faucets on and off	6.80E-05
58) patient is unable to stabilize a jar	6.86E-05
59) are you able to open previously opened jars	7.00E-05
60) use a key to unlock a door	7.19E-05
61) i use my weaker arm to turn on a light with a light switch	7.27E-05
62) patient is unable to stabilize a pillow	7.33E-05
63) can you turn around door knob	7.37E-05
64) how difficult are the following activities tearing open a pack of chips	7.37E-05
65) lift telephone receiver, put to ear	7.38E-05
66) patient is unable to stabilize a package	7.38E-05
67) patient is unable to complete a hold a pouch	7.53E-05
68) opening a jar	7.74E-05
69) patient is unable to fold a sheet	7.78E-05
70) patient is unable to blocks and box	7.96E-05
71) pinch grip impossible on affected side	7.96E-05
72) patient is unable to cat's cradle	8.14E-05
73) i use my weaker arm to wash hands includes lathering and rinsing hands does not include turning water on and off with a faucet handle	8.37E-05
74) during the past week where you limited in your work or other regular daily activities as a result of your arm shoulder or hand problem	8.71E-05
75) i use my weaker arm to dry your hands	8.84E-05
76) i use my weaker arm to take off your socks	8.94E-05
77) can you hold a bowl	9.13E-05
78) i can open a tight jar with no difficulty	9.42E-05
79) i use my weaker arm in taking individual coins out of a pocket or purse	9.48E-05
80) patient is unable to complete a shoulder abduction	0.00010119
81) actively moves impaired arm across body the rest of the body moves as a block	0.0001038
82) during the past week to what extent has your arm shoulder or hand problem	0.00010818

Items	Silhouette score (distance to cluster center)
interfered with your normal social activities with family friends neighbours or groups circle number extremely	
83) i am using my weaker arm in turning water on off with knob lever on faucet	0.00010869
84) i normally removing bills from a wallet only with my dominant hand before the stroke and continue to do with my dominant hand now	0.00011772
85) can you button your shirt	0.00012075
86) i use my weaker arm to remove an item of clothing from a drawer	0.0001212
87) patient is unable to complete a hand into lap	0.00012537
88) in the past week how would you rate the strength of your grip of your hand that was most affected by your stroke	0.00012783
89) i use my weaker arm to use a television remote control	0.00012885
90) in the past week how would you rate the strength of your arm that was most affected by your stroke	0.00013281
91) grasps towel end	0.00013453
92) removing top from a medicine bottle	0.00014043
93) i use my weaker arm to use of keyboard computer	0.00014417
94) playing your musical instrument or sport because of arm shoulder or hand pain	0.00014828
95) i normally remove keys out of a pocket or purse only with my dominant hand before the stroke and continue to do with my dominant hand now	0.00015146
96) in the past 2 weeks how difficult was it to use your hand that was most affected by your stroke to open a can or jar	0.00015309
97) i can perform thumb adduction	0.00015384
98) i use my weaker arm to eat half a sandwich or finger foods	0.0001543
99) grip plastic bottle with tips of thumb and index finger and lift it 2 cm	0.00016024
100) i use my weaker arm in swiping a credit card or a card for an atm	0.00017089
101) can you hold a toothbrush efficiently	0.00017144
102) stiffness in your arm shoulder or hand extreme	0.00017808
103) i can place string around head and tie bow at back do not allow neck to flex affected hand must be used for more than just supporting string this tests function of hand without help of sight	0.00018157
104) can you prick things well with a fork	0.000184
105) can you cut meat with a knife	0.00018637
106) did you have trouble opening a jar	0.00019801
107) how difficult are the following activities unwrapping a chocolate bar	0.00019831
108) i can do same exercise as in 6 above with pencil patients must use thumb and fingers to grip	0.00020888
109) how difficult are the following activities cutting one s tails	0.00021436
110) how difficult are the following activities threading a needle	0.00021849
111) i normally keypad press only with my dominant hand before the stroke and continue to do with my dominant hand now	0.0002375
112) i use my weaker arm to write on paper if hand used to write pre stroke is more affected score item if non writing hand pre stroke is more affected drop item and assign	0.00025264
113) lifting a bag of groceries above your head	0.00026651
114) i normally unlock the door only with my dominant hand before the stroke and continue to do with my dominant hand now	0.00028969
115) have the patient reach forward to pick up the top of a pen with their affected hand, bring the affected arm back to their side and put the pen cap down in front of them	0.00029366
116) carry an object in your hand draping an item over the arm is not	0.00031551

Items	Silhouette score (distance to cluster center)
acceptable no that is an activity that i normally did only with my dominant hand before the stroke and continue to do with my dominant hand now	
117) open a door by turning a door knob	0.00033589
118) in the past 2 weeks how difficult was it to use your hand that was most affected by your stroke to turn a doorknob	0.00033872
119) pick up a piece of paper from table in front and release five times patient must use thumb and fingers to pick up paper and not to pull it to edge of table arm position as in 6 above	0.0003439
120) wring out washcloth	0.00035216
121) how difficult are the following activities opening a screw topped jar	0.00037906
122) lifting a bag of groceries to waist level	0.00040634
123) retrieving object from floor	0.00044047
124) use a knife to cut food	0.00047655
125) can you peel fruit	0.0005627
126) are you able to cut your own meat	0.00059596
127) remove an item of clothing from a drawer	9.37E-07
128) I can cut putty with a knife and fork on plate with nonslip mat and put pieces into container at side of plate bite size pieces	NA
129) open jar of coffee	NA
130) how difficult are the following activities spreading butter on a slice of bread	NA
131) how difficult are the following activities shelling hazel nuts	NA
132) are you able to reach and get down a 5 pound object such as a bag of sugar from above your head	NA
133) are you able to lift a full cup or glass to your mouth	NA
134) in the past 2 weeks how difficult was it to cut your food with a knife and fork	NA
135) use a fork or spoon for eating	NA
136) pick up a cup by a handle	NA
137) turn on a light with a light switch	NA
138) have the patient take a dessert spoon of liquid to their mouth with their affected hand without lowering the head toward the spoon or spilling	NA
139) how difficult are the following activities taking the cap of a bottle	NA
140) how difficult are the following activities wrapping up gifts	NA
141) i normally pouring liquid from a bottle only with my dominant hand before the stroke and continue to do with my dominant hand now	NA
142) i use my weaker arm in putting on makeup base lotion or shaving cream on face	NA
143) pick up a glass or bottle drinking cup or can	NA
144) since your stroke how much difficulty do you have shopping for and carrying a few items 1 bag of shopping or less when at the shops	NA
145) can you hold a plate full of food	NA
146) how difficult are the following activities cutting meat	NA
147) i need assistance in using a glass or cup	NA
148) reaches for towel	NA
149) carrying out the garbage	NA
150) pick up glass	NA
151) place container on table	NA
152) putting groceries on shelves	NA
153) in the past 2 weeks how difficult was it to use your hand that was most affected by your stroke to tie a shoelace	NA

Items	Silhouette score (distance to cluster center)
154) pick up cup	NA
155) how difficult are the following activities buttoning up a shirt	NA
156) i use my weaker arm to put on your shoes includes tying shoestrings and fastening straps	NA
157) how difficult are the following activities fastening a snap jacket bag	NA
158) how difficult are the following activities buttoning up trousers	NA
159) i normally comp my hair only with my dominant hand before the stroke and continue to do with my dominant hand now	NA
160) i use my weaker arm to take off your shoes includes untying shoestrings and unfastening straps	NA
161) knitting needle crafts	NA
162) putting on or taking off watch band no that is an activity that i normally did only with my dominant hand before the stroke and continue to do with my dominant hand now	NA
163) did you wash small items of clothing on your own with difficulty	NA
164) controlled grasp with soda can grasp	NA
165) how difficult are the following activities pulling up the zipper of trousers	NA
166) lifting an object like a bag of groceries from the floor	NA
167) pull chair toward table after sitting down	NA
168) in the past 2 weeks how difficult was it to use your hand that was most affected by your stroke to carry heavy objects e g bag of groceries	NA
169) put paper clip on envelope	NA
170) fold paper put into envelope	NA
171) i find it hard to reach for things	NA
172) have the patient pick up a polystyrene cup with their affected hand and put it on the table on the other side of their body without any alteration to the cup	NA
173) pour a glass of water	NA
174) pour water from cup	NA
175) pour water from glass to glass	NA
176) pour water from jug	NA
177) lift iron over edge 5 cm in height	NA
178) subject performs 3 or more arm lifts	NA
179) lift wooden cubes over edge 5 cm in height	NA
180) open or close zip	NA
181) able to pick up safely and easily	NA
182) place 8 jellybeans in a teacup an arms length away on the affected side place another teacup an arms length away on the intact side have the patient pick up one jellybean with their affected hand and place the jellybean in the cup on the intact side	NA
183) grasping a ball presented from a high angle	NA
184) ability to reach	NA
185) raises arm overhead to fullest elevation	NA
186) pick up the pegs one at a time using your right or left hand only and put them into the holes in any order until the holes are all filled then remove the pegs one at a time and return them to the container stabilize the peg board with your left or right hand	NA
187) my current means of mobility allows me to reach and carry out tasks at different surface heights as independently, safely and efficiently as possible	NA
188) push open a heavy door with no difficulty	NA
189) pick up nuts	NA
190) open door with key	NA

Items	Silhouette score (distance to cluster center)
191) pushing up on your hands	NA
192) have the patient pick up a pen pencil with their affected hand, hold the pen as for writing and position it without assistance and make rapid consecutive dots not strokes on a sheet of paper goal at least 2 dots a second for 5 seconds	NA
193) i want to see how quickly you can pick up one block at a time with your right or left hand and carry it to the other side of the box and drop it make sure your fingertips cross the partition	NA
194) time 30 seconds ask the person if he is right or left handed take a piece of paper hold it up in front of the person and say take this paper in your right left hand whichever is non dominant fold the paper in half once with both hands and put the paper down on the floor unable to perform one or more activities	NA
195) place a 5 inch ball on the table so that the patient has to reach forward with arms extended to reach it have the patient reach forward with shoulders protracted elbows extended wrist in neutral or extended pick up the ball with both hands and put it back down in the same spot	NA
196) pat a cake seven times in 15 sec mark crosses on wall at shoulder level clap both hands together both hands touch crosses each sentence counts as one give patients three tries this is a complex pattern which involves co ordination speed and memory as well as good arm function	NA
197) reach forward pick up large ball with both hands and place down again ball should be on table so far in front of patient that he has to extend arms fully to reach it shoulders must be protracted elbows extended wrist neutral or extended and fingers extended throughout movement palms should be kept in contact with the ball	NA
198) standing with affected arm abducted to 90 degrees with palm flat against wall maintain arm in position turn body towards wall and as far as possible towards arm i e rotate body beyond 90 degrees do not allow flexion at elbow and wrist must be extended with palm of hand fully in contact with wall	NA
199) reach with correct orientation of fingers and wrist for a plastic bottle standing on the table at arms length in front of the patient's midline	NA
200) i normally popping top of beverage only with my dominant hand before the stroke and continue to do with my dominant hand now	NA
201) place an object on a shelf above your head	NA
202) reaching up for an object with the better arm, feet in walking position right foot in front	NA
203) reaching forward with outstretched arm	NA
204) turn door handle 30 degrees	NA
205) ability to maintain outstretched arm position	NA
206) bending down to pick up an object from the floor 20 cm from toes with the better hand	NA
207) carry an object in your hand	NA
208) picking up a pencil from the floor	NA
209) throwing a ball	NA

2. Emotional Functions bank of items

A. Depression bank of items

Items	Silhouette score (distance to cluster center)
1) i show less affection	8.25E-06
2) i do not cry any more than usual	8.95E-06
3) how often do you blame yourself for your situation	1.24E-05
4) do you feel that your situation is hopeless	1.46E-05
5) i cry more now than i used to	1.46E-05
6) ideas of guilt	1.75E-05
7) present illness is a punishment or delusions of guilt	1.76E-05
8) i do not find my life very exciting	1.79E-05
9) in the past week how often did you blame yourself for mistakes that you made	1.92E-05
10) feeling bad about yourself or that you are a failure or have to let yourself or your family down	1.94E-05
11) i felt fidgety	2.07E-05
12) i don t feel particularly guilty	2.10E-05
13) i feel the future is hopeless and that things cannot improve	2.29E-05
14) inappropriate social interaction acting childish silly rude behavior not fitting for time and place	2.36E-05
15) i blame myself for everything bad that happens	2.41E-05
16) in the past week how often did you feel that you are a burden to others	2.47E-05
17) i get sudden frights	2.51E-05
18) during the last 4 weeks for each question please give the answer that comes closest to the way you have been feeling have you felt so down in the dumps that nothing could cheer you up	2.53E-05
19) i blame myself all the time for my faults	2.61E-05
20) i was discouraged about my future	2.68E-05
21) how often do you feel hopeless about your future life	2.69E-05
22) i am so sad and unhappy that i cannot stand it	2.77E-05
23) as i look back on my life all i can see is a lot of failures	2.87E-05
24) i feel i am a burden to people	2.94E-05
25) hallucinations of guilt	2.96E-05
26) i felt i was a burden to my family	3.00E-05
27) i laugh or cry suddenly	3.15E-05
28) i cry all the time now	3.19E-05
29) i am sad all the time and i cannot snap out of it	3.23E-05
30) i do not feel i am any worse than anybody else	3.28E-05
31) feelings of incapacity listlessness indecision and vacillation	3.80E-05
32) do you frequently feel like crying	4.38E-05
33) i feel i am a complete failure as a person	4.95E-05
34) poor appetite or overeating	5.03E-05
35) loss of appetite or increased appetite	5.83E-05
36) i am disappointed in myself	0.00010011
37) i did not like myself	0.00011368
38) i do not feel disappointed in myself	0.00013325
39) i feel i have failed more than the average person	0.00015386
40) are you depressed	NA
41) i am disgusted with myself	NA
42) i wake up feeling depressed	NA
43) i felt depressed	NA

Items	Silhouette score (distance to cluster center)
44) feeling down depressed or hopeless	NA
45) i am feeling on edge	NA
46) feeling depressed or sad	NA
47) in the past week how often did you feel sad all of the time	NA
48) feeling depressed or tearful	NA
49) how often do you feel lonely	NA
50) i do not feel sad	NA
51) i feel sad	NA
52) in the past week how often did you smile and laugh at least once a day	NA
53) during the past 4 weeks have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems such as feeling depressed or anxious cut down the amount of time you spent on work or other activities	NA
54) i feel lonely	NA
55) i was not interested in other people or activities	NA
56) during the last 4 weeks have you felt calm and peaceful	NA
57) i show less interest in other peoples problems for example do not listen when they tell me about their problem	NA
58) feeling no interest in things	NA
59) i am less interested in sex than i used to be	NA
60) i have no appetite at all anymore	NA
61) are you hopeful about the future	NA
62) i was not interested in food	NA
63) in the past week how often did you feel that life is worth living	NA
64) i do not feel happy most of the time	NA
65) during the last 4 weeks have you been a happy person	NA
66) do you feel that your life is empty	NA
67) i am less interested in other people than i used to be	NA
68) in the past week how often did you feel that there is nobody you are close to	NA
69) little interest or pleasure in doing things	NA
70) my appetite is no worse than usual	NA
71) do you think it is wonderful to be alive now	NA
72) how often do you refuse to talk to people	NA
73) i feel there is nobody that i am close to	NA
74) i do not get real satisfaction out of anything anymore	NA
75) i lost interest in my usual activities	NA
76) i feel cheerful	NA
77) i do not enjoy things the way i used to	NA
78) i feel that i can deal with life events as they happen	NA
79) i stay home most of the time	NA
80) nothing made me happy	NA
81) i have forgotten what its like to enjoy myself	NA
82) in the past week how often did you feel that you have nothing to look forward to	NA
83) i am restricted from leaving even with someone else	NA
84) in the past week how often did you enjoy things as much as ever	NA
85) how often do you just sit doing nothing	NA
86) i have lost interest in sex completely	NA
87) do you prefer to stay at home rather than going out and doing new things	NA
88) i have lost most of my interest in other people	NA
89) i do not feel like a failure	NA
90) i have lost all of my interest in other people	NA

Items	Silhouette score (distance to cluster center)
91) sometimes i am left alone for most of the day	NA
92) do you feel pretty worthless the way you are now	NA
93) i have lost interest in my appearance	NA
94) do you often feel helpless	NA
95) i still enjoy the things i used to enjoy	NA
96) i felt withdrawn from other people	NA
97) i feel i may be punished	NA
98) feels life is no worth living	NA
99) i feel i am being punished	NA
100) i feel guilty a good part of the time	NA
101) my appetite is so much worse now	NA
102) feeling of worthlessness	NA
103) i feel quite guilty most of the time	NA
104) how often do you want to do something	NA
105) i say how bad or useless i am for example that i am a burden on others	NA
106) i am not particularly discouraged about the future	NA
107) i believe that i look ugly	NA
108) i hate myself	NA
109) i have lost interest in other people	NA
110) sometimes i am left alone for an hour or two	NA
111) i do not feel that i look any worse than i used to	NA

B. Anxiety bank of items

Items	Silhouette score (distance to cluster center)
1) are you afraid that something bad is going to happen to you	4.46E-06
2) i feel as if i am losing control	1.02E-05
3) are you bothered by thoughts you cannot get out of your head	1.24E-05
4) do you worry a lot about the past	2.22E-05
5) i am worried that i am looking old or unattractive	2.63E-05
6) worrying thoughts go through my mind	3.03E-05
7) i feel there are permanent changes in my appearance that make me look unattractive	3.08E-05
8) i am very worried about physical problems and its s hard to think of much else	3.78E-05
9) do you frequently worry about the future	3.81E-05
10) i am critical of myself for my weaknesses or mistakes	4.06E-05
11) suddenly scared for no reason	8.06E-05
12) i get a sort of frightened feeling as if something awful is about to happen	9.67E-05
13) i get a sort of frightened feeling like butterflies in the stomach	0.00010093
14) how often do you refuse to do something because you are scared to fail almost	0.00012419
15) i get sudden feelings of panic	0.00013882
16) is your mind as clear as it used to be	NA
17) worrying about minor matters	NA
18) since your stroke how often do you feel bored with your free time at home	NA
19) how often do you feel inferior or unable to assert yourself against others	NA
20) do you think that most people are better off than you	NA
21) how often do you feel bored	NA

Items	Silhouette score (distance to cluster center)
22) i am dissatisfied or bored with everything	NA
23) do you often feel downhearted and blue	NA
24) do you often get bored	NA
25) feels he has let people down	NA
26) anxiety tense nervous fearful phobias nightmares flashbacks of stressful events	NA
27) are you afraid to leave your home without having someone accompany you	NA
28) are you afraid to stay home alone	NA
29) my personality has changed	NA
30) i do not feel that i look any worse than i used to	NA
31) are you afraid people may think that you are intoxicated	NA
32) have you been embarrassed in front of others	NA

C. Anger bank of items

Items	Silhouette score (distance to cluster center)
1) i have thoughts of killing myself but i would not carry them out	6.51E-06
2) during the last 4 weeks for each question please give the answer that comes closest to the way you have been feeling have you been a very nervous person	1.33E-05
3) i lose my temper easily these days	2.28E-05
4) i am slightly more irritated now than usual	2.30E-05
5) i wanted to hurt myself	2.32E-05
6) i felt like a bad person	2.39E-05
7) i would kill myself if i had the chance	3.14E-05
8) poor frustration tolerance, feeling easily overwhelmed by things	3.21E-05
9) how often do you get into arguments with other people	3.47E-05
10) poor frustration tolerance or feeling easily overwhelmed by things	3.54E-05
11) i act irritable and impatient with myself for example talk badly about myself swear at myself blame myself for things that happen	3.99E-05
12) i feel tense or wound up	4.08E-05
13) how often do you get impatient with yourself	5.08E-05
14) being irritable, easily angered	5.16E-05
15) i would like to kill myself	5.34E-05
16) do you feel frustrated	5.96E-05
17) feeling tense or keyed up	5.99E-05
18) i often act irritable to those around me for example snap at people	6.03E-05
19) i was irritable	6.08E-05
20) i wished i were dead	6.15E-05
21) thoughts that you would be better off dead or of hurting yourself in some way	6.39E-05
22) irritability or easily annoyed	6.56E-05
23) thoughts of ending your life	7.64E-05
24) how often do you get angry or shout at other people	8.38E-05
25) nervousness or shakiness inside	9.88E-05
26) attempts at suicide	0.00011731
27) irritability anger aggression verbal or physical expressions of anger	0.00013695
28) in the past week how often did you feel quite nervous	0.00014107
29) do you frequently get upset over little things	NA

Items	Silhouette score (distance to cluster center)
30) i am quite annoyed or irritated a good deal of the time	NA
31) i feel irritated all the time	NA
32) how often do you feel overwhelmed or worn out never	NA

3. Balance bank of items

Items	Silhouette score (distance to cluster center)
1) able to place feet together independently and stand for 1 minute without supervision	7.90E-06
2) needs help to attain position but able to stand for 15 seconds with feet together	1.04E-05
3) needs help to step but can hold for 15 seconds	1.77E-05
4) able to lift leg independently and hold up to 3 seconds	1.89E-05
5) tries to lift leg, unable to hold 3 seconds but remains standing independently	2.18E-05
6) able to lift leg independently and hold more than 10 seconds	2.76E-05
7) able to sit for 2 minutes under supervision	3.42E-05
8) able to stand for 3 seconds	4.07E-05
9) able to lift leg independently and holds for 5 to 10 seconds	4.30E-05
10) able to stand for 10 seconds without supervision	4.37E-05
11) can you seize a full bottle and raise it	4.49E-05
12) able to stand using hands after several tries	4.84E-05
13) standing with feet together	5.80E-05
14) standing on non paretic leg	5.83E-05
15) able to stand safely for 2 minutes	5.90E-05
16) able to stand independently using hands	6.00E-05
17) standing with one foot in front	6.14E-05
18) able to sit for 10 seconds	6.34E-05
19) able to place feet together independently but unable to hold for 30 seconds	6.47E-05
20) standing up without using the hands	6.59E-05
21) standing feet together	6.78E-05
22) stand on one leg	6.90E-05
23) able to take small step independently and hold for 30 seconds	6.94E-05
24) able to stand with no hands and stabilize independently	7.04E-05
25) able to turn 360 in less than 4 seconds to each side	7.34E-05
26) can reach forward more than 5 inches safely	7.81E-05
27) able to turn 360 safely to one side only in less than 4 seconds	7.83E-05
28) walk on toes	8.13E-05
29) stepping dynamic double stance	8.51E-05
30) can reach forward confidently more than 10 inches	8.55E-05
31) compensatory lateral stepping correction	8.57E-05
32) can reach forward more than 2 inches safely	8.66E-05
33) able to turn 360 safely but slowly	8.95E-05
34) compensatory backward stepping correction	9.12E-05
35) dynamic standing balance	9.52E-05
36) stand on non affected leg	9.76E-05
37) can you using hands and an aid if necessary stand up from a chair in less than 15 seconds and stand there for 15 seconds	9.77E-05
38) subject performs 1 or more step up and down	9.86E-05
39) static standing balance	0.000100287
40) sits independently but had uncontrolled descent	0.000100306
41) stand on affected leg	0.000101733
42) patient assisted to standing the patient weight is unevenly distributed and may use hands for support	0.000103476
43) standing while holding onto stable support	0.000103555

Items	Silhouette score (distance to cluster center)
44) rise to toes	0.000103717
45) compensatory forward stepping correction	0.000104027
46) turning 360 degrees on the spot right side leading	0.000109038
47) able to stand 2 minutes without supervision	0.000109411
48) maintains standing for 20 counts	0.000110088
49) turning 360 degrees on the spot left side leading	0.000112713
50) i am able to walk independently for 8 meter in 20 seconds or less	0.000113208
51) with assistance the patient stands on affected leg with the affected weight bearing hip extended and steps forward with the intact leg	0.000113314
52) subject performs 2 or more footsteps	0.000114524
53) rising from a chair followed by a three meter walk than return to a seated position	0.000115643
54) arm drifts before 5 seconds pass and maintains lower position	0.000116036
55) i need bilateral support and more than 20 seconds to walk 8 meter and i may use wheelchair on occasion	0.000116239
56) standing with support	0.000117604
57) 180 degree tandem pivot	0.000122059
58) uses back of legs against chair to control descent	0.000122891
59) patient cannot walk but can stand supported	0.000122968
60) leg drifts to intermediate position by the end of 5 seconds	0.000125006
61) unable to keep eyes closed for 3 seconds but remains steady	0.000133608
62) manual contact is continuous and necessary to support nods weight or to maintain balance or assist coordination	0.000134759
63) supported single stance	0.000141768
64) sitting unsupported 1 minute	0.000141948
65) stand with support	0.000144758
66) i always shift forward a little at first before i get up from the toilet	0.000146469
67) stand on your right/left leg and move sideways by alternately pivoting on your heel and toe and keep pivoting straight across until you touch the line and maintain your balance in this position	0.000149181
68) patient stands up and sits down again when standing hips & knees are extended with weight evenly distributed	0.000149658
69) static double stance	0.000150257
70) patient can walk with aid	0.000156808
71) without worrying about the speed of movement try to sit and then to rise from the floor using the minimum support you believe is needed	0.000156943
72) able to stand independently and safely and complete eight steps in less than 20 seconds	0.000159836
73) turn to look behind over left and right shoulders while standing	0.000159883
74) able to sit for 30 seconds	0.000163734
75) i have a walking limitation to several steps with bilateral support and unable to walk 8 meter and i may use wheelchair for most activities	0.00016384
76) able to place one foot ahead of the other independently and hold for 30 seconds	0.000166282
77) volitional movement with little or no synergy	0.000167369
78) dynamic single stance	0.00017207
79) when i get into a car i always flop down at the end	0.000178206
80) able to place feet in tandem position independently and hold for 30 seconds	0.000184321
81) lower extremity volitional movement with little or no synergy in standing position	0.000196317
82) unable to sit without support for 10 seconds	0.000196587
83) step up and down on this step as quickly as you can until i say stop the pattern is right left up and right left down and try not to look at your feet	0.000199177

Items	Silhouette score (distance to cluster center)
84) changing the base of support between double and single stance	0.000202289
85) leg maintains position for 5 seconds	0.000207563
86) walk forward on the line heel touching toes and keep your feet pointing straight ahead look ahead down the track not at your feet and i will tell you when to stop	0.000209584
87) able to stand 30 seconds unsupported	0.00022539
88) actively moves impaired arm and leg rolling to intact side but overbalances	0.00023662
89) i always have to shift forward a little at first before i get up from a low chair or sofa	0.000238354
90) standing feet apart for 30 seconds	0.000239138
91) move sideways along the line by repeatedly crossing one foot in front of and over the other and place part of your foot on the line with every step then reverse direction whenever i call change do this as fast as you can yet at a speed that you feel safe	0.000243107
92) i always shift to the edge of the bed first before i get up	0.00026268
93) needs several tries to stand 30 seconds unsupported	0.000422993
94) needs assistance to keep from falling	NA
95) visual biofeedback on unstable support surface	NA
96) pick up object from the floor from a standing position	NA
97) subject keeps his/her balance for 30 seconds or more without support or assistance from the tester	NA
98) unable to try needs assistance to keep from losing balance or falling	NA
99) sitting with back unsupported with feet on floor or on a stool	NA
100) turns sideways only but maintains balance	NA
101) in the past 2 weeks how difficult was it to stay standing without losing your balance	NA
102) is it difficult for you to walk around your house in the dark	NA
103) needs assistance while turning	NA
104) stand unsupported with feet together	NA
105) in the past 2 weeks how difficult was it to walk without losing your balance	NA
106) can you walk over uneven ground grass gravel dirt snow or ice without help	NA
107) if you drop something on the floor can you manage to walk 5 meters to pick it up and walk back	NA
108) use of hands impaired strength or coordination in one or both hands	NA
109) place alternate foot on bench or stool while standing unsupported	NA
110) in the past 2 weeks how difficult was it to stay sitting without losing your balance	NA
111) did you lose your balance when bending over to or reaching for something	NA
112) stand unsupported with one foot in front	NA
113) pick up object from floor from between feet	NA
114) lose balance while stepping or standing	NA
115) unable to pick up shoe but comes within 1 or 2 inches and maintains balance independently	NA
116) sitting without support with feet touching the floor	NA
117) standing without support	NA
118) sit unsupported without holding on edge of bed feet unsupported	NA
119) subject keeps his balance for 30 seconds or more with upper limb support but without assistance from the tester	NA
120) needs minimal assistance to stand or to stabilize	NA
121) manual contact is continuous or intermittent light touch to assist balance or coordination	NA
122) lifting your heels just a little pivot all the way around to face the opposite direction without stopping and put your heels down and maintain your balance in this	NA

Items	Silhouette score (distance to cluster center)
position	
123) static item which assess the ability to maintain a position within time limits	NA
124) patient sits unsupported for 10 seconds with arms folded knees and feet together and feet on the floor	NA
125) feeling so restless you could not sit still	NA
126) visual biofeedback on stable support surface	NA
127) poor coordination or clumsy	NA
128) patient stands up the patients weight is evenly distributed but hips and knees are flexed no use of hands for support	NA
129) gait with eyes closed	NA
130) sits on stool unsupported with feet on the floor patients reaches sideways without moving the legs or holding on and returns to sitting position. support affected arm if needed	NA
131) sitting balance at the edge of the bed with thigh supported hands on lap and feet flat on floor	NA
132) unable to stand 30 seconds unassisted	NA
133) performs head turns smoothly with no change in gait	NA
134) gait with horizontal head turns	NA
135) standing unsupported with eyes closed	NA
136) patient sits unsupported with weight shifted forward and evenly distributed over both hips or legs	NA
137) dynamic sitting balance	NA
138) patient stands up and sits down again 3 times in 10 seconds with hips and knees extended and weight evenly distributed	NA
139) pivot turns safely within 3 seconds and stops quickly with no loss of balance	NA
140) i do not get around in the dark or in unlit places without someones help	NA
141) balance in sitting position	NA
142) hop on affected leg five times on the spot must hop on ball of foot without stopping to regain balance no help with arms	NA
143) stand on your right/left foot hop twice straight along this line to pass the 1m mark with your heel maintain your balance on your right/left leg at the finish	NA
144) sitting to standing may use hands to push up must stand up in 15 sec	NA
145) stand on spot maintain upright position pat large ball on floor with palm of hand for 5 continuous bounces	NA
146) stand at center line then jump 30 cm to the right and touch the line with the closest foot then jump back to the center then jump 30 cm to the other side then back you the center	NA
147) try to complete the sequence as fast and as safely as possible without touching the sticks with both feet must make contact with the floor in each square and if possible face forward during the entire sequence	NA
148) stand on your right or left leg and hold for as long as you can up to 45 seconds and look straight ahead	NA
149) could you sit on the edge of the bed without holding on for 10 seconds	NA
150) sits unsupported with feet together on the floor. without allowing the legs or feet to move and without holding on the patient must reach forward to touch the floor 10 cm or 4 inches in front of them the affected arm may be supported if necessary	NA

4. Motor Control bank of items

Items		Silhouette score (distance to cluster center)
1)	sitting elbow into side pronation and supination three quarters range is acceptable with elbow unsupported and at right angles	1.07E-05
2)	shoulder abduction to 90 degrees	1.12E-05
3)	reaching forward horizontally for an object with the better hand forehand flush with knee	1.29E-05
4)	sitting pronation supination affected arm on table with elbow unsupported at side patient asked to supinate and pronate forearm	1.31E-05
5)	elbow flexion from 90 so that the arm touches the shoulder	1.40E-05
6)	hip flexion with the hip bent at 90 moving the knee towards the chin	1.47E-05
7)	knee extension with the foot unsupported and the knee at 90 degrees	1.52E-05
8)	shoulder flexion to 90 degrees	1.55E-05
9)	opposition thumb and little finger	1.61E-05
10)	elbow fully flex	1.84E-05
11)	shoulder flex to 30 degrees	2.16E-05
12)	grip dice sideways with tips of thumb and index finger and rotate dice once around its vertical axis	2.48E-05
13)	touching a marked place with the left elbow on the left 30 cm from hip	2.77E-05
14)	shoulder to 30 extension with elbow flex	2.80E-05
15)	supinates and pronates forearm so elbow flexed at 90 degrees	2.80E-05
16)	touching a marked place with the right elbow on the right 30 cm from hip	2.81E-05
17)	ankle dorsiflexion with foot in a plantar flexed position	3.09E-05
18)	standing have patients affected arm abducted to 90 degrees with palm flat against wall patient must maintain arm position while turning body toward the wall	3.31E-05
19)	dorsiflexes affected ankle with knee extended	3.33E-05
20)	pull tip of index finger on the dice and rotate dice once around its vertical axis with fingers 1 and 3	3.40E-05
21)	arm maintains position for 5 seconds but affected hand pronates	3.47E-05
22)	extends elbow in supine	3.86E-05
23)	selective extension of 5th finger	3.86E-05
24)	flexes affected knee with hip extended	3.92E-05
25)	the limb is placed in the appropriate position when patient holds the leg at 30 degrees	3.98E-05
26)	supine patient assumes above position and brings hand to forehead and extends the arm again flexion and extension of elbow therapist may assist with supination of forearm	4.46E-05
27)	hand to stomach	4.48E-05
28)	sitting at a table radial deviation of wrist therapist should place forearm with ulnar side on table in mid pronation supination position thumb in line with forearm and wrist in extension fingers around cylindrical object patient is asked to lift hand off table. no wrist flexion or extension	4.74E-05
29)	ball bearing 2nd finger and thumb	4.83E-05
30)	sitting at a table wrist extension affected forearm resting on table place cylindrical object in palm of patients hand patient asked to lift object off table by extending the wrist no elbow flexion allowed	4.94E-05
31)	knee external rotation moment max	4.96E-05
32)	knee extension moment max	5.02E-05

Items	Silhouette score (distance to cluster center)
33) knee internal rotation moment max	5.08E-05
34) flexes hip and knee in supine	5.10E-05
35) sitting patient lifts affected arm to 90 degrees forward flexion holds it there for 10 seconds and then lowers it with some shoulder external rotation and forearm supination no pronation	5.47E-05
36) abducts affected hip with knee extended	5.87E-05
37) start position supine ankle plantar flexed hip in neutral rotation and flexion and with the knee flexed to 15 degree movement dorsiflex the patient s ankle from maximum possible plantar flexion to maximum possible dorsiflexion considerable	6.05E-05
38) ball bearing 1st finger and thumb	6.15E-05
39) the patient is instructed to next to but not touching a wall and position the arm that is closer to the wall at 90 degrees of shoulder flexion with a closed fist	6.42E-05
40) flexion and extension of elbow with arm as in 2 above elbow must extend to at least 20 degrees full extension palm should not face out during any part of movement	6.49E-05
41) flexes hip in sitting	6.62E-05
42) I can lying protract shoulder girdle with arm in elevation arm may be supported	6.67E-05
43) touch opposite knee	6.80E-05
44) supine therapist places affected arm in 90 degrees shoulder flexion and holds elbow in extension hand toward ceiling the patient protracts the affected shoulder actively	6.82E-05
45) plantar flexes ankle in sitting	7.08E-05
46) knee flexion moment max	7.16E-05
47) ankle dorsiflexion moment max	7.18E-05
48) extends knee and dorsiflexes ankle in sitting	7.21E-05
49) protraction or retraction of the scapula arm supported on table or lap	7.27E-05
50) hand to mouth elbow remains on the table	7.30E-05
51) dorsiflexes ankle in sitting	7.35E-05
52) knee valgus moment max	7.50E-05
53) knee varus moment max	7.52E-05
54) actively moves impaired leg across body to roll but leaves impaired arm behind	7.62E-05
55) wrist extension with shoulder in misposition	7.62E-05
56) hip abduction moment max	7.75E-05
57) start position elbow fully flexed forearm neutral movement extend elbow from maximum possible flexion to maximum possible extension triceps would be in the same position opposite direction normal tone	7.77E-05
58) start position prone so that the ankle falls beyond end of the plinth hip in neutral rotation movement flex the patient s limb from maximum possible flexion to maximum possible extension affected part s rigid in flexion or extension	7.96E-05
59) hip extension moment max	8.23E-05
60) flexes knee in sitting	8.34E-05
61) the limb is placed in the appropriate position when patient extends the arms 90 degrees or 45 degrees	8.46E-05
62) sitting therapist places affected arm in 90 degrees of forward flexion patient must hold the affected arm in position for 2 seconds with some shoulder external rotation and forearm supination no excessive shoulder elevation or pronation	8.47E-05
63) lower extremity volitional movement mixing synergies in supine position with knee 10 cm from the edge of the chair or bed	8.49E-05
64) hip external rotation moment max	8.54E-05

Items	Silhouette score (distance to cluster center)
65) starting position with fingers 4 and 5 slightly spread out spread index and middle finger simultaneously sliding on the table	9.80E-05
66) lower extremity volitional movement within synergies in supine position	0.00010057
67) start position elbow as straight as possible forearm neutral all fingers are done at once movement extend the patient s fingers from maximum possible flexion to maximum possible extension	0.00010224
68) standing tap ground lightly five times with unaffected foot without retraction of pelvis or hyperextension of knee weight must stay on leg this again tests knee and hip control while weight bearing through the affected leg but is more difficult than in 6	0.00010496
69) hip adduction moment max	0.00010612
70) hip flection moment max	0.00010769
71) lying hold extended arm in elevation some external rotation for at least 2 sec therapist should place arm in position and patient must maintain position with some external rotation do not allow pronation elbow must be held within 30 degrees of full extension	0.00011015
72) wrist flex with shoulder in misposition	0.00011017
73) supination and pronation on to palm of unaffected hand 20 times in 10 sec arms must be away from body the palm and dorsum of hand must touch palm of good hand each tap counts	0.00011082
74) forearm pronation from misposition shoulder	0.00011314
75) opposes thumb to index fingertip to tip	0.00011417
76) continuous opposition of thumb and each finger more than 14 times in 10 sec must do movement in consistent sequence do not allow thumb to slide from one finger to the other	0.00011439
77) start position prone so that the ankle falls beyond end of the plinth hip in neutral rotation movement extend the patient s knee from maximum possible flexion to maximum possible extension	0.00011499
78) extends knee in sitting	0.00011517
79) standing step unaffected leg on and off block without retraction of pelvis or hyperextension of knee this tests knee and hip control while weight bearing through the affected leg	0.00012058
80) start position elbow as straight as possible forearm pronated movement extend the patient s wrist from maximum possible flexion to maximum possible extension affected part s rigid in flexion or extension	0.00012392
81) supine therapist places affected arm in above position the patient must maintain the position for 2 seconds with some external rotation and with the elbow in at least 20 degrees of full extension	0.00012393
82) stretch arm forward pick up tennis ball from table release on affected side return to table then release again on table repeat five times shoulder must be protracted elbow extended and wrist neutral or extended during each phase	0.00012457
83) lying dorsiflex affected ankle with leg flexed physiotherapist may hold affected leg in position knee at 90 degrees do not allow inversion must have half range of movement of unaffected foot	0.0001282
84) continuous opposition of thumb to each finger 14 times in 10 seconds each finger in turn taps the thumb, starting with the index finger do not allow thumb to slide from one finger to the other or go backwards	0.00013205
85) wrist circumduction shoulder in misposition	0.00013569
86) volitional movement mixing synergies	0.00013638
87) shoulder abduction moving the flexed elbow from off the chest	0.00013835
88) protracts scapula in supine	0.00014256

Items	Silhouette score (distance to cluster center)
89) dynamic item which assess the ability to move head or arm in a supine or sitting position or to move from a position to another	0.00014987
90) marble 2nd finger and thumb	0.00015951
91) forearm supination from misposition shoulder	0.00015976
92) marble 3rd finger and thumb	0.00016265
93) do not allow hyperextension of the fingers measure distance vertically from hand palm to table	0.00019313
94) i move my hands or fingers with some limitation or difficulty	0.00051175
95) opposition to digit 4 pad pinch	0.00080545
96) opposition to digit 3 pad pinch	0.00080551
97) opposition to digit 5 tip pinch	0.00080888
98) opposition to digit 2 pad pinch	0.00080987
99) opposition to digit 4 tip pinch	0.00081022
100) pinch grip with starting position with abduction of thumb	0.00081239
101) full isolated movement with no decrease in strength	NA
102) in the past week how would you rate the strength of your foot ankle that was most affected by your stroke	NA
103) leg falls to bed immediately	NA
104) leg drifts to bed within 5 seconds but not immediately	NA
105) opens hand from fully closed position	NA
106) hypertonic all of the time	NA
107) lower extremity passive joint motion in supine position compare with the unaffected side	NA
108) flaccid limp no resistance when body parts are handled	NA
109) lower extremity normal reflex activity in supine position	NA
110) ask the patient to show teeth or raise eyebrows and close eyes	NA

5. Self-Care bank of items

Items	Silhouette score (distance to cluster center)
1) i need assistance in blowing my nose	2.80E-06
2) did you need help taking a bath or shower	3.68E-06
3) bathing discharge independently	3.85E-06
4) wash your back	3.90E-06
5) i need assistance in using equipment for urinating condom catheter	3.96E-06
6) wash or blow dry your hair with no difficulty	3.98E-06
7) i need assistance while taking bath	4.66E-06
8) grooming your hair	5.16E-06
9) dressing upper body	6.07E-06
10) i need assistance in taking a bath or shower	6.11E-06
11) in your present state of health, how much difficulty do you have washing yourself without assistance	6.88E-06
12) tub shower admission independently and safely	7.40E-06
13) did you need help getting dressed for example putting on socks or shoes buttoning buttons or zipping	7.59E-06
14) combing one's hair	7.67E-06
15) can you squeeze a new tube of toothpaste	7.71E-06
16) monitor blood pressure	7.90E-06
17) did you have trouble zipping a zipper no help needed no trouble	8.50E-06
18) i am satisfied with cleaning and cutting your fingernails and toenails	8.57E-06
19) in the past 2 weeks how difficult was it to bathe yourself	8.83E-06
20) dressing or undressing with no rest or needed break	8.91E-06
21) independent on and off dressing	9.35E-06
22) using the toilet in your home including transfer	9.40E-06
23) is your capacity to wash yourself without assistance more or less than what you actually do in your present surroundings	9.88E-06
24) bladder management follow up independently and safely	1.00E-05
25) are you able to take a tub bath	1.03E-05
26) i may not take quite as much care	1.07E-05
27) i am satisfied in maintaining the material required for urinating and bowel elimination	1.08E-05
28) did you have trouble putting on socks no help needed no trouble	1.11E-05
29) typing or lacing shoes	1.13E-05
30) toileting follow up independently and safely	1.14E-05
31) bathing follow up independently and safely	1.14E-05
32) dry back with towel	1.18E-05
33) clean a pair of eyeglasses	1.19E-05
34) how many hours in a typical 24-hour day do you have someone with you to provide physical assistance for personal care activities such as eating bathing dressing toileting and mobility	1.22E-05
35) i am satisfied in combing and styling your hair	1.22E-05
36) can you get in and out of a shower or bath unsupervised and wash yourself	1.26E-05
37) in the past 2 weeks how difficult was it to control your bladder not have an accident	1.28E-05
38) how many hours in a typical 24 hour day do you have someone with you to provide physical assistance for personal care activities	1.29E-05

Items	Silhouette score (distance to cluster center)
39) how difficult are the following activities squeezing toothpaste on a toothbrush	1.39E-05
40) in the past 2 weeks how difficult was it to clip your toenails	1.42E-05
41) i need assistance in changing clothes when they are soiled or dirty	1.47E-05
42) put toothpaste on toothbrush	1.58E-05
43) putting on your shoes or socks	1.58E-05
44) putting in shoes stocking or socks with nor rest or break	1.59E-05
45) i have accomplished looking after minor discomfort and light injuries band aids over the counter medicine	1.64E-05
46) toilet discharge independently and safely	1.67E-05
47) are you able to dress yourself including shoelaces and buttons	1.69E-05
48) ability to dressing	1.73E-05
49) conducting personal care	1.76E-05
50) i am comfortable with how myself care needs dressing feeding toileting bathing are met	1.83E-05
51) put on your shoes	1.84E-05
52) are you able to shampoo your hair	1.90E-05
53) zip up the zipper	1.95E-05
54) in the past 2 weeks how difficult was it to control your bowels not have an accident	2.00E-05
55) i need assistance in renewing prescriptions	2.07E-05
56) i don't take as much care as i should	2.17E-05
57) in the last 3 months how often have you undertaken washing up after meals	2.17E-05
58) i take just as much care as ever	2.19E-05
59) dressing lower body	2.20E-05
60) take off your shoes	2.23E-05
61) incontinent or catheterized and unable to manage alone	2.43E-05
62) i am satisfied in choosing appropriate clothing according to the weather type of activity	2.48E-05
63) put on your socks	2.52E-05
64) i need assistance in undressing to use the toilet and re dressing	2.55E-05
65) during a typical day does your health now limit you in these activities if so how much bathing or dressing yourself	2.69E-05
66) put on tub grip stocking on the other hand	2.74E-05
67) i have trouble getting shoes socks or stocking on	2.90E-05
68) is anyone helping you more now with your personal care activities	2.92E-05
69) dressing and undressing the upper half of your body	2.96E-05
70) in the past 2 weeks how difficult was it to dress the top part of your body	3.08E-05
71) since your stroke how much difficulty do you have dressing yourself fully	3.32E-05
72) i need assistance in dressing and undressing the lower half of your body	3.65E-05
73) wash your hands	3.78E-05
74) i have problems washing or dressing myself	3.81E-05
75) how much help or assistance from other people do you need with bathing or showering	4.02E-05
76) i am satisfied brushing your teeth	4.36E-05
77) ability to grooming	6.07E-05
78) i need assistance in washing and drying the lower half of your body	6.59E-05
79) in your own home, how much of a problem do you actually have washing yourself	6.64E-05
80) in the last 3 months how often have you undertaken washing clothes	9.49E-05
81) are you able to wash and dry your body	9.98E-05

Items	Silhouette score (distance to cluster center)
82) i need assistance in washing and drying the upper half of your body	0.00012201
83) ability to feeding	0.00018827
84) did you manage to feed yourself on your own with difficulty	0.00027274
85) dressing upper body discharge independently and safely	NA
86) eat half a sandwich or finger food	NA
87) i am satisfied using equipment for eliminating the contents of the bowel	NA
88) i need assistance in eating with utensils or hands	NA
89) dressing lower body discharge independently and safely	NA
90) i need assistance to putting on and taking off orthoses and prostheses	NA
91) getting into or out of bath	NA
92) grooming follow up independently and safely	NA
93) i need assistance in shaving	NA
94) how much help or assistance from other people do you need with preparing something to eat or drink	NA
95) bowel management discharge independently and safely	NA
96) i am satisfied using feminine hygiene products	NA
97) i am satisfied taking prescribed medicine including following dosage and administrating instructions	NA
98) i am unable to wash or dress myself	NA
99) i am satisfied conforming to table manners according to the context eating tidily using proper etiquette	NA
100) i get dressed only with someone help	NA
101) eating follow up independently and safely	NA
102) did you need help eating for example cutting food or preparing food	NA
103) i find it hard to get dressed by myself	NA
104) how much help or assistance from other people do you need with facial care	NA
105) going to the hairdresser barber	NA
106) going to the doctor dentist	NA
107) ability to wheelchair management	NA
108) put on a jumper	NA

6. Social Life and Relationship bank of items

Items	Silhouette score (distance to cluster center)
1) conducting personal business	3.33E-06
2) who usually plans social arrangements such as get together s with family and friends	5.46E-06
3) how often do you meet see or spend some time with your partner spouse	5.70E-06
4) spending time with family friends	9.03E-06
5) my physical condition interfered with my social life	9.74E-06
6) with whom do you spend time	9.83E-06
7) my physical condition interfered with my personal life	9.84E-06
8) looks toward people approaching	9.85E-06
9) social interaction admission	9.97E-06
10) how often do you meet see or spend some time your father	1.15E-05
11) how often do you meet see or spend some time your closest friend	1.15E-05
12) social life such as going out seeing friends going to the movies	1.16E-05
13) i participate in social activities with family friends and or business acquaintances as is necessary or desirable to me	1.22E-05
14) how many times a month you now usually participate in visiting friends or relatives	1.32E-05
15) initiates communication with others	1.32E-05
16) going on outings	1.34E-05
17) dating companion seeking	1.35E-05
18) home life such as relationship with other people in your home	1.37E-05
19) how often do you meet see or spend some time a colleague of yours	1.42E-05
20) how often do you meet see or spend some time other relatives of yours	1.43E-05
21) how often do you meet see or spend some time a new acquaintance	1.44E-05
22) how often do you meet see or spend some time your sister or brother	1.47E-05
23) being with your spouse partner	1.62E-05
24) how often do you spend your time going out to visit or meet people	1.68E-05
25) in general i am comfortable with myself when i am in the company of others	1.71E-05
26) social contact with friends work associates and other people who are not family significant others or professionals	1.75E-05
27) during the past 4 weeks how much of the time have you been limited in your social activities	1.83E-05
28) expressing your needs outside the home or with people other than close family members	1.89E-05
29) in your community, how much of a problem do you actually have participating in community gatherings festivals or other local events	1.89E-05
30) how often do you visit family or friends	1.92E-05
31) expressing your needs at home or with close family members	1.95E-05
32) how often do you go to pubs	2.03E-05
33) how often do you meet see or spend some time another long standing friend	2.16E-05
34) is your capacity to participate in community events, without assistance more or less than what you actually do in your present surroundings	2.24E-05
35) since your stroke how often do you visit friends others	2.31E-05
36) in your present state of health how much difficulty do you have participating in community gatherings festivals or other local events without assistance	2.36E-05
37) how often do you meet see or spend some time your mother once a day	2.37E-05
38) how often do you meet see or spend some time your own children	2.56E-05
39) have your relative s relationships with other people outside family changed because of the injury	2.65E-05

Items	Silhouette score (distance to cluster center)
40) how often do you go to parties	2.69E-05
41) did you go out socially	2.92E-05
42) do you have a best friend with whom you confide	2.93E-05
43) i attend a social community group	2.93E-05
44) have your relative s relationships with other family members changed because of the injury	3.24E-05
45) how many friends non relatives contacted outside business or organizational settings do you visit phone or write to at least once a month	3.25E-05
46) in your present situation how much of a problem do you actually have making friends	3.33E-05
47) how often do you spend your time going out to a restaurant or pub	3.41E-05
48) how many business or organizational associates do you visit phone or write to at least once a month	3.52E-05
49) do you live with a spouse or significant others	3.97E-05
50) going for drinks at pubs social clubs	3.98E-05
51) have your relative's social skills and behavior in public changed because of the injury	4.01E-05
52) how many friends do you visit phone or write to at least once a month	4.19E-05
53) has there been family or friendship disruption due to psychological problems	4.20E-05
54) with how many strangers have you initiated a conversation in the last month	4.20E-05
55) if you don't live with a spouse or significant other are you involved in a romantic relationship	4.35E-05
56) is your capacity to make friends without assistance more or less than what you actually do in your present surroundings	4.47E-05
57) since your stroke how would you describe the amount of communication between you and your friends associates	4.68E-05
58) how many children do you live with	4.74E-05
59) does your relative have a partner or spouse and did they have one at the time of the injury	5.12E-05
60) visiting family friends who are ill	5.42E-05
61) how many other relatives do you live with	5.68E-05
62) how many people do you live with	5.74E-05
63) i go to places on my own as long as they are familiar	5.75E-05
64) how many attendants do you live with	5.75E-05
65) have your relative's personal habits changed because of the injury	5.77E-05
66) of the people you live with how many are relatives	5.95E-05
67) during the past 4 weeks how much of the time has your physical health or emotional problems interfered with your social activities like visiting with friends relatives	6.05E-05
68) how many roommates do you live with	6.13E-05
69) with how many strangers have you initiated a conversation in the last month for example to ask information or place an order	7.49E-05
70) how often do you spend your time going out to parties or dancing	7.66E-05
71) in your present state of health, how much difficulty do you have making new friends without assistance	7.74E-05
72) do you live alone	7.78E-05
73) in general i am comfortable with my personal relationships	8.21E-05
74) i go to parties	8.38E-05
75) how many relatives not in your household do you visit phone or write to at least once a month	8.45E-05

Items	Silhouette score (distance to cluster center)
76) has your relative s living situation changed due to the injury	9.61E-05
77) being on a committee	9.62E-05
78) i did not see as many of my friends as i would like	9.85E-05
79) during the past 4 weeks how much of the time have you been limited in your role as a family member and or friend	0.00010209
80) how often do you spend your time socializing with people family at home	0.00010626
81) how often did you engage in volunteer activities	0.0001094
82) does you problem significantly restrict your participation in social activities	0.0001102
83) emotional problems interfered with your normal social activities with family friends neighbors or groups	0.00011844
84) how often do you attend at day centers and club	0.00011987
85) research family local history	0.00012131
86) is this problem made worse, or better, by the way your community is arranged or the specially adapted tools, vehicles or whatever you use	0.00013225
87) i move around my community as i feel necessary	0.00014145
88) since your stroke how satisfied are you with the level of interests and activities you share with your friends associates	0.00014296
89) i attend celebrations ceremonies	0.00018328
90) how many hours per week do you spend in ongoing volunteer work for an organization	0.00018363
91) i am doing fewer social activities with groups of people	0.00019518
92) i do voting	NA
93) has your problem placed stress on your relationship with members of your family or friends	NA
94) i am finding it hard to get along with people	NA
95) is this problem making friends made worse, or better, by anything or anyone in your surroundings	NA
96) i am finding it hard to make contact with people	NA
97) during the past 4 weeks how much of the time have you been limited in your participation in spiritual or religious activities	NA
98) how much change is there in his or her ability to form and maintain such a relationship compared to before	NA
99) family significant relationships interactions with close others describe stress within the family or those closest to the person with brain injury family functioning means cooperating to accomplish those tasks that need to be done to keep the household running	NA
100) i am left alone without anyone checking on me	NA
101) in the last 3 months how often have you undertaken social occasions	NA
102) how often do you eat out	NA
103) do you prefer to avoid social gatherings	NA

7. Cognition bank of items

Items	Silhouette score (distance to cluster center)
1) patient does not perform any command	1.47E-06
2) fails to return to a task after an interruption unless prompted to do so	2.02E-06
3) fails to notice situations affecting current performance	2.17E-06
4) how much of the time is someone with you to help you with remembering, decision making or judgment when you go away from your home	2.35E-06
5) how often do you have problems understanding what other people are saying	2.52E-06
6) forgetfulness cannot remember things	2.64E-06
7) difficulty remembering information about self and family from years ago	2.75E-06
8) attention concentration problems ignoring distractions shifting attention keeping more than one thing in mind at a time	3.08E-06
9) i have difficulty doing activities involving concentration and thinking	3.08E-06
10) patient is unable to complete higher level tasks	3.17E-06
11) novel problem solving problems thinking up solutions or picking the best solution to new problems	3.30E-06
12) patient is asked to describe what is happening in the attached picture to name the items on the attached naming sheet and to read from the attached list of sentences	3.40E-06
13) trouble concentration on things, such as reading the newspaper or watching television	3.82E-06
14) i had trouble remembering things	3.87E-06
15) how often do you have difficulty remembering important things that you must do	3.89E-06
16) tends not to initiate tasks which are within his/her capabilities	4.10E-06
17) i cannot make decisions at all anymore	4.22E-06
18) patient responds specifically and inconsistently with delays to stimuli, but may follow simple commands for motor action	4.46E-06
19) patient is unable to complete an association reaction	4.53E-06
20) taking longer to think	4.73E-06
21) i had trouble keeping my mind on what i was doing	4.96E-06
22) patient gives context appropriate, goal-directed responses, dependent upon external input for direction and there is carry over for relearned, but not for new tasks, and recent memory problems persist	5.01E-06
23) in the past week how difficult was it for you to remember things that happened the day before	5.06E-06
24) in the past week how difficult was it for you to remember things that people just told you	5.16E-06
25) patient gives random fragmented and no purposeful responses to complex or unstructured stimuli and simple commands are followed consistently memory and selective attention are impaired and new information is not retained	5.18E-06
26) patient oriented and responds to the environment but abstract reasoning abilities are decreased relative to premorbid levels	5.41E-06
27) requires standby guarding of one person because of poor judgment questionable cardiac status or the need for verbal cuing to complete the task	5.94E-06
28) stops performing a task when given something else to do or to think about	6.47E-06
29) do you have trouble concentrating	6.51E-06
30) performs better on tasks when directions are given slowly	6.62E-06
31) in the past week how difficult was it to say the name of someone who was in front of you	7.04E-06
32) patient heaves appropriately in familiar settings, performs daily routines automatically and shows carry over for new learning at lower than normal rates and	7.33E-06

Items	Silhouette score (distance to cluster center)
patient initiates social interactions but judgment remains impaired	
33) patient does not respond to external stimuli and appears asleep	7.86E-06
34) in the past week how difficult was it for you to remember to do things e g keep scheduled appointments or take medication	8.42E-06
35) i could not focus on the important things	9.20E-06
36) how much of the time is someone with you to help you with remembering decision making or judgment when you go away from your home	9.42E-06
37) I need assistance in carrying out activities that require attention or concentration checkers memory tasks crossword puzzles	9.74E-06
38) in the past week how difficult was it to call another person on the telephone including selecting the correct phone number and dialing	9.84E-06
39) someone is always with me to help with remembering decision making or judgment when i go anywhere	1.07E-05
40) organizing what you want to say	1.18E-05
41) slow thinking difficulty getting organized cannot finish things	1.23E-05
42) writing notes to yourself such as appointments or to do lists	1.27E-05
43) patient exhibits bizarre, no purposeful incoherent or inappropriate behaviors has no short term recall attention is short and non selective	1.35E-05
44) how much help or assistance from other people do you need with managing appointments	1.36E-05
45) I am satisfied in planning food purchases grocery list	1.37E-05
46) in the past week how difficult was it for you to remember to do things such as keep scheduled appointments or take medication	1.43E-05
47) visuospatial abilities problems drawing assembling things route finding being visually aware on both the left and right sides	1.64E-05
48) in the past week how difficult was it for you to remember the day of the week	1.82E-05
49) who takes responsibility for instructing and directing your attendants or caregivers	1.91E-05
50) attends to nearby conversations rather than the current task or conversation	2.30E-05
51) memory problems learning and recalling new information	2.50E-05
52) patient able to tell you who he is and where he is and why he is there	3.39E-05
53) it was hard for me to concentrate	NA
54) i cross intersections but it takes me longer	NA
55) i cross intersections but with some difficulty	NA
56) impaired self awareness lack of recognition of personal limitations and disabilities and how they interfere with everyday activities and work or school	NA
57) did you cross roads on your own with difficulty	NA
58) how much help or assistance from other people do you need with structuring your activities for the day	NA
59) is it difficult for you to concentrate	NA
60) in the past week how difficult was it for you to concentrate	NA
61) perseveres on previous topics of conversation or previous actions	NA
62) how much help or assistance from other people do you need with knowing the date and time of the week	NA
63) in the past week how difficult was it to reply to questions	NA
64) in the past week how difficult was it for you to solve everyday problems	NA
65) i make decisions about as well as i ever could	NA
66) keeping a diary calendar of events	NA
67) in the past week how difficult was it to understand what was being said to you in a conversation	NA
68) i put off making decisions more than i used to	NA

Items	Silhouette score (distance to cluster center)
69) how often do you have problems with finding particular words or names	NA
70) severe word finding difficulties conversation is difficult	NA
71) slight word finding difficulty conversation is possible	NA
72) persists at a task or conversation for several minutes without stopping or drifting off	NA
73) in the past week how difficult was it to correctly name objects	NA
74) poor concentration, cannot pay attention easily distracted	NA
75) did you have trouble finding the word you wanted to say no	NA
76) initiation problems getting started on activities without prompting	NA
77) i am confused and start several actions at a time	NA
78) is it easy for you to make decisions	NA
79) how often do you feel confused by things going on around you	NA
80) i have greater difficulty in making decisions more than i used to	NA
81) i had to write things down to remember them	NA
82) difficulty making decisions	NA
83) orientation of time place and person	NA
84) in the past week how difficult was it for you to think quickly	NA
85) has no difficulty stopping one task or step in order to begin the next one	NA
86) time 1 minute maximum place design eraser and pencil in front of the person say copy this design please allow multiple tries	NA
87) draw a vertical line on a piece of paper have the patient draw horizontal lines to touch the vertical line the goal is 10 lines in 20 seconds with at least 5 lines stopping at the vertical	NA
88) draw 3 circles in between the printed circles, without touching the edges of the printed or any circle already drawn circles	NA
89) persists with an activity or response after being told to stop	NA
90) time 20 seconds say i am going to name three objects when i am finished i want you to repeat them remember what they are because i am going to ask you to name them again in a few minutes	NA
91) time 30 seconds spell the word world say now spell it backwards please unable to spell	NA
92) time 30 seconds hand the person a pencil and paper page 3 say write any complete sentence on that piece of paper	NA

8. Walking bank of items

Items	Silhouette score (distance to cluster center)
1) i almost always walk outside with an aid for example a walking stick a crutch a wheeled walker or a walking frame	8.44E-06
2) i need to use an assistive device to walk and i am able to walk 8 meter in 20 second or less	1.31E-05
3) walk forward and without stopping bend to pick up the bean bag and then continue walking down the line	1.91E-05
4) i walk at home but in a different way such as i limp waddle stumble or walk with a stiff leg	2.10E-05
5) i do walk outside but in a different way e g i limp waddle stumble or walk with a stiff leg	2.19E-05
6) i can walk about only indoors	2.20E-05
7) i have abnormal gait that noticed by family and friends but i am able to walk 8 meter in 10 second or less	2.20E-05
8) i use cane while walking	2.33E-05
9) walks up and down 4 steps with or without a device but without holding on to a rail 3 times in 35 seconds	2.44E-05
10) does walking down the aisle of a supermarket increase your problem	2.62E-05
11) walks 6 m in less than 5.5 seconds with no assistive devices	3.01E-05
12) walk with pivot turns	3.12E-05
13) forward to backward walking	3.22E-05
14) walk down the stairs and try not to use the railing	3.30E-05
15) i walk more slowly	3.35E-05
16) takes 3 steps backwards	3.83E-05
17) i need help to walk about outside such as a walking aid or someone to support me	4.32E-05
18) walks 10 feet or 3 meters without assistance but with an assistive device	4.49E-05
19) i use two canes while walking	4.51E-05
20) walks 6 m with no assistive devices	4.52E-05
21) walk at your usual pace to the end of the line carrying the grocery bags and i will tell you when to look at the circle. keep looking at it while you walk past it i will then tell you when to look straight ahead again try not to veer off course while you walk	4.66E-05
22) walks 16 feet or 5 meters without a device or assistance in 15 seconds	5.26E-05
23) i do walk outside but more slowly	5.57E-05
24) i do walk outside but for shorter periods	5.62E-05
25) i walk in one room but not in all rooms such as i only walk in the living room or in the bedroom	5.86E-05
26) five meter walk on a carpeted surface	5.95E-05
27) i get around only by using a walker crutches cane walls or furniture	5.95E-05
28) i walk at home but more slowly	6.24E-05
29) i do walk outside but shorter distances	6.39E-05
30) i walk at home but shorter distances	6.39E-05
31) i walk at home but i almost always hold on to something e g a table a piece of furniture or the wall	6.47E-05
32) walks 33 feet or 10 meters without assistance or a device. is able to pick up a small object from the floor with either hand and walk back in 25 seconds	6.57E-05
33) ambulates only in parallel bars	6.64E-05
34) gait with narrow base of support	6.65E-05
35) walks 10 meters indoors	6.83E-05

Items	Silhouette score (distance to cluster center)
36) walks 20 meters with no assistive devices	6.83E-05
37) i do walk outside but i stand still for a moment more often	6.84E-05
38) five meter walk on a hard floor	6.92E-05
39) i do walk outside but less frequently	7.00E-05
40) i use solid walker	7.03E-05
41) unable to ambulate	7.09E-05
42) i walk at home but i stand still for a moment more often	7.21E-05
43) i walk at home but for shorter periods	7.57E-05
44) can you walk 10 meters inside with no caliper splint or aid and no standby help	7.77E-05
45) walking between rooms	7.94E-05
46) i walk at home but less frequently	8.15E-05
47) walk at your usual pace to the end of the line i will tell you when to look at the circle and keep looking at it while you walk past it and i will then tell you when to look straight ahead again try not to veer off course while you walk	8.24E-05
48) walks with the assistance of one person	8.66E-05
49) walk forwards to the halfway mark turn around and continue to walk backwards until i say stop try not to veer off course and walk as quickly as you can yet at a speed that you feel safe	8.73E-05
50) fully ambulatory but with moderate disability	9.01E-05
51) ambulatory without aid for about 100 meters	9.68E-05
52) requires manual contact of one person during ambulation on level surfaces	9.89E-05
53) change in gait speed	9.97E-05
54) walking 1 block on level ground nonstop	0.000103207
55) can you walk 10 meters with an aid if necessary but with no standby help	0.000103524
56) ambulation is independent on unlevel and level surface	0.000103829
57) walking a mile	0.000104128
58) takes 3 steps sideways to affected side	0.000104603
59) able to complete four steps without assistance but with supervision	0.000107346
60) does walking down a sidewalk increase your problem	0.000108677
61) walking 2 miles	0.000109987
62) able to ambulate for 10 steps heel to toe with no staggering	0.000110244
63) i use 4 wheeled walker	0.000110374
64) fully ambulatory without aid self sufficient up and about some 12 hours a day despite relatively severe disability consisting of one fs grade 4 others 0 or 1 or combination of lesser grades exceeding limits of previous steps able to walk without aid or rest some 500 meters	0.000110717
65) walking 3 miles or golf 18 holes	0.000111184
66) i use2 wheeled walker while walking	0.000112856
67) walking 2 blocks on level ground nonstop	0.000115143
68) moderately severe disability unable to walk without assistance and unable to attend to own bodily needs without assistance	0.000117327
69) walking half a block on level ground nonstop	0.000117738
70) ambulation with aids	0.000120564
71) ambulate in independent on level surfaces	0.000122898
72) walking 6 blocks on level ground nonstop	0.000123626
73) places affected foot onto first step	0.000129084
74) is able to walk around cones safely without changing gait speed	0.000130903
75) fully ambulatory without aid up and about much of the day able to work a full day may otherwise have some limitation of full activity or require minimal assistance characterized by relatively severe disability	0.00013561

Items	Silhouette score (distance to cluster center)
76) able to complete fewer than 2 steps	0.000137146
77) walk 10 m indoors without an aid no stand by help no caliper splint or walking aid	0.000143262
78) ambulation occurs on level surfaces without manual contact of another person	0.000197908
79) able to step over 2 stacked shoe boxes taped together without changing gait speed	0.000208043
80) patient can walk with physical assistance of one or more persons	0.000208198
81) does your health now limit you in these activities if so how much walking more than a mile	0.000212851
82) during a typical day does your health now limit you in these activities if so how much walking several blocks	0.000217067
83) walk over obstacle	0.000227685
84) i do not walk up or down hills	0.00023838
85) are you able to walk outdoors on flat ground	0.000261537
86) in your present state of health, how much difficulty do you have walking long distances such as a kilometer or more without assistance	0.000265164
87) during a typical day does your health now limit you in these activities if so how much walking one block	0.000265869
88) is able to step over the box without changing gait speed	0.000268066
89) do you walk around outside alone on pavements	0.000289903
90) i have slight problems in walking	0.000296452
91) able to smoothly change walking speed without loss of balance or gait deviation	0.000306327
92) is it difficult for you to go for a walk by yourself	0.000374483
93) in your present surroundings, how much of a problem do you actually have in walking long distances such as a kilometer or more	0.000403075
94) number of cadence	NA
95) i walk around my living quarters as i feel necessary	NA
96) i walk at home but i walk insecurely	NA
97) how much help or assistance from other people do you need with moving from room to room	NA
98) i do walk outside but i walk insecurely	NA
99) since your stroke how much difficulty do you have moving around all areas of the home	NA
100) walk up and down four steps patient may use an aid if he would normally use one but may not hold on to rail this is included to test ability to negotiate curb or stairs without a rail	NA
101) are you unable to get from place to place within your immediate environment	NA
102) i need to use bilateral support like walker and walks 8 meter in 20 seconds or less or requires unilateral support but needs more than 20 seconds to walk 8 meters	NA

9. Postural Transition bank of items

Items	Silhouette score (distance to cluster center)
1) moving lying to sitting	9.99E-06
2) moves from lying supine to sitting with feet on the floor	1.12E-05
3) side lying to sitting on side of the bed through the weak side	1.28E-05
4) moving in a sitting position from bed to a chair and back to bed moving to the right	1.54E-05
5) side lying to sitting on side of the bed through strong side	1.56E-05
6) moving in a sitting position from bed to a chair and back to bed moving to the left	1.81E-05
7) sitting up on the left hand side of the bed	2.06E-05
8) supine to sitting up on the edge of the table	2.07E-05
9) it takes me longer to sit down on a low chair or sofa such as an easy chair or a deep sofa	2.23E-05
10) placing alternate foot on stool	2.43E-05
11) supine to side lying on weak side	2.44E-05
12) sit up from lying down	2.64E-05
13) sitting on the edge of the table to supine	2.94E-05
14) side lying to long sitting through strong side	3.04E-05
15) sitting up on the right hand side of the bed	3.23E-05
16) supine to affected side lateral	3.32E-05
17) supine to sitting over side of bed	3.44E-05
18) it takes me longer to sit down on a raised chair such as a dining chair a kitchen chair or an office chair	3.50E-05
19) supine to side lying on strong side	3.60E-05
20) i can perform lying to sitting on side of bed using any method	3.84E-05
21) supine to side lying onto intact side	4.05E-05
22) supine to non affected side lateral	4.47E-05
23) sitting with the back to the wall leaning left	4.50E-05
24) get to sitting position from supine lying in bed	4.62E-05
25) roll in bed from supine to lying to affected side	5.55E-05
26) turning onto left side when supine	5.56E-05
27) raises hips off bed in crook lying	5.65E-05
28) in the past 2 weeks how difficult was it to move from a bed to a chair	5.78E-05
29) rolling over in bed	5.80E-05
30) rolling to weak side	5.90E-05
31) turning onto right side when supine	5.91E-05
32) transfer from wheelchair to chair towards affected side may use hands	6.07E-05
33) does turning over in bed increase your problem	6.30E-05
34) sitting with unaffected side near the wall and leaning forward	7.17E-05
35) sitting with the back to the wall and leaning right	7.20E-05
36) transfer to and from bed towards strong side	7.38E-05
37) i always use my arms when i sit down on a low chair or sofa such as i hold on to a table i lean on the armrests or i lean on the seat	7.69E-05
38) roll in bed from supine to lying to unaffected side	7.74E-05
39) transfer to and from bed towards weak side	7.86E-05
40) horizontal transfer from chair or wheelchair to bed	8.60E-05
41) patient assisted to the side lying position patient lifts head sideways but cannot sit up	8.66E-05
42) patient is assisted to sitting and needs support to remain sitting	9.39E-05
43) patient may be assisted to side lying and is assisted with lowering legs off bed to assume sitting	9.39E-05

Items	Silhouette score (distance to cluster center)
44) sitting to standing may not use arms feet must be flat on floor must put weight through both feet	9.93E-05
45) from lying in bed are you able to get up to sit on the edge of the bed on your own	0.00010577
46) get up from a chair with arm rests	0.00010764
47) i always use my arms when i sit down on the bed such as i hold on to something or i lean on the bed with my hands	0.00011163
48) are you able to stand up from a straight chair	0.00011356
49) patient may be assisted to side lying and is assisted to sitting but has head control throughout	0.00011841
50) i only use wheelchair to transfer independently	0.00012455
51) rolling to strong side	0.00012965
52) i get up from a raised chair with some difficulty	0.00013006
53) i get in and out of bed or chairs by grasping something for support or using a cane or walker	0.00013344
54) i am on a wheelchair and unable to transfer independently	0.00013584
55) ability to bed mobility	0.00013957
56) i can roll to affected side starting position should be lying not crook lying	0.00014046
57) it takes me longer to get up from a low chair or sofa such as an easy chair or a deep sofa	0.00014636
58) patient able to move from supine to sitting without help in 10 seconds	0.00014813
59) patient may be assisted to side-lying but is able to sit up without help	0.00014971
60) rolls onto side	0.00015519
61) patient able to move from supine to sitting without help	0.00015833
62) i get up from a low chair or sofa with some difficulty	0.00016341
63) it takes me longer to get up from a raised chair such as a dining chair a kitchen chair or an office chair	0.00016491
64) are you able to move from bed to chair and back without any help	0.00016593
65) do you have difficulty getting into or out of bed	0.00016639
66) getting in and out of chairs or bed without assistance	0.00017759
67) do you turn over from your back to your side without help	0.00018689
68) i can stand with affected hip in neutral position	0.00020142
69) place hand on top of head	0.00020739
70) sits safely with minimal use of hands	0.00020873
71) hand on top of the head	0.00021158
72) place hand behind head	0.00021338
73) touch top of head	0.00022215
74) raises hand to touch top of the head	0.00025105
75) touching the back with the palm	0.00041111
76) ability to transfer	NA
77) changing the base of support	NA
78) able to transfer safely with definite use of hands	NA
79) subject performs 3 or more transfers	NA
80) rolls to intact side in 3 seconds without use of hands	NA
81) able to transfer safely with minor use of hands	NA
82) in the past 2 weeks how difficult was it to get in and out of a car	NA
83) get out of a car includes only the movement needed to get body from sitting outside of the car once the door is open	NA
84) standing up to sitting down	NA
85) i get out of cars but i do it in a different way such as i place both feet on the ground before i stand up	NA

Items	Silhouette score (distance to cluster center)
86) i find it difficult to changing positions in bed	NA
87) rises to standing from sitting	NA
88) transfer up and down from floor and standing	NA
89) i get into cars but in a different way such as i first sit down and then i pull my legs inside	NA
90) get up from a chair with armrests no that is an activity that i normally did only with my dominant hand before the stroke and continue to do with my dominant hand now	NA

10. Recreation and Leisure Activities bank of items

Items	Silhouette score (distance to cluster center)
1) i read a book	2.02E-06
2) i do gambling	2.48E-06
3) attending a movie play church event or sports activity	2.80E-06
4) playing cards or table games	5.76E-06
5) going to watch a sports event	6.47E-06
6) in the last 6 months how often have you undertaken reading books	6.51E-06
7) i go to the cinema	8.26E-06
8) i read a magazine	8.67E-06
9) i do activities with grandchildren children	8.75E-06
10) watching films on dvd video	9.13E-06
11) having a picnic bbq	1.02E-05
12) i can enjoy a good book or radio or television program	1.16E-05
13) I need assistance in carrying out activities to ensure your psychological or mental well being yoga meditation personal growth	1.18E-05
14) i attend a hobby leisure group	1.20E-05
15) how often do you dance	1.48E-05
16) reading a newspaper	1.51E-05
17) how often do you exercise	1.60E-05
18) i go to the beach	1.62E-05
19) reading a religious book	1.73E-05
20) how often do you spend your time watching sports spectator	1.78E-05
21) playing table games	1.82E-05
22) how often do you spend your time taking part in sports	2.07E-05
23) doing puzzles crosswords	2.31E-05
24) reading books magazines or newspapers	2.46E-05
25) what did you do for fun preinjury and now	2.49E-05
26) how often do you read books	2.73E-05
27) i do fishing	2.77E-05
28) attending a night class adult education class	2.81E-05
29) how often do you read newspapers or magazines	2.95E-05
30) how often do you spend your time shopping for pleasure	3.02E-05
31) usual hobbies recreational or sporting activities	3.15E-05
32) I am satisfied in listening to the radio	3.29E-05
33) when you participate in leisure activities do you usually do this alone or with others	3.42E-05
34) recreational activities which require little effort such as card playing knitting	3.43E-05
35) leisure and recreational activities	3.52E-05
36) how often do you spend your time pursuing an active hobby	3.65E-05
37) how often do you listen to radio	3.84E-05
38) i do hiking rambling	3.87E-05
39) interests and hobbies such as sports arts and crafts	4.28E-05
40) does performing more ambitious activities like sports or dancing and household chores increase your problem	4.29E-05
41) during the past 4 weeks how much of the time have you been limited in quiet recreation crafts reading	4.31E-05
42) having a tea coffee with someone else	4.33E-05
43) how often do you shop for pleasure	4.37E-05
44) loss of interest in hobbies decreased social activities	4.59E-05

Items	Silhouette score (distance to cluster center)
45) how often do you cook for pleasure	4.77E-05
46) how often do you sport activities	5.00E-05
47) how often do you attend sport events	5.47E-05
48) how many times a month you now usually participate in leisure activities such as movies, sports, restaurants, etc.	5.52E-05
49) how often do you indoor games cards bingo or dominos	5.71E-05
50) listening to the radio music	5.75E-05
51) how many hours per week do you spend in recreational activities or going to movies	5.85E-05
52) am able to participate in recreational activities hobbies crafts sports reading television games computers etc as i want to	5.86E-05
53) recreational activities which require you to take some force or impact through your arm shoulder or hand such as golf hammering tennis	5.93E-05
54) what is the extent of restriction on their social and leisure activities	5.97E-05
55) how many hours per week do you spend in other self-improvement activities such as hobbies or leisure reading please do not include time spent watching television or listening to the radio	6.08E-05
56) does the extent of restriction in regular social and leisure activities outside home represent a change in respect or pre-trauma	6.11E-05
57) playing tennis or racquetball	6.11E-05
58) i am satisfied in participating in outdoor physical activities to maintain or improve your physical health or fitness	6.13E-05
59) has there been any change in the number or type of leisure activities or interests because of the injury	6.31E-05
60) in the last 3 months how often have you undertaken actively pursing hobby	6.33E-05
61) how often do you holidays	6.41E-05
62) recreational activities in which you move your arm freely e g playing frisbee badminton	6.56E-05
63) i need assistance in participating in outdoor physical activities to maintain or improve your physical health or fitness	6.90E-05
64) how many hours per week do you spend in recreational activities such as sports, exercise, playing cards, or going to movies please do not include time spent watching television or listening to the radio	6.92E-05
65) how often do you church activities	7.00E-05
66) has there been any change in the way your relative organizes work and leisure activities because of the injury	7.37E-05
67) are they able to resume regular social and leisure activities outside home	7.69E-05
68) going to a public library	7.97E-05
69) during the past 4 weeks how much of the time have you been limited in active recreation sports outings travel	7.99E-05
70) i did my hobbies and recreation for shorter periods of time than i would like no help needed no trouble at all	8.16E-05
71) spending your usual amount of time practicing or playing your instrument or sport	8.83E-05
72) i did not join in activities just for fun with my family no help needed no trouble at all	0.00012404
73) how often do you spend your time listening to music or radio	0.00012805
74) going to music performing arts events	0.00012932
75) i do cultural visits	0.00016552
76) going on holiday traveling	0.00021453

Items	Silhouette score (distance to cluster center)
77) going to gardens parks	0.00021896
78) how often do you spend your time going out to the theater concerts cinema	0.00033386
79) i need assistance in watching television	NA
80) how often do you watch television	NA
81) playing your instrument or sport as well as you would like	NA
82) how often do you sing	NA
83) i need assistance in carrying out relaxation activities listening to music reading	NA
84) how often do you spend your time reading	NA
85) how often do you entertain at home	NA

11. Domestic Life bank of items

Items	Silhouette score (distance to cluster center)
1) making beds changing sheets	1.39E-06
2) in the last 3 months how often have you undertaken local shopping	1.70E-06
3) in the past 2 weeks how difficult was it to do light household tasks chores such as dust make a bed take out garbage do the dishes	2.11E-06
4) who usually does shopping for groceries or other necessities in your household	2.15E-06
5) did you do a full clothes wash	2.33E-06
6) i do heavy household jobs e g wash windows clean floors	2.42E-06
7) making a bed not changing sheets	2.97E-06
8) did you have trouble doing daily work around the house	4.09E-06
9) i am satisfied in using an oven	4.28E-06
10) patient is unable to light bulb	4.74E-06
11) did you manage to make yourself a hot drink	4.91E-06
12) i can clean	4.97E-06
13) i need assistance in getting clothes out of dresser drawers	5.37E-06
14) i need assistance in preparing simple meals daily meals of meat and vegetables sandwiches	5.42E-06
15) how many times a month you now usually participate in shopping	5.66E-06
16) i am satisfied with using a dishwasher	5.75E-06
17) i need assistance in serving food	6.05E-06
18) ironing or folding clothes	6.23E-06
19) i need assistance in operating other electric kitchen appliances coffee machine food processor	6.50E-06
20) looking after home such as cleaning and cooking repairs odd jobs around the home	8.03E-06
21) i need assistance in using a stove	8.87E-06
22) i need assistance in washing and drying dishes	9.43E-06
23) in your home, who usually does normal everyday housework	1.02E-05
24) did you make yourself a hot snack on your own with difficulty	1.11E-05
25) how much help or assistance from other people do you need with doing laundry	1.13E-05
26) i need assistance in using a refrigerator including freezer	1.20E-05
27) is it difficult for you to do strenuous housework or yard work	1.28E-05
28) change a light bulb overhead	1.36E-05
29) in the last 6 months how often have you undertaken household maintained	1.44E-05
30) how many hours in a typical month do you occasionally have assistance with such things as grocery shopping, laundry, housekeeping, or infrequent medical needs because of the disability	1.47E-05
31) i need assistance in using a microwave oven	1.55E-05
32) to what extent are you able to carry out your everyday physical activities such as walking climbing stairs carrying groceries or moving a chair	1.58E-05
33) getting clothes from drawers or closets	1.59E-05
34) performing heavy activities around your home	1.60E-05
35) cooking your own meals	1.68E-05
36) are you able to do chores such as vacuuming or yard work	1.72E-05
37) i need assistance in preparing complex meals multiple courses including following a recipe	1.74E-05
38) did you do your own housework	1.79E-05
39) in the last 3 months how often have you undertaken preparing main meals	2.04E-05
40) are you able to mending repairing clothes	2.12E-05

Items	Silhouette score (distance to cluster center)
41) who usually prepares meals in your household	2.22E-05
42) doing the laundry	2.32E-05
43) i am not doing any of the house cleaning that i would usually do	2.72E-05
44) is the assistance of another person at home essential every day for some activities of daily living	2.74E-05
45) performing light activities around your home	2.74E-05
46) how many hours per week do you spend in active homemaking including parenting, housekeeping, and food preparation	3.06E-05
47) in the past 2 weeks how difficult was it to do heavy household chores such as vacuum laundry or yard work	3.87E-05
48) how many hours per week do you spend in home maintenance activities such as gardening, house repairs or home improvement	3.88E-05
49) making your bed	4.44E-05
50) in the last 6 months how often have you undertaken gardening	4.76E-05
51) since your have stroke how satisfied are you with your overall ability to perform daily activities in and around the home	4.99E-05
52) what were your normal home management responsibilities preinjury and now	5.67E-05
53) i am not doing any of the clothes washing that i would usually do	5.78E-05
54) is your capacity to clean your floor without assistance more or less than what you actually do in your present surroundings	5.84E-05
55) using tools or appliances	6.17E-05
56) in your present state of health, how much difficulty do you have cleaning the floor of your where you live, without assistance	6.65E-05
57) is this problem made worse, or better, by the way your home is set up or the specially adapted tools you use	6.90E-05
58) in the last 3 months how often have you undertaken heavy housework	7.00E-05
59) in the last 3 months how often have you undertaken light housework at least once a week	0.0001094
60) in your own home, how much of a problem do you actually have cleaning the floor	0.00014456
61) vacuuming carpets 5 min nonstop	NA
62) sweeping 5 min nonstop	NA
63) did you manage your own garden on your own with difficulty	NA
64) dusting or polishing furniture or polishing car	NA
65) how much help or assistance from other people do you need with cleaning your room house	NA
66) i have problems doing my usual activities	NA
67) how often do you garden	NA
68) in the past 2 weeks how difficult was it to go shopping	NA
69) shoveling digging or spading	NA
70) painting interior and exterior	NA
71) scrubbing door walls or cars	NA
72) performance of comparable activities is inconsistent from one day to the next	NA
73) how often do you spend your time housework	NA
74) did you do your own shopping on your own with difficulty	NA
75) i am not doing any of the maintenance or repair work that i would usually do in my home or yard	NA

12. Physical Functioning bank of items

Items	Silhouette score (distance to cluster center)
1) walking 30 yards nonstop	4.78E-07
2) swimming 25 yards	1.83E-06
3) running or jogging 3 miles	2.31E-06
4) walk outdoors 6 blocks or 900 meters	2.31E-06
5) run 10 m must be symmetrical	2.42E-06
6) standing for one hour	3.39E-06
7) making sharp turns while running fast	4.82E-06
8) in the past 2 weeks how difficult was it to walk one block	9.42E-06
9) walk outside 40 m may use walking aid caliper or splint no stand by help	9.56E-06
10) in the last 3 months how often have you undertaken walking outside for more than 15 minutes	9.68E-06
11) i have to push myself very hard to do anything	9.82E-06
12) standing < 1 min	1.13E-05
13) sitting for one hour	1.30E-05
14) in the past 2 weeks how difficult was it to walk fast	1.32E-05
15) standing < 5 min	1.33E-05
16) walk outdoors over rough ground for 150 meters	1.47E-05
17) independent but may use any aid for example stick to walk> 50 yards	1.51E-05
18) swimming 25 yards nonstop	2.26E-05
19) walks with help of one person verbal or physical > 50 yards	2.53E-05
20) could you run 10 meters in 4 seconds without limping a fast walk is acceptable	2.89E-05
21) i almost always walk longer distances outside with an aid	4.32E-05
22) using public transport or driving a car less 110 miles	4.52E-05
23) using public transport or driving a car less 99 miles	4.77E-05
24) constant bilateral assistance canes crutches braces required to walk about 20 meters without resting	5.57E-05
25) walk 10m pick up bean bag from floor turn and carry back bend down any way may use aid to walk if necessary no stand by help may use either hand to pick up bean bag	6.03E-05
26) running or jogging 2 miles	6.79E-05
27) running or jogging 0.25 mile nonstop	7.26E-05
28) how often do you drive	7.28E-05
29) walking half a block uphill nonstop	7.57E-05
30) running or jogging 2 miles in < 12 min	7.59E-05
31) in the last 3 months how often have you undertaken driving a car or going on bus	7.72E-05
32) bicycling 2 miles nonstop	7.80E-05
33) doing aerobics 5 min nonstop	7.81E-05
34) bicycling 1 mile nonstop	8.05E-05
35) climbing walking 1 mile nonstop	8.05E-05
36) running or jogging 0.5 mile nonstop	8.24E-05
37) running 110 yards or playing softball	8.28E-05
38) climbing 36 steps nonstop	8.32E-05
39) walking 2 miles nonstop	8.32E-05
40) running or jogging 2 miles in < 20 min	8.45E-05
41) running or jogging 2 miles in < 30 min	8.57E-05
42) in the last 6 months how often have you undertaken travel outing car ride	9.20E-05
43) i can drive	9.25E-05
44) did you drive a car	9.46E-05

Items	Silhouette score (distance to cluster center)
45) walk indoor for 25 meters	0.0001002
46) running on even ground	0.0001047
47) running or jogging 1 mile	0.0001054
48) intermittent or unilateral constant assistance cane crutch brace required to walk about 100 meters with or without resting usual	0.0001159
49) running with controlled stop	0.000211
50) i sit down on a low chair or sofa with some difficulty	NA
51) during a typical day does your health now limit you in these activities if so how much vigorous activities such as running lifting heavy objects participating in strenuous sports	NA
52) i sit down on a raised chair with some difficulty	NA
53) unaffected arm function starting position by sitting at a table in a wheelchair or chair	NA
54) when i sit down on a low chair or sofa i always flop down at the end	NA
55) I need major help one or two people to sit	NA
56) sit without support	NA
57) i find it hard to stand for long at the kitchen sink or waiting in a line	NA
58) i can sit at ease and feel relaxed	NA
59) riding a bicycle	NA
60) using the forearm for support while seated	NA
61) when i sit down on a raised chair i always flop down at the end	NA
62) I am satisfied participating in indoor physical activities to maintain or improve your physical health or fitness	NA
63) patient assisted to standing	NA
64) kneeling or squatting to do light work	NA
65) step over obstacles	NA
66) running on uneven ground	NA
67) run as fast as you can to the end of the track and stop abruptly with both feet on the finish line and hold this position	NA

13. Communication bank of items

Items	Silhouette score (distance to cluster center)
1) unable to write	2.98E-07
2) how much help or assistance from other people do you need with writing official letters	3.11E-07
3) I am satisfied in communicating through writing letter message	4.52E-07
4) able to transfer with verbal cueing and/or supervision	5.56E-07
5) write your name in your own handwriting between two lines	6.17E-07
6) copying of words of a sentence	7.04E-07
7) i can write	1.02E-06
8) can you write a letter with a pencil or ordinary pen	1.49E-06
9) can you write a short sentence with a pencil or ordinary pen	1.77E-06
10) writing letters or notes	1.81E-06
11) writing of dictated or visually presented words	1.86E-06
12) how much help or assistance from other people do you need with writing private letters	2.69E-06
13) reading comprehension of sentences	2.69E-06
14) did you have to repeat yourself so others could understand you	2.70E-06
15) dictated letters and numbers	2.72E-06
16) how often do you spend your time writing letters or phoning people	2.73E-06
17) write on paper	2.89E-06
18) write with pen	2.98E-06
19) spelled word recognition	3.28E-06
20) nonverbal communication restricted or unusual gestures or facial expressions talking too much or not enough missing nonverbal cues from others	3.82E-06
21) maintaining a conversation with a person at home or within the community	4.87E-06
22) how much help or assistance from other people do you need with using a diary or notebook	5.17E-06
23) I need assistance in reading newspapers magazines books letters	5.46E-06
24) did you have trouble writing or typing	8.22E-06
25) an adequate sample of speech must be obtained by asking patient to read or repeat words from the attached list	8.42E-06
26) draw lines to connect the circles in an ascending patter but with the added task of alternating between the numbers and letters	2.00E-05
27) draw lines to connect the numbers in ascending order	2.30E-05
28) did you write letters on your own with difficulty	NA
29) in the past week how difficult was it to participate in a conversation with a group of people	NA
30) how often do you have problems taking part in conversations with others	NA
31) did you read newspapers or books on your own with difficulty	NA
32) carrying on a conversation with a small group of familiar people	NA
33) talking on the telephone	NA
34) how often do you have difficulty communicating with other people	NA
35) i carry on a conversation only when very close to the other person or looking at him	NA
36) I am satisfied in receiving and understanding written information written instructions advertisements road signs	NA
37) i am satisfied maintaining a conversation with a group of people at home or within the community	NA
38) sustains conversation without interjecting irrelevant or off topic comments	NA

Items	Silhouette score (distance to cluster center)
39) in the past week how difficult was it to have a conversation on the telephone	NA
40) writing on request	NA
41) did you have trouble speaking clearly enough to use the telephone	NA
42) do you have difficulty reading	NA
43) did you have trouble speaking for example get stuck stutter stammer or slur your words	NA
44) understanding family and friends on the phone	NA
45) how often do you feel you are speaking less clearly under pressure or distress	NA
46) verbal communication problems expressing or understanding language	NA
47) did other people have trouble in understanding what you said	NA
48) receiving and understanding oral information at home or within the community	NA
49) speaking clearly enough to use the telephone	NA
50) i do not speak clearly when i am under stress	NA
51) i have difficulty speaking for example get stuck	NA
52) initiates activity whether appropriate or not without cuing	NA

14. Work/Study bank of items

Items	Silhouette score (distance to cluster center)
1) how many hours per week do you spend in school working toward a degree or in an accredited technical training program including hours in class and studying	1.45E-06
2) have the hours of work or study changed because of injury	1.66E-06
3) does your problem interfere with your job or household responsibilities	3.86E-06
4) are you currently able to work or look after others at home to their previous capacity	5.24E-06
5) is this problem fulfilling your job requirements made worse, or better, by the way the work environment is set up or the specially adapted tools you use	6.35E-06
6) in the last 6 months how often have you undertaken gainful work	6.65E-06
7) during the past month i work part time less than or equal to 20 hours per week	6.66E-06
8) how many hours per week do you spend working in a job for which you get paid	7.36E-06
9) during the past month i have been not working and not looking for work	7.53E-06
10) in your present surroundings, how much of a problem do you actually have getting done all the work you need to do for your job	7.56E-06
11) patient can compete in a limited job market for a relatively narrow range of jobs	7.58E-06
12) how many hours per week do you spend working in a job for which you get paid	7.65E-06
13) during the past month i have been not working but actively looking for work	7.67E-06
14) cannot compete successfully in a job market because of moderate or severe physical limitations	7.71E-06
15) unable to work	7.81E-06
16) in your present state of health, how much difficulty do you have getting done all the work you need to do for your job, without assistance	8.27E-06
17) did you have trouble finishing jobs that you started	8.76E-06
18) is your capacity to do your job, without assistance, more or less than what you actually do in your present surroundings	1.01E-05
19) are you currently working	1.56E-05
20) what is your current school or training program situation	0.00018294
21) have the work or study skills changed because of injury	0.00022392
22) are you currently attending school	0.00039537
23) how often do you spend your time doing unpaid or voluntary work	NA
24) during the past month i work full time more than 20 hours per week	NA
25) how often do you spend your time studying training doing courses	NA
26) how often do you volunteer work	NA
27) i spend most of my days occupied in work activity that is necessary or important to me	NA
28) other employment involved in constructive role appropriate activity other than paid employment	NA
29) during the past 4 weeks how much of the time have you been limited in your work paid voluntary or other	NA
30) how often do you spend your time doing paid work	NA

15. Climbing bank of items

Items	Silhouette score (distance to cluster center)
1) i go up stairs and almost always hold on to the handrail	3.17E-05
2) i go downstairs and almost always use an aid e g a walking stick or a crutch	3.38E-05
3) i go downstairs and am almost always helped by someone	3.45E-05
4) i go downstairs and almost always hold on to the handrail	3.57E-05
5) during a typical day does your health now limit you in these activities if so how much climbing one flight of stairs	3.58E-05
6) i do go up and down stairs but fewer flights floors	3.77E-05
7) i go up stairs and am almost always helped by someone	3.91E-05
8) i go up stairs but in a different way such as i place one foot next to the other on every step	3.96E-05
9) did you have trouble climbing stairs	4.46E-05
10) i go up stairs and almost always use an aid such as a walking stick or a crutch	4.87E-05
11) i do go up and down stairs but less frequently	7.14E-05
12) during a typical day does your health now limit you in these activities if so how much climbing several flights of stairs	6.22E-05
13) ascending and descending five stairs	7.96E-05
14) are you able to climb up and down four steps with no rail but using an aid if necessary	8.46E-05
15) did you climb stairs	8.89E-05
16) in the past 2 weeks how difficult was it to climb several flights of stairs	9.49E-05
17) in the past 2 weeks how difficult was it to climb one flight of stairs	9.56E-05
18) going up or down 10 stairs about one flight of stairs	0.000111214
19) i do go up and down stairs but i try to avoid them	0.000102584
20) are you able to climb up five steps	0.000113318
21) climb stairs independently any method may use banister and aid must be a full flight of stairs	0.0001272
22) climbing 24 steps nonstop	0.000202178
23) climbing 9 steps nonstop	0.000207798
24) climbing walking 1 mile	0.00021252
25) climbing 6 steps nonstop	0.000214668
26) climbing 50 steps nonstop	0.000219651
27) climbing 12 steps nonstop	0.000231001
28) can you manage a flight of steps alone without help	0.000264176

16. Sensory Functions bank of items

Items		Silhouette score (distance to cluster center)
1)	change in taste or smell	8.28E-05
2)	audition problems hearing ringing in the ears	8.52E-05
3)	touch small of back	8.62E-05
4)	did you have trouble seeing the television well enough to enjoy a show	8.84E-05
5)	visual problems blurring or trouble seeing	8.95E-05
6)	conjugate deviation of eyes	0.00010195
7)	light sensitivity easily upset by bright light	0.00013097
8)	does looking up increase your problem	0.00020716
9)	sensitivity to light	0.00022251
10)	dizziness feeling unsteady dizzy light headed	NA
11)	feelings of dizziness	NA
12)	i have headaches	NA
13)	numbness or tingling in parts of your body	NA
14)	tingling pins and needles in your arm shoulder or hand extreme	NA
15)	sensation or grimace to pinprick when tested or withdrawal from noxious stimulus in the abounded or aphasic patient	NA
16)	noise sensitivity, easily upset by loud noise	NA
17)	do quick movements of your head increase your problems	NA
18)	sensitivity to noise	NA
19)	vision problems seeing double vision eye brain or nerve injuries that interfere with seeing	NA
20)	did you have trouble reaching things because of poor eyesight	NA
21)	loss of insight	NA
22)	did you have trouble seeing things off to one side	NA

17. General Health bank of items

Items		Silhouette score (distance to cluster center)
1)	compared to one year ago how would you rate your health in general now	0.00033532
2)	how does this compare with someone, just like yourself only without your health condition	0.00027079
3)	i am no more worried about my health than usual	0.00033754
4)	i have lost more than 10 pounds	0.00031658
5)	i have lost more than fifteen pounds	0.00029537
6)	i have lost more than five pounds	0.00031004
7)	i lost a lot of weight without trying to	0.00030729
8)	in general would you say your health is excellent	0.00033767
9)	in most ways my life is close to my ideal	0.00031302
10)	my health is excellent	0.00031623
11)	please rate how well you are doing on a scale of 0 to 100	0.00030069
12)	the conditions of my life are excellent	0.00027383
13)	how true or false is each of the following statements for you i seem to get sick a little easier than other people	NA
14)	how true or false is each of the following statements for you i expect my health to get worse	NA
15)	during a typical day does your health now limit you in these activities if so how much bending kneeling or stooping	NA
16)	I have accomplished following therapeutic instructions diet exercise to be done at home	NA
17)	so far i have gotten the important things i want in life	NA
18)	i have not lost much weight if any lately	NA
19)	i am so worried about my physical problems that i cannot think of anything else	NA
20)	i am satisfied with my life	NA

18. Fatigue bank of items

Items	Silhouette score (distance to cluster center)
1) i am too tired to do anything	2.81E-08
2) during the last 4 weeks did you feel tired	5.00E-08
3) i get tired more easily than i used to	5.77E-08
4) everything is an effort	6.21E-08
5) fatigue or loss of energy or getting tired easily	8.08E-08
6) i get tired from doing almost anything	1.08E-07
7) do you feel full of energy	9.58E-07
8) i walk normally but sometimes i feel fatigue that interferes with athletic or other demanding activities	2.50E-06
9) i was too tired to do what i wanted to do	2.88E-06
10) during the last 4 weeks did you feel full of pep	3.05E-06
11) is your capacity to walk long distances without assistance more or less than what you actually do in your present surroundings	4.31E-06
12) during the last 4 weeks did you feel worn out	4.79E-06
13) during the last 4 weeks have you been feeling that you have a lot of energy	1.18E-05
14) i soon run out of energy	NA
15) i had to stop and rest during the day	NA
16) performance is best early in the day or after a rest	NA
17) did you have to stop and rest more than you would like when walking or using wheelchair	NA
18) evaluate the hearts recovery rate during the minute immediately following the exercise	NA
19) it takes an extra effort to get started at doing something	NA

19. Functional Independence bank of items

Items	Silhouette score (distance to cluster center)
1) significant restriction and unable to lead a total independent existence	5.34E-05
2) needs some help but can do something alone	0.0001038
3) needs help but can do about half unaided	0.000111
4) unable to live independently but does not require constant attention	0.000136
5) i need assistance in asking for help in an emergency situation neighbor police ambulance 911 health information	0.0001382
6) moderate disability requiring some help but able to walk without assistance	0.0001407
7) totally dependent and requires constant attention day and night	NA
8) was the patient independent at home before the injury	NA
9) can you enter and exit your home without any assistance from someone	NA
10) needs two people to assist or supervise to be safe	NA
11) in your home do you have independent access to your sleeping area kitchen bathroom telephone and television or radio	NA
12) since your stroke how independent are you in your ability to move around your local neighborhood	NA
13) do they need frequent help of someone to be around at home most of the time	NA
14) i need assistance using a video or sound system	NA
15) I need assistance in using a computer	NA
16) i do not need help going anywhere	NA
17) requires supervision or physical assistance from more than 1 person	NA

20. Pain bank of items

Items	Silhouette score (distance to cluster center)
1) i find it painful to change position	1.83E-06
2) i am in pain when i am sitting	2.81E-06
3) lower extremity joint pain during passive motion	3.11E-06
4) during the past 4 weeks how much did pain interfere with your normal work including both work outside the home and housework	3.58E-06
5) i am in pain when going up or down stairs	3.72E-06
6) how much pain have you had in the past week	4.04E-06
7) i have pain at night	4.13E-06
8) i am worried about physical problems like aches pains upset stomach or constipation	4.42E-06
9) pains in heart or chest	4.78E-06
10) how much bodily pain have you had during the past 4 weeks	5.73E-06
11) i have unbearable pain	6.27E-06
12) i am in pain when i am standing	6.70E-06
13) i am in pain when i walk	8.59E-06
14) i have pain or discomfort	8.94E-06
15) i am in constant pain	1.20E-05
16) during the past week how much difficulty have you had sleeping because of the pain in your arm shoulder or hand circle number	2.21E-05

21. Alcohol and Drugs Use bank of items

Items	Silhouette score (distance to cluster center)
1) dependent use of alcohol	9.46E-08
2) how many drinks containing alcohol do you have on a typical day when you are drinking	2.40E-07
3) how after do you have six or more drinks on one occasion	3.42E-07
4) alcohol use of alcoholic beverages	4.50E-07
5) how often during the last year have you failed to do what was normally expected from you because of drinking	8.12E-07
6) has a relative or friend or a doctor or another health worker been concerned about your drinking or suggesting you cut down	9.08E-07
7) how often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking sessions	1.13E-06
8) have too or someone else been injured as a result of your drinking	1.48E-06
9) how often during the last year have you had a feeling of guilt or remorse after drinking	2.08E-06
10) how often do you have a drink contain alcohol	2.35E-06
11) how often during the last year have you been unable to remember what happened the night before because you had been drinking	3.38E-06
12) drug use of illegal drugs or abuse of prescription drugs	3.61E-06
13) dependent use of psychoactive substances	7.36E-06
14) dependent use of tobacco	1.41E-05

22. Transportation bank of items

Items	Silhouette score (distance to cluster center)
1) is anyone helping you more now with transportation outside of your immediate environment	1.10E-07
2) does your transportation allow you to get to all the places you would like to go	1.80E-07
3) did you travel on public transport	2.34E-07
4) do you restrict your travel for business or pleasure	3.18E-07
5) i am able to take trips out of town as i feel are necessary	4.23E-07
6) can you use your transportation with little or no advance notice	5.13E-07
7) can you use your transportation independently	9.45E-07
8) are they able to travel locally without assistance	1.15E-06
9) has your relative's use of transport and travel around the community changed due to the injury	2.29E-06
10) how much help or assistance from other people do you need with using public transport	1.75E-05
11) how often do you travel outside the home	NA
12) manage transport needs getting from one place to another	NA
13) were they able to travel locally without assistance before the injury	NA

23. Sleeping bank of items

Items	Silhouette score (distance to cluster center)
1) i slept much more than usual	NA
2) i wake up 12 hours earlier than usual and find it hard to get back to sleep	NA
3) i sleep badly at night	NA
4) difficulty falling or staying asleep	NA
5) trouble falling or staying asleep or sleeping too much	NA
6) worry is keeping me awake at night	NA
7) my sleep was restless	NA
8) it takes me along time to get to sleep	NA
9) i take pills to help me sleep	NA
10) i slept much more than usual	NA
11) i wake up 12 hours earlier than usual and find it hard to get back to sleep	NA
12) i sleep badly at night	NA
13) difficulty falling or staying asleep	NA

24. Finances bank of items

Items	Silhouette score (distance to cluster center)
1) how much help or assistance from other people do you need with dealing with your own bank account	4.42E-07
2) who usually looks after your personal finances, such as banking or paying bills	4.68E-07
3) compared to your preinjury work are you currently earning less money at least 25 percent less or are you in a job which has less responsibility due to the injury	5.05E-07
4) managing money and finances shopping keeping a check book or other bank account managing personal income and investments if independent with small purchases but not able to manage larger personal finances or investments	5.07E-07
5) what financial resources do you have	6.99E-07
6) managing financial matters given up	8.64E-07
7) approximately how much did you pay last year for medical care expenses consider any amounts paid by yourself or the family members in your household and not reimbursed by insurance or benefits	9.57E-07
8) how much help or assistance from other people do you need with paying your household bills	1.20E-06
9) how much of your money do you control	5.11E-06
10) approximately what was the combined annual income, in the last year, of all family members in your household consider all sources including wages and earnings, disability benefits, pensions and retirement income, income from court settlements, investments and trust funds, child support and alimony, contributions from relatives, and any other source	5.97E-06
11) did you manage your own money when out	NA

References

1.   Ashford, S., et al. Evaluation of functional outcome measures for the hemiparetic upper limb: a systematic review. *Journal of Rehabilitation Medicine.* 2008;40(10):787-795.

2.   Ashford, S., S. Brown, and L. Turner-Stokes. Systematic review of patient-reported outcome measures for functional performance in the lower limb. *Journal of Rehabilitation Medicine.* 2015;47(1):9-17.

3.   Baker, K., S.J. Cano, and E.D. Playford. Outcome measurement in stroke: a scale selection strategy. *Stroke.* 2011;42(6):1787-1794.

4.   Barak, S. and P.W. Duncan. Issues in selecting outcome measures to assess functional recovery after stroke. *NeuroRx.* 2006;3(4):505-524.

5.   Connell, L.A. and S.F. Tyson. Clinical reality of measuring upper-limb ability in neurologic conditions: a systematic review. *Archives of Physical Medicine and Rehabilitation.* 2012;93(2):221-228.

6.   Croarkin, E., J. Danoff, and C. Barnes. Evidence-based rating of upper-extremity motor function tests used for people following a stroke. *Physical Therapy.* 2004;84(1):62-74.

7.   Fini, N.A., et al. How is physical activity monitored in people following stroke? *Disability and Rehabilitation.* 2015;37(19):1717-1731.

8.   Gebruers, N., et al. Monitoring of physical activity after stroke: a systematic review of accelerometry-based measures. *Archives of Physical Medicine and Rehabilitation.* 2010;91(2):288-297.

9.   Geroin, C., et al. Systematic review of outcome measures of walking training using electromechanical and robotic devices in patients with stroke. *Journal of Rehabilitation Medicine.* 2013;45(10):987-996.

10. Gor-García-Fogeda, M.D., et al. Scales to assess gross motor function in stroke patients: a systematic review. *Archives of Physical Medicine and Rehabilitation.* 2014;95(6):1174-1183.

11. Hong, I. and H.S. Bonilha. Psychometric properties of upper extremity outcome measures validated by Rasch analysis: a systematic review. *International Journal of Rehabilitation Research.* 2017;40(1):1-10.

12. Lemmens, R.J., et al. Valid and reliable instruments for arm-hand assessment at ICF activity level in persons with hemiplegia: a systematic review. *BMC Neurology.* 2012;12(1):21.

13. Martins, J.C., et al. Measurement properties of self-report physical activity assessment tools for patients with stroke: a systematic review. *Brazilian Journal of Physical Therapy.* 2019;23(6):476-490.

14.   Oczkowski, C. and M. O'Donnell. Reliability of proxy respondents for patients with stroke: a systematic review. *Journal of Stroke and Cerebrovascular Diseases.* 2010;19(5):410-416.

15.   Pearson, O.R., et al. Quantification of walking mobility in neurological disorders. *QJM.* 2004;97(8):463-475.

16.   Pollock, C., J. Eng, and S. Garland. Clinical measurement of walking balance in people post stroke: a systematic review. *Clinical Rehabilitation.* 2011;25(8):693-708.

17.   Rowland, T.J. and L. Gustafsson. Assessments of upper limb ability following stroke: a review. *British Journal of Occupational Therapy.* 2008;71(10):427-437.

18.   Salbach, N.M., et al. Considerations for the selection of time-limited walk tests poststroke: a systematic review of test protocols and measurement properties. *Journal of Neurologic Physical Therapy.* 2017;41(1): 3-17.

19.   Salter, K., et al., Issues for selection of outcome measures in stroke rehabilitation: ICF Body Functions. *Disability and Rehabilitation.* 2005;27(4):191-207.

20.   Salter, K., et al. Issues for selection of outcome measures in stroke rehabilitation: ICF Participation. *Disability and Rehabilitation.* 2005;27(9):507-528.

21.   Salter, K., et al. Issues for selection of outcome measures in stroke rehabilitation: ICF activity. *Disability and Rehabilitation*. 2005;27(6):315-340.

22.   Scrivener, K., C. Sherrington, and K. Schurr. A systematic review of the responsiveness of lower limb physical performance measures in inpatient care after stroke. *BMC Neurology.* 2013;13(1):4.

23.   Silva, P.F., et al. Measurement properties and feasibility of clinical tests to assess sit-to-stand/stand-to-sit tasks in subjects with neurological disease: a systematic review. *Brazilian Journal of Physical Therapy.* 2014;18(2):99-110.

24.   Simpson, L.A. and J.J. Eng. Functional recovery following stroke: capturing changes in upper-extremity function. *Neurorehabilitation and Neural Repair.* 2013;27(3):240-250.

25.   Sivan, M., et al. Systematic review of outcome measures used in the evaluation of robot-assisted upper limb exercise in stroke. *Journal of Rehabilitation Medicine.* 2011;43(3):181-189.

26.   Sorrentino G., S.P., Solaro C., Rabini A., Cerri C., Ferriero G. Clinical measurement tools to assess trunk performance after stroke: a systematic review. *European Journal of Physical and Rehabilitation Medicine.* 2018.

27.   Stevens, P.M. Clinimetric properties of timed walking events among patient populations commonly encountered in orthotic and prosthetic rehabilitation. *Journal of Prosthetics and Orthotics.* 2010;22(1):62-74.

28.   Teale, E.A. and J.B. Young. A review of stroke outcome measures valid and reliable for administration by postal survey. Reviews in Clinical Gerontology, 2010. 20(4): p. 338-353.

29.   Tse, T., et al. Measuring participation after stroke: a review of frequently used tools. *Archives of Physical Medicine and Rehabilitation*. 2013;94(1):177-192.

30.   Tyson, S. and L. Connell. The psychometric properties and clinical utility of measures of walking and mobility in neurological conditions: a systematic review. *Clinical Rehabilitation.* 2009;23(11):1018-1033.

31.   van Bloemendaal, M., A.T. van de Water, and I.G. van de Port. Walking tests for stroke survivors: a systematic review of their measurement properties. *Disability and Rehabilitation.* 2012;34(26):2207-2221.

32.   Van Peppen, R.P., et al. The development of a clinical practice stroke guideline for physiotherapists in The Netherlands: a systematic review of available evidence. *Disability and Rehabilitation.* 2007;29(10):767-783.

33.   Velstra, I.-M., C.S. Ballert, and A. Cieza. A systematic literature review of outcome measures for upper extremity function using the international classification of functioning, disability, and health as reference. *PM&R.* 2011;3(9):846-860.

34.   Verheyden, G., et al. Clinical tools to measure trunk performance after stroke: a systematic review of the literature. *Clinical Rehabilitation.* 2007;21(5):387-394.

35.   Wilde, E.A., et al. Recommendations for the use of common outcome measures in traumatic brain injury research. *Archives of Physical Medicine and Rehabilitation.* 2010;91(11):1650-1660.