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CORRELATES OF RECOVERY OF UPPER EXTREMITY FUNCTION IN THE ACUTE PHASE POST STROKE

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ABSTRACT

Despite its importance in activities of daily living, little research has been done on the recovery of upper extremity (UE) function in acute stroke. The objectives of this prospective study were to quantify the recovery of UE function during the first five weeks post-stroke; to compare the recovery of UE function with the recovery of lower extremity (LE) function; and to identify predictors of recovery of UE function.

Fifty-five first-time stroke patients were evaluated using measures of UE and LE function at the first and fifth week post-stroke. Standardized response means were used to compare the recovery of UE and LE. Multiple linear regression was used to identify predictors of UE function. There was no evidence that the recovery of the UE was different from that of the LE. Measures of UE function at the first week post-stroke were the most important predictors of UE function one month post-stroke.

ABRÉGÉ

Malgré son importance dans les activités de la vie quotidienne, peu de recherches ont porté sur la récupération du membre supérieur (MS) après un AVC. Les objectifs de cette étude prospective étaient de quantifier la récupération du MS, de comparer la récupération de la fonction du MS à celle du membre inférieur (MI), et d'identifier les prédicteurs de la fonction du MS pendant les cinq premières semaines suivant l'AVC. Des mesures standardisées de déficiences et d'incapacités du MS et du MI ont été utilisée pour l'évaluation de cinquante-cinq patients à la première et cinquième semaines suivant un premier AVC. Une mesure de la sensibilité (standardized response mean) a été utilisée afin de comparer la récupération de la fonction du MS à celle du MI. La régression linéaire multiple a été utilisée afin de déterminer les prédicteurs significatifs de la récupération fonctionnelle du MS. Les résultats de cette études ne démontrent aucune évidence que la récupération du MS est différente de celle du MI. La fonction du MS mesurée dans les premiers dix jours suivant l'AVC est le plus important prédicteur de la fonction du MS cinq semaines plus tard.

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Je tiens à remercier mes parents Robert et Denise du fond de mon cœur pour m'avoir toujours encouragée à poursuivre mes études et mes rêves, pour avoir cru en moi et pour avoir été là pour m'écouter.

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PREFACE

Guidelines for Manuscript-Based Thesis
Faculty of Graduate Studies and Research,
McGill University

In order to inform the external examiner of the regulations regarding a manuscript-based thesis, the Faculty of Graduate Studies and Research (FGSR) of McGill University requires that the first five paragraphs of the *Guidelines for Thesis Preparation* be reproduced in the Preface section of this thesis. The last two paragraphs regarding originality and co-authorship do not apply to this thesis.

"1. Candidates have the option of including, as part of the thesis, the text of one or more papers submitted, or to be submitted, for publication, or the clearly-duplicated text (not the reprints) of one or more published papers. These texts must conform to the Thesis Preparation Guidelines with respect to font size, line spacing and margin sizes and must be bound together as an integral part of the thesis.

2. The thesis must be more than a collection of manuscripts. All components must be integrated into a cohesive unit with a logical progression from one chapter to the next. In order to ensure that the thesis has continuity. Connecting texts that provide logical bridges between the different papers are mandatory.

3. The thesis must conform to all other requirements of the "Guidelines for thesis preparation" in addition to the manuscripts. The thesis must include the following: a table of contents; an abstract in English and French; an introduction which clearly states the rationale and objectives of the research, a comprehensive review of the literature; a final conclusion and summary; and , rather than individual reference lists after each chapter or paper, one comprehensive bibliography or reference list, a the end of the thesis, after the final conclusion and summary.

4. As manuscripts for publication are frequently very concise documents, where appropriate, additional material must be provided (e.g. appendices) in sufficient detail to allow a clear and precise judgment to be made of the importance and originality of the research reported in the thesis.

5. In general, when co-authored papers are included in a thesis the candidate must have made a substantial contribution to all papers included in the thesis. In addition, the candidate is required to make an explicit statement in the thesis as to who contributed to such work and to what extent. This statement should appear in the single section entitled

"Contributions of Authors" as a preface to the thesis. The supervisor must attest to the accuracy of this statement at the doctoral oral defense. Since the task of the examiners is made more difficult in these cases, it is in the candidate's interest to clearly specify the responsibilities of all the authors of the co-authored papers."

Organization of the Thesis

The first chapter of this thesis presents the introduction and rationale for the research project described in this thesis. In chapter two, background material related to stroke and its clinical picture are presented. The definition of stroke and the symptoms it causes according to the site of the lesion are reviewed. Then, literature pertaining to the recovery of the upper extremity, its pattern of recovery as well as the importance of a functional upper extremity in every day life is explained. Finally, the relevance for quantifying upper extremity recovery and identifying the predictors of the outcome of stroke is explained. In chapter three, the principal objectives of this research project are presented.

The manuscript constitutes chapter 4. The different sections of the manuscript are formatted according to the style of the journal entitled *"Archives of Physical Medicine and Rehabilitation"*. Because the FGSR of McGill University requires a literature review separate from the one found in the manuscript, there is some duplication of material.

Chapter 5 provides a final discussion and conclusions for the results obtained from the research project and is described in the manuscript. Suggestions for future studies are also presented.

Supplementary information regarding the methods used in the project, including a detailed description of the instrumentation material, which is not normally presented in a manuscript prepared for a journal, is presented in the appendices at the end of the thesis.

The guidelines set by the FGSR specify that a literature review and a final conclusion separate from that included in the manuscript must be provided. This resulted in the duplication of some material in the thesis.

Ethical Considerations

This study was approved by the Institutional Review Board (IRB) as well as by the ethics committees at the five McGill teaching hospitals. The assessment tools that were used for this study are commonly used in clinical settings. Furthermore, they are activities that imitate tasks that most people do in their activities of daily living, thus the risk was negligible. A licensed physical or occupational therapist performed the testing. A written consent form was required before entry into the study indicating that all eligible subjects understood the procedures involved in this study. Subjects were permitted to withdraw from the study at any time without this having an effect on the care they received. Finally, complete confidentiality of the patients' medical record was ensured at all times.

CHAPTER 1

INTRODUCTION AND RATIONALE

Stroke is a leading cause of death in industrialized countries.[1,2] Although the mortality rate has decreased in recent years, stroke remains the third most important cause of death in the developed world after heart disease and cancer.[3] In fact, stroke accounts for 10% to 12% of all deaths in industrialized countries.[4]

In Canada, stroke is estimated to newly affect approximately 35,000 persons each year.[5] It is the fourth leading cause of mortality for men and the third for women.[6] In this country, stroke accounts for more than 67,000 hospital discharges and 3.2 million hospitalization days per year.[7] Each year in Quebec approximately 8,000 people have a stroke,[8] and between 50% and 70% are alive one year later.[9-13] It is estimated that over 200 000 Canadians are now living with the consequences of stroke.[12]

Not only is the mortality associated with stroke considerable[1] but in the elderly, it is a major source of disability leading to institutionalization.[2] At least 50% of the survivors suffer permanent neurologic dysfunction.[14] Many of those people are living with the impairments and disabilities that are the sequelae of stroke.[15] In fact, stroke is the leading cause of paralysis, and an important cause of disablement.[16] It is the most common diagnosis among persons referred for in-patient physical rehabilitation.[16]

Hospital care, in the acute phase following a stroke, is the most expensive component in the care of stroke patients.[3] It has been reported that the average cost of acute stroke care in a Toronto hospital was over $25 000 per person. The cost is even greater for patients who are institutionalized.[17] The majority of the costs associated with cerebrovascular accidents (CVA) relate to the physical disability which determines time

of hospitalization more than the need for medical treatment.[5,18] Stroke places a tremendous burden upon the community and the individual which is why this disease is very important for those responsible for planning and providing health care.[1]

Global recovery from stroke, including motor outcomes and function, has been extensively studied with attempts to identify predictors of recovery. However, the population selected has usually been persons participating in rehabilitation programs and outcomes have been only measured at completion of rehabilitation, the duration of which varied greatly between settings and patients. When outcome is measured, variability in the time since stroke can affect the degree to which a potential prognostic variable is associated with outcome. In addition, most studies did not take into account differences among patients in the estimation and interpretation of associations. A further limitation of these outcome studies was in failing to use standardized measures of outcome and instead choosing self-developed scales or scales of dubious reliability and validity.[19]

As common sequelae of stroke include an unfunctional upper extremity and walking deficits, research has focused on the recovery of pure motor impairment. In fact the focus has been on the recovery of lower extremity deficits because of their importance for gait. However, upper extremity function is of paramount importance particularly for the performance of basic and instrumental activities of daily living.[20] Impairment of the upper extremity contributes to a large extent to the functional disability of the patient after the stroke.[21,22] Despite its importance, the recovery of function of the upper extremity post-stroke has not received the same amount of attention as the recovery of ambulation.[23]

This study intends to fill a gap in our knowledge about the recovery of upper extremity function. The principal objective of this study is to quantify the motor recovery

of upper extremity function and to compare the recovery of upper extremity function with the recovery of lower extremity function during acute recovery post-stroke using psychometrically sound outcome measures. The second objective is to identify predictors of acute upper extremity recovery.

Knowledge of the pattern of recovery of the upper extremity after the onset of hemiplegia will assist with prognostication and planning of treatment strategies.[24] The ability to make an early prediction of the degree of recovery will enable clinicians to set realistic goals for rehabilitation and allow patients and their families to make proper arrangements for the future. Patients' families often ask whether their relative will recover from a stroke. They need such information to make financial decisions and to prepare for the person's future care. Also, the prediction of functional outcome is of utmost importance in order to justify the length of stay in the hospital. In these times of fiscal restraint, functional outcomes provide accountability and better utilization of health care resources.

One of the most difficult tasks of the clinician is to judge the rehabilitation potential and to predict the likely outcome of an individual patient.[25] It is believed that certain subgroups of stroke survivors may benefit more than others from certain rehabilitation services, and that, in order to use these services as efficiently as possible, it is important to identify predictors that discriminate between stroke patients with good and poor prognoses.[19] There is general agreement that patients with significant impairment and with good potential should be offered an active rehabilitation program while those with uncertain potential should at least be given a try at rehabilitation.[25] Also, knowledge of the indicators of dependency is useful to health professionals in designing strategies to help

individuals overcome the limitations of disability and even to delay the onset of dependency.

From the research perspective, predicted outcomes resulting from this study can be compared with actual outcomes of stroke patients to estimate, for example, the potential effectiveness of new interventions.

CHAPTER 2

LITERATURE REVIEW

Stroke and its Clinical Picture

The World Health Organization (WHO) defines stroke as "rapidly developing clinical signs of focal (or global) disturbance of cerebral function, with symptoms lasting 24 hours or longer or leading to death with no apparent cause other than of vascular origin".[26] Although subarachnoid hemorrhages are included in this definition, transient ischemic attacks (TIA), subdural hematoma, and tumor or infection causing hemorrhage or infarction are not.[27] Clinical diagnoses of strokes have been shown to be reliable.[28]

Sometimes called shock, cerebrovascular accident or apoplexy, stroke is caused by a pathology in the vascular supply to the brain. A restriction in the blood supply to the brain caused by thrombus, embolus, or hemorrhage results in cerebral ischemia and ultimately, in secondary brain damage. The onset of a stroke is most often unanticipated and sudden.[29] Stroke induces a complex disorder attributable to a cerebral lesion.[30] Resulting from the stroke is an upper motor neuron dysfunction that leads to hemiplegia or paralysis of one side of the body. Limbs, the face, and oral structures on the opposite side to the hemisphere of the brain in which the lesion occurred can be affected to varying degrees.[14] In addition to the motor dysfunction it produces, stroke can also cause other disorders that have a significant impact on the patient's performance. They include sensory, perceptual and cognitive dysfunctions, personality and emotional changes as well as speech and language disorders.

Sensory dysfunctions include disturbances in the senses of touch, pain, temperature, pressure and vibration and proprioception. Examples of perceptual dysfunctions are apraxia or the inability to plan motor acts,[31] body scheme disorders, homonymous hemianopsia or blindness of the nasal half of one eye and the temporal half of the other eye[32] and unilateral neglect or the inability to integrate and utilize perceptions from the hemiplegic side of the body.[31]

Some patients may present with cognitive problems such as memory loss, and poor judgment. Depression, emotional lability, rigidity and denial can also be part of the personality and emotional changes that can occur following stroke.

Speech and language disorders include aphasia and dysarthria. Aphasia corresponds to a range of communication deficits. There are three types of aphasia. In Wernicke' aphasia, the person is unable to understand language. In Broca's aphasia, the person is unable to express himself. Global aphasia is a combination of the two types. Dysarthria is an articulation disorder resulting from a dysfunction of the central nervous system mechanisms that control speech musculature.[33]

The outcome of the stroke depends on which artery supplying the brain is involved in the vascular disease. Cerebral anoxia and aneurysm can also produce brain damage leading to hemiplegia[14,34] but the most common cause is a thromboembolic lesion in the middle cerebral artery (MCA).[35,36] The MCA divides into many branches that supply the insula, emerge from the lateral fissure, and spread out to supply almost the whole lateral surface of the cerebral hemisphere.[37] Ischemia in the area supplied by the MCA results in contralateral hemiplegia with greater involvement of the face and tongue, sensation, contralateral homonymous hemianopsia and the upper extremity.[14,35]

The greatest loss in upper extremity function takes place in the wrist and hand.[30] Upper extremity function revolves around fine hand function, the control of which requires moderate sensory input and motor control[38] and for which the patient can less easily compensate.[23] The homunculus shown below describes the pattern of distribution of the cell bodies of each part of the body. The size and severity of deficits are related to the size of the geographic area in the homonculus that represents that function. The area supplying the hand is much larger because of the fine movements or dexterity required of the hand.

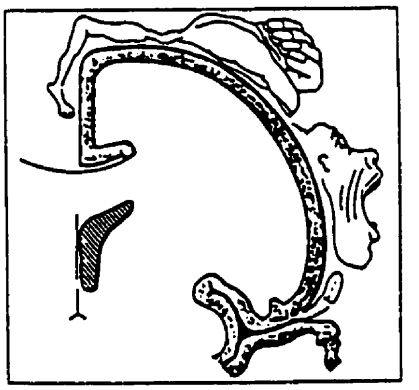

Figure 2.1 Motor homunculus representing the organization of the motor cortex. From: Godaux and Chéron[39]

Based on her findings, Poirier[40] proposed that dexterity be defined as *"Manual ability that requires rapid coordination of gross or fine voluntary movements, based on a certain number of capacities, which are developed through learning, training and experience."* [a]

In general, dexterity refers to the ability to use the hands[41] or to the ability to manipulate objects with the hands.[42] There are two types of manual dexterity: fine

[a] From: Poirier[40] pp71-72.

dexterity and gross dexterity. Fine dexterity refers to the ability to manipulate objects using the distal part of the fingers.[43] In the literature, the expressions "finger dexterity",[44,45,46] "digital dexterity" and "fine finger dexterity"[47] are also used to define this concept. Gross manual dexterity refers to a more global movement of the hand with less involvement of the fingers and objects manipulated are larger.[43]

Recovery of Motor Function

In general, the outcome of stroke includes impairments, disabilities and handicaps. The International Classification of Impairment, Disability and Handicap was devised by the WHO.[48] The WHO defines impairment as *"any loss or abnormality of psychological, physiological or anatomical structure of function"* and disability as *"any restriction of lack of ability to perform an activity in the manner or within the range considered normal for a human being"*. A handicap is *"a disadvantage for a given individual, resulting from an impairment or disability, that limits or prevents the fulfillment of a role that is normal for that individual"*.

The majority of individuals who survive stroke will experience at least a partial recovery.[23] Twitchell[49] described a sequence of motor recovery after a CVA. He suggested that recovery after a CVA constitutes a reversal of the regression of the central nervous system function and stated that primitive responses are the bases for the evolution of more elaborate motor responses. Twitchell also found that all proprioceptive responses were influenced by reflexes and tactile stimulation. The recovery process after CVA described by Twitchell[49] and later by Brunnstrom[50] is summarized sequentially by the presence of flaccidity, stretch reflexes, complex proprioceptive reactions, limb synergies,

decline in spasticity and finally, improvement of willed movement and ability to be influenced by tactile stimuli. Although the recovery pattern contains common characteristics that may be observed in most patients, there is much variation, however, in the recovery process among individuals.[50] This recovery from physiological impairments can lead to recovery from disabilities and eventually to a reduction of handicaps.[23]

Recovery of Upper Extremity Function

According to Teasell,[51] most of the upper extremity problems are seen following a middle cerebral artery stroke where the upper extremity is more involved and where recovery is not as complete. It is believed that motion occurs first in the proximal and then in the more distal portions of the arm.[52,53] This pattern of recovery is similar to the normal acquisition of motor skills in young children.[37]

The flexor synergy of the upper limb is the first movement pattern to recover after the flaccidity stage immediately following the acute episode. Then, the spasticity increases and synergy pattern or some of their components can be performed voluntarily. At later stages, the spasticity declines, movements that deviate from synergies become possible and isolated joint movements can finally be performed with ease.[50]

The return of upper extremity function takes place mainly in the first three months.[21,22] As mentioned by Duncan and associates,[23] however, the most improvement occurs within the first month post-stroke indicating that it is a crucial period for the recovery of motor function. There is general agreement that the recovery of upper extremity is not as good as that of the lower extremity.[23,54-57] In fact, in one third of patients who have had a severe stroke, the affected upper extremity never becomes useful,

even after intensive therapy and the outcome of patients admitted with severe upper extremity paresis is poor despite extensive rehabilitation.[58]

Duncan and associates[23] compared the recovery of upper and lower extremities at the impairment level. These authors investigated the validity of the popular tenet that post-stoke recovery of the upper extremity is less rapid and complete than recovery of the lower extremity. They found that both lower and upper extremities improved over time and that the most improvement occurred during the first month post-stroke. They also found that the patterns of recovery were very similar for both extremities. In this study, however, the subjects were restricted to individuals with anterior circulation, non-embolic, ischemic strokes and so it may not be possible to generalize these results to other types of stroke. Furthermore, sample size for this study was small. Once patients were stratified by severity of stroke, there were insufficient numbers in each cell to detect even large or important differences in recovery patterns. Also, they did not examine other potentially influential characteristics, such as age, comorbidity, preexisting function, and cognition. Finally, the assessment of recovery did not include performance-based measures of upper or lower extremity function. Rather, they relied on the Fugl-Meyer scale,[59] a measure relating changes in motor control at the impairment level. Consequently, their assessment of change is based on measures of motor impairment rather than functional performance measures.

Upper Extremity Function: Importance for Independent Living

Upper extremity function plays a vital role in the performance of activities of daily living[20] and serves as an important prognostic indicator after stroke.[23] A great majority of

the activities performed in our daily lives require the use of our arms. Consider tasks of self-maintenance, such as bathing, dressing and feeding and also tasks involving the management of the environment such as using the telephone, keys and faucets. Other activities of daily living requiring the use of the upper extremity are communication skills including, for example, the ability to write or operate a personal computer; and home management activities including meal planning and preparation, cleaning, laundry, child care, and operating household appliances all require the arms to be functional. These activities of daily living enable an individual to achieve independence in his or her environment and can all be affected by a motor dysfunction after a stroke.[30] The loss of ability to care for personal needs and to manage the environment can results in a loss of self-esteem, a deep sense of dependence and can affect the role and function of the person who has survived a stroke as well as the caretakers.[30] Finally, upper extremity function has been shown to be directly related to the quality of life of patients having sustained a stroke.[15]

Dexterity has a great impact on the global performance of the upper extremity and is often used to estimate upper extremity performance in the activities of daily living[43]. Williams and collaborators[60,61] and Falconer[62] have both demonstrated that manual dexterity explained most of the variations in the health care requirements of elderly women who were able to perform basic activities of daily living. Moreover, Williams and his groups also showed that manual dexterity was a better predictor than professional judgments in estimating changes in health care needs over a period of one year. Among an important group of variables including age, gender, education, cognitive status, medical comorbidities and medications, manual dexterity was the most important determinant of

functional dependence.[63] These authors also found that manual dexterity, for the elderly population, was the most important predictor of living in a nursing home.

Six months after the stroke, one third of stroke patients will have residual difficulties in meeting their personal self-care needs.[64] This loss of independence, which may be due to impaired motor function, perception, or language, represents to many stroke survivors the end of useful life.[2] Consequently, stroke causes psychological problems and survivors may become depressed and anxious. Astrom and associates[65] found that stroke patients reported a very important reduction in their global life satisfaction one year after the stroke. Soderback and associates[66] also noted that the impact of stroke on function and personal activity were considerable even three years post-stroke According to Dennis and Warlow,[1] 45% of stroke victims will be independent (Rankin scale[67] 0-2); 22% will be dependent (Rankin scale 3-5) and 33% will be deceased one year following stroke.

Predictors of Motor Recovery

The ability to predict the natural course of recovery and the effect of particular therapeutic intervention, is one of the major challenges facing therapists.[68] Gowland[68] has suggested that predictors of rehabilitation outcome should be identified early in the course of the disease in order to provide direction in the selection of proper treatment strategies. Prognostic indicators are objective clinical features, or patient characteristics, that will help in predicting the outcome. According to Gowland,[69] most predictors cannot be used alone, but are most useful when used in combination with each other.

Factors such as the nature and severity of the stroke,[70-73] sensory deficits,[74] perceptual deficits,[74,75] and functional ability at the beginning of the period of observation have been shown to influence recovery after stroke.[72,75,76] As well, factors such as age, comprehension difficulties, and depression have been shown to influence the rate of recovery.[77] According to Bonita and Beaglehole,[78] hemianopsia, perception and cognitive disorders should also be regarded as indicators of the impact of stroke in addition to motor deficits. However, foremost among these variables identified as predictors of recovery during rehabilitation is the stage of recovery at initial assessment.[68]

A study by de Weerdt and associates[79] identified predictors of upper extremity function at six and twelve months post-stroke, using the Action Research Arm Test (ARA)[80] as the outcome measure. These authors found that recovery of upper extremity function as measured by the ARA at six and twelve months post-stroke was predicted by the initial score on the ARA, exteroceptive sensation of light touch and overall motor ability at initial evaluation. Most of the variance in the final score of the ARA (44% and 33% for six and twelve months respectively) was explained by the initial score on the ARA. The other variables, exteroceptive sensation of light touch and overall motor ability only explained less than 4% of the variability at six months or twelve months post-stroke. This study, however, evaluated patients only at baseline and at six and twelve months post-stroke and lost 37% of their original cohort of patients between the initial evaluation and the two follow-up evaluations.

Measuring Recovery after Stroke

Stroke assessment scales are often used as outcome measures of stroke rehabilitation. It is necessary for all health professionals involved in the management of stroke patients to assess impairment, disability and handicap using psychometrically sound measures, in a standardized manner.[81] Functional assessment in stroke patients is also of critical in outcomes studies.[82]

Impairment scales

Measures of impairment include the Fugl-Meyer,[59] the Canadian Neurological Scale (CNS)[83] and the Stroke Rehabilitation Assessment of Movement (STREAM).[84,85]

The Fugl-Meyer is based on Brunnstrom's pattern of motor recovery.[59] It is subdivided into five parts: motor function, including the upper and lower extremities, balance, sensation, passive joint motion and joint pain. It is scored on an ordinal three point scale scale. A score of "0" indicates no performance, "1" indicates partial performance and "2", normal performance. It takes between ten and twenty minutes to administer and requires little equipment. Duncan and associates[86] have established intrarater reliability for all components of physical performance. These authors also found a high interrater reliability for the total score of the upper and lower extremity subscales. There is, however, no substantial evidence of responsiveness.

The CNS[83] is a simple and fast measure specifically designed for the acute stroke population. It classifies mental function, motor response and motor function. A complete description of the CNS and its psychometric properties is presented in appendix A.

The STREAM[84] is a relatively new instrument. It comprises 30 items divided into three subscales: mobility, motor function of the upper extremity and motor function of the lower extremity. A complete description of the instrument and its psychometric properties is also presented in appendix A.

Disability Scales

The functional disabilities induced by stroke can by assessed using activities of daily living (ADL) scores[81]. Two well known measures of ADL are: the Barthel Index[87] and the Katz Index of Activities of Daily Living.[88]

A complete description of the Barthel Index can be found in appendix A. It has been the most widely used functional assessment scale since 1965. Out of 78 studies predicting disability in stroke between 1966 and 1994, the Barthel was used in 29 (37%) of them. The Katz Index was used three times.[89]

The Katz Index[88] was developed to evaluate the impact of rehabilitation interventions on functional independence. It includes self-care activities, continence and mobility.[90] It ranks the patient's level of independence on a nominal scale from "A" indicating independence to "G" indicating dependence. Proof of test-retest reliability, and sensitivity, however, is lacking. Brorsson and collaborators[91] have reported a high interrater reliability and validity among aged abled or disabled patients in short-term care.

There are also general measures of independence such as the Rankin Scale.[67] It is a six point scale ranging from 0, no symptoms at all to 5, severe disability.

According to Wade[92] the Rankin Disability Scale might be useful as a simple outcome measure but only at the cost of low sensitivity. The interrater reliability has been

established by Van Swieten and associates.[93] A study by Wolfe and colleagues[81] compared the reliability of the Barthel Index and the Rankin Scale and determined their agreement. A very close agreement was found between the two measures, indicating a close association between disability and handicap. Authors suggest that a Barthel score be assessed and a Rankin score by derived to assess handicap.[81]

Measuring Recovery of Upper Extremity Function

Measuring upper extremity function is a difficult task because of the many uses of the arms and hands. In activities of daily living, they range from simple arm gestures requiring gross strength to fine finger movements such as writing or using a computer. Nonetheless, many assessment scales have been developed that measure impairments and disabilities of the proximal as well as the distal part of the upper extremity.

Measures of impairment

Grip strength is an upper extremity impairment measure and is considered to be a good indicator of upper limb strength in the elderly population.[94] It is also a useful prognostic indicator after stroke[95,96] and is known to predict mortality in the elderly population.[97]

The Jamar™ dynamometer is considered the most accurate instrument for measuring grip strength.[98-100] It is a hydraulic instrument equipped with a sensitive gauge.[101] A description of the standard position and instructions for using the Jamar™ dynamometer as well as the psychometric properties are given in appendix A.

Other measures of impairment that include an upper extremity component are the Fugl-Meyer[59] assessment scale as well as the STREAM, described earlier. On the Fugl-

Meyer, there are 66 points for the upper extremity motor function divided into upper extremity reflexes, movements of the shoulder, elbow, wrist and hand; individual finger movements and finally an assessment of coordination. The upper extremity subscale of the STREAM comprises ten items totaling 20 points.

Measures of disability

There are also a number of test batteries that assess arm function. Examples include the Frenchay Arm Test (FAT)[102] and the Action Research Arm test (ARA).[80]

The FAT, a disability scale which assesses proximal control and dexterity, consists of five pass/fail tasks; the subject scores "1" for each task that is completed successfully. It does not require a lot of equipment and takes about 10 minutes to administer. The validity of this test had been demonstrated: patients scoring 5/5 are likely to use their affected upper extremity, even if they feel it is not normal. The reliability of the test has also been reported.[95] Sensitivity, however, is limited at the upper and lower ends of the scale.[22,95] Patients tend to score "0" or "5" and subjective difficulties are present when interpreting a normal score.[92] A complete description of the FAT can be found in Appendix A.

The ARA is a also a disability measure that assesses proximal and distal strength and dexterity.[92] Based on a previously test developed by Carroll,[103] it is comprised of four parts containing simple, global arm movements to more advanced prehension tasks. The tasks are graded from zero to three, the maximum score being 60. There is some evidence of intra-rater and inter-rater reliability[80] but no information about content and predictive validity or responsiveness.

There are also a good number of fine and gross manual dexterity assessments that have been developed. Desrosiers and associates[43] recently reviewed tests of both fine and gross manual dexterity and Table 2.1 is an English reproduction from her article.

Table 2.1: Psychometric characteristics of manual dexterity measures.

Test	Dexterity		Reliability		Validity	Norms
	Fine	Gross	Test-retest*	Inter-rater*		
Nine Hole Peg Test	X		R 0.97 L 0.99	R 0.69 L 0.43	Correlates with the Purdue Pegboard	-Adults -Elderly
Fifty Hole Beaded Peg Test	X		-	-	-	-Adults -Elderly
Box and Block Test		X	R 0.98 L 0.94	R 1 L 0.99	Correlates with the Minnesota Rate Manipulation Test	-Children -Adults -Elderly
Purdue Pegboard	X		0.60 to 0.76 (1 try) 0.82 to 0.91 (3 tries)	-	Correlates with diverse tools Construct	-Children -Adults -Elderly
Minnesota Rate Manipulation Test	X	X	0.87 to 0.95	-	Correlates with Box and Block Test	-Adults -Elderly
Molbeck Pins Test	X		-	-	-	-Adults
R-G Pegboard	X		0.95	-	-	No
Matches Test	X		-	-	-	No
Rosenbusch Test	X		NDH 0.79 to 0.93 DH 0.73 to 0.88	0.97 to 0.99	-Content -Construct	-Adults

Abbreviations: NDH, Non-Dominant Hand; DH, Dominant Hand.
*Correlation Coefficients
From: Desrosiers et al.[43]

The tests presented all involve manipulation of relatively small objets, usually pegs. To the authors' knowledge, no information about the responsiveness of these measures is available. A complete description of the dexterity tests used in this study, the Nine-Hole Peg Test[104] and the Box and Block Test[105] can be found in Appendix A.

This short inventory of assessment scales is far from exhaustive. Many more scales are being used in clinical settings with those who have had a stroke as well as for research purposes. To the authors' knowledge, these are the most commonly used and well-known.

When choosing a measure, one must consider many factors. According to Wade[92], the measure must be relevant, valid, reliable, sensitive enough to detect the change expected, simple, and the results interpretable. It is also important to determine the patient or population groups tested and whether population norms exist. Before choosing a measure it is also relevant to find out its cost in terms of obtaining the right to use it, in terms of training and also in terms of response burden.

Summary of Literature

Stroke has a great impact on society in that it is more disabling than any other chronic condition.[106] Many survivors live with both physical and psychological consequences. The upper extremity paresis or paralysis that often results from the stroke can significantly impede on the patient's level of independence. The upper extremity is of utmost importance for the accomplishment of activities of daily living and its function is directly related to the quality of life of patients who have survived a stroke. Unfortunately, little is known about the recovery and rehabilitation of the affected upper

extremity in the acute phase following stroke. Very few studies have looked at the recovery of the upper extremity post-stroke and its predictors. Duncan[23] only measured upper extremity function at the impairment level and deWeerdt[79] only assessed patients at baseline, six months and twelve months post-stroke. The pattern of recovery over the first six months post-stroke was not captured and the six month data reflects survivors of that period. The extent of recovery during those six months could have been overestimated or even underestimated if deterioration is a factor.

Many scales have been developed to measure recovery after stroke. When choosing a measure, its relevance, simplicity and interpretability must be considered. It is also important to use scales of known validity, reliability and responsiveness.

CHAPTER 3

OBJECTIVES

General Study Objective:

The global purpose of this study is to quantify the recovery of upper extremity function post-stroke.

Specific Aims:

1) To estimate the extent of recovery of upper extremity function during the first five to six weeks post-stroke;

2) To compare the recovery of upper extremity function with the recovery of lower extremity during the first five to six weeks following the stroke;

3) To identify predictors of recovery of upper extremity function.

In order to reach these objectives, a study was initiated in the fall of 1995. The following chapters describe the methods, results, and conclusions of that research project.

CHAPTER 4

CORRELATES OF RECOVERY OF UPPER EXTREMITY FUNCTION IN THE ACUTE PHASE POST STROKE

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INTRODUCTION

Cerebrovascular accident (CVA) is a very common disabling neurologic disease affecting all ages, but primarily older elderly men and women. In many patients with severe stroke, the affected upper limb never becomes useful, even after therapy.[1] The outcome of patients with severe upper extremity paresis is poor; in a study by Nakayama and associates,[1] 83% of survivors had to be institutionalized. Only about 15% of those suffering from severe cerebrovascular accident recover hand function.[2] It has also been shown that self-reported well-being is decreased one year following a stroke and that this is mainly due to upper extremity impairments and disabilities.[3,4]

The 'unaffected' upper extremity of stroke patients may show deficits in performance when compared with healthy subjects.[5-8] This sequale is devastating because use of the arms and hands is fundamental for the performance of the activities of daily life and the accomplishment of purposeful tasks. Use of the upper extremity (UE) is indispensable to survival; it enables an individual to fulfill his/her roles in society and lead a gratifying life.

Little research has been done on the recovery of function of the upper extremity but there is a general agreement that it is slower and less complete than the recovery of lower extremity function.[9] A study by Nakayama and associates[1] looked at the recovery of upper extremity function from the first week post-stroke up until patients were discharged or died. In this study, upper extremity function was evaluated using the Barthel Index (BI)[10] subscale for feeding and personal hygiene. As the BI has a ceiling effect for mild and moderate strokes,[11] this scale is not sufficiently sensitive to detect deficits among

persons with higher levels of functioning. To the authors' knowledge, only one study compared the recovery of upper and lower extremities and it included only individuals with anterior circulation, nonembolic, ischemic strokes[9]. The results of this study indicated that the patterns of motor recovery were similar for the upper and the lower extremities. Sample size for this study, however, was small. Once patients were stratified by severity of stroke, there were insufficient numbers in each cell to detect even large or important differences in recovery patterns.

A brief report by deWeerdt and associates[12] indicated that recovery of upper extremity function assessed at six and twelve months post-stroke using the Action Research Arm Test (ARA)[13] was predicted by the initial score on the ARA, exteroceptive sensation of light touch and overall motor ability at initial evaluation. Most of the variability in the final score of the ARA (44% and 33% for six and twelve months respectively) was explained by the initial score on the ARA. The other variables explained less than 4% of the variability at six months or twelve months post-stroke respectively. This study, however, evaluated patients only at baseline and at six and twelve months post-stroke and lost 37% of the original cohort of patients between the initial evaluation and the two follow-up evaluations.

The primary objective of the present study was to quantify the recovery of upper extremity function during the first five weeks post-stroke and to compare the recovery of upper extremity function with the recovery of lower extremity function. The second objective was to determine predictors of upper extremity recovery over the five week period following stroke.

METHODS

Overview and Study Design

In this prospective cohort study, measures of upper and lower extremity function were performed within the first ten days post-stroke and again four weeks later. The cohort of patients were individuals with a first time stroke. Persons who were eligible and willing to participate were required to sign a consent form. Participants were assessed using standardized measures of cognition, motor function, dexterity and mobility. This study was conducted in conjunction with another study on the recovery of gait speed post-stroke which has been described recently by Salbach.[14]

Subjects

Subjects targeted for this study were patients admitted with a first time stroke between September 1, 1996 and June 15, 1997 to one of five urban, university-based, hospitals in Montreal, Canada. Having a 'first-time' stroke was interpreted as having no documented evidence of a previous non-reversible ischemic deficit. Excluded from the study were persons presenting without measurable upper extremity deficits, with major medical comorbidities that would have made assessment of motor function very difficult, or with severe cognitive deficits, or living more than 50 kilometers from Montreal.

Sampling Procedures

Upon admission to the hospital, patients having sustained a first-time stroke were identified and screened by one of the two principal investigators (JH and NS) for upper extremity function and cognitive status to confirm eligibility for the study. Cognitive

status was evaluated using the abbreviated Mini-Mental State Examination (Brief MMSE). A cut-off score of 14 was used as it has been suggested for identifying patients with significant cognitive impairment.[15] The Nine-Hole Peg Test[16] was administered to identify persons with subnormal hand function. In addition, patients were asked if they felt they had completely recovered their arm and hand function to confirm their score on the Nine-Hole Peg Test as their pre-stroke level of function may have been sub-normal. Those that responded 'yes' to the question were excluded regardless of their performance on the Nine-Hole Peg Test. Any patients responding 'no' were included. Patients who felt they had not fully recovered their arm and hand function, even with a normal score on the Nine-Hole Peg Test, and who otherwise met eligibility criteria, were approached to participate. The principal investigators evaluated the subjects within the first ten days following the stroke and again four weeks later using standardized measures of cognition, motor impairment and disability, upper and lower extremity function, and mobility.

Instrumentation

Base-line Status

Once consent was obtained, baseline information, including age, side and site of lesion was gathered from the patient's medical record. As well, the Canadian Neurological Scale was performed in order to determine the severity of the stroke.

***The Canadian Neurological Scale (CNS)*[17].** The CNS was administered by the principal investigators to the participants who were then classified according to their score into one of three categories of stroke severity: a mild stroke (CNS $\geq$ 11), a moderate stroke (9 $\leq$ CNS < 11) or a severe stroke (CNS < 9). These cut-off values have been

shown to predict mortality, another vascular event and independence in activities of daily living.[17,18] Content validity has also been demonstrated and an evaluation of concurrent validity comparing the CNS with a standard neurologic evaluation, resulted in Spearman rank correlation coefficients ranging from 0.574-0.775 ($p<0.001$).

Screening

Brief Version of the Mini-Mental State Examination (Brief MMSE). The brief version of the MMSE has four items and is scored out of 18. The items have been shown to explain 98.8% of the variability of the full MMSE and a cutoff of 13 or lower correctly identified 95.5% of cognitively impaired individuals (sensitivity) with a specificity of 90.5%.[15]

The Nine-Hole Peg Test (NHPT).[16] Deficits in upper extremity function were screened using the NHPT, a timed test of fine manual dexterity. The subject takes nine dowels from the table top, puts them into 9 holes on a board, and then takes the dowels out again.[19] A study by Mathiowetz and associates[20] demonstrated a very high interrater reliability (right $r = 0.97$, left $r = .99$) and a moderate to high test-retest reliability (right $r = 0.43$, left $r = 0.43$). Also clinical norms for adults 20 to 75+ years of age for both males and females were established.[20]

Single Question. To confirm results of the Nine-Hole Peg test this question was asked: compared to your level of function prior to your stroke, do you feel that the function of your arm and your hand has completely recovered?

Upper Extremity Function

The Box and Block Test (BBT).[21] The BBT evaluates gross unilateral manual dexterity. The subject is required to move, one by one, the maximum number of blocks from one compartment of a box to another of equal size within one minute. Cromwell[21] has shown that the test-retest reliability is greater than 0.9, and that the test correlated highly with another similar test of dexterity. Desrosiers and associates[22] verified the test-retest reliability and construct validity of this instrument in the elderly population with upper extremity impairment. The intraclass correlations (ICC) ranged from 0.89 to 0.97, and significant correlations were found between the BBT, an upper limb performance measure, and a measure of functional independence. According to McEwen,[3] the BBT is a significant predictor of physical health as measured by the SF-36 (Medical Outcomes Study 36-Item Short Form Questionnaire).[23]

The Frenchay Arm Test (FAT).[24] This test of upper extremity function consists of five pass/fail tasks; the subject scores 1 for each task that is completed successfully. The validity of this test has been demonstrated. Patients scoring 5/5 are likely to use their affected upper extremity, even if they feel it is not normal. Good reliability of the test has also been reported.[25]

Grip Strength. The Jamar™ dynamometer was used to measure grip strength. Three grip strength measures of each hand were taken and the highest score was retained. A study by Mathiowetz[26] indicates that inter-rater reliability can be achieved by using the standardized positioning and instructions. Mathiowetz and associates[27] have established clinical norms for adults aged 20 to 75 years and over. Desrosiers and associates[28] have developed normative data for grip strength of elderly men and women.

Lower Extremity and Mobility

The Timed 'Up and Go' (TUG).[29] This test measures, in seconds, the time taken by an individual to stand up from a standard arm chair, walk a distance of three meters, turn, walk back to the chair, and sit down again. Both the intrarater and the interrater reliabilities have been demonstrated and it has been shown to correlate with the Berg Balance scale, the BI and gait speed.[3] The TUG has demonstrated excellent test-retest reliability (ICC = 0.99) and interrater reliability (ICC = 0.99) in elderly subjects.[29]

Comfortable Gait Speed (5 meters). Gait speed is a valid and reliable measure of stroke outcome and has been shown to correlate with the level of independence in daily living ,[30] as well as functional mobility.[29] Coefficients of test-retest reliability have been reported to range between 0.89 and 1.00[31-33] over different distances. Comfortable walking speed was determined over a distances of 5 meters (m), at a comfortable pace. This particular testing procedure has been found more responsive than the 5 m test (maximum speed), the 10 m test (comfortable speed) and the 10 m test (maximum speed)[14].

Other Measures

The Stroke Rehabilitation Assessment of Movement (STREAM).[34] The STREAM was developed to measure voluntary motor ability and basic mobility. It consists of 30 items, divided into three sections: voluntary movement of the upper extremity, voluntary movement of the lower extremity, and basic mobility. Excellent interrater and intrarater reliability were reported[35] with generalizability correlation coefficients of 0.99 for total STREAM scores, and a range of 0.963-0.998 for subscale scores. For 29 out of the 30

individual items, Kappa statistics demonstrated excellent agreement, ranging from 0.8 to 1.0, with only one showing moderate agreement (0.65).

The Telephone Version of the Mini-Mental State Examination (ALFI-MMSE).[36] Cognitive status was measured using the ALFI-MMSE. Test scores for the original version[37] and the telephone version of the test correlated strongly for all subjects (Pearson's r = 0.85, p = 0.001) and remained significant for the cognitively intact (p = 0.02) and questionably (p = 0.002), mildly (p = 0.0001) and moderately (p= 0.003) demented. Comparison of the two versions' equivalent 22 items revealed no significant difference for scores of all subjects (p = 0.07) but with a trend towards higher scores in the original version. Sensitivity and specificity relative to the Brief Neuropsychiatric Screening test (BNPS) were 67% and 100%.[36]

Albert's Test of Perceptual Neglect (ATPN).[38,39] Visuo-spatial neglect was evaluated using Albert's Test of Perceptual Neglect. This test requires the subject to draw a line across all of 49 lines distributed on a sheet of paper. If more than 70% of the uncrossed lines are on the same side as the patient's hemiplegia, lateralized neglect is indicated. This test was found to be highly correlated to a full perception test battery, as well as being predictive of mortality and functional activity at six months.[3]

The Barthel Index (BI).[10] The validity [40-43] and reliability [10,44,45] of the BI has been established and extensive work using the BI as a predictor of outcome has shown a close relation between the score on this Index at admission and outcome.[43,46,47] It is a weighted scale measuring performance in self-care (feeding, bathing personal toilet, dressing, bowel and bladder care) and mobility (transfers, ambulation and stair-climbing). The interrater

reliability of the BI in a mixed neurological population using the Pearson product moment correlation has been shown to range from 0.884 to 0.991 ($p<0.001$) for total scores.[48] Table 4.1 summarizes the measurement strategy used in this study.

Evaluators

Subjects were evaluated throughout the study by an occupational therapist and a physical therapist (JH and NS). Therapists were familiar with the outcome measures employed in this study, and had undergone a training session in the use of the instruments. Standardized instructions were used routinely.

Data Analysis

The first step was to compare clinical characteristics of the study participants and the eligible non-participants using chi-square tests for categorical variables (gender, side of the lesion, type of CVA and severity of CVA) and a t-test for the continuous variable, age.

For the first objective, to quantify the recovery of upper extremity function during the first five weeks post-stroke, upper extremity function was estimated using the BBT, the FAT and Grip Strength. The difference between the first and second evaluations was determined and paired t-tests were performed in order to check for significance.

The comparison between the recovery of upper extremity function and the recovery of lower extremity function were made using Standardized Response Means (SRM) for each measure. The SRM is the mean change in score divided by the standard deviation of change in scores.[49] It takes errors at both times into account. It is a unitless measure of change allowing scores on different instruments to be compared. It is a variant of effect

sizes and higher values indicate a better responsiveness. Variants of effect sizes came from Cohen.[50] He set out values for interpreting effect sizes: 0.2 or less is small; 0.5 is moderate and 0.8 or more is large. Using the SRM, measures of impairment and disability of the upper and lower extremities were ranked in order from largest to smallest, the largest SRM corresponding to the measure that changed the most. Confidence intervals (C.I.) were subsequently derived using the procedure described by Liang.[49] Because of the concern that UE function has a higher ceiling than lower extremity function, each person's value on the BBT and gait speed, the two measures used to compare the recovery of the upper extremity to that of the lower extremity, was compared to age- and gender-specific norms and percent predicted values calculated. From these, SRM and C.I. were also derived.

The second question related to the predictors of upper extremity recovery post-stroke over a five week period and was addressed using multiple linear regression (MLR). The primary outcome variable was upper extremity function as estimated using the BBT. Potential predictors of recovery of upper extremity function included gait speed, level of cognition, perceptual neglect, motor recovery, independence in activities of daily living (ADL), and functional mobility. Other important variables, age, gender, number of comorbid conditions, type of stroke, side and site of lesion and hand dominance were also incorporated.

As the number of independent variables was quite large, they were divided into three groups to perform the MLR analysis. The first group included the sociodemographic variables, the second and third groups included measures of impairment and disability for

the upper and lower extremity respectively. The three groups were modeled separately and only the significant predictors ($p < 0.05$) were retained. The significant variables were then used together in the same equation to obtain the final model.

Two estimators of change were used as the dependent variable: (1) the final score on the BBT (2) the change in score between the first and the second assessment on the BBT. When the final BBT score was the outcome, two models were developed, one with and one without the initial BBT score as an independent variable. Including the initial score as a covariate in a regression model could lead to biased estimates because an assumption of linear regression, the independence of the error term from the outcome variable, is violated.[51] In addition, because initial and final BBT scores are measures of the same construct, they will be more highly correlated with each other than with measures of other constructs. When the change between initial and final BBT score was the outcome, the model, as recommended by Suissa,[52] did not include the initial BBT score. In both approaches, MLR was used to identify predictors of recovery of upper extremity motor function and recovery of function of lower extremity and mobility, while adjusting for the effects of other variables. To determine the best fitting model, variables were considered both as continuous and categorical. The STREAM, the FAT and grip strength were eventually included only as dichotomous variables split approximately at the median.

Residual and partial regression plots were generated in order to verify the assumptions of normality, homoscedasticity, and linearity. Finally, a cross-validation of the models was performed by randomly dividing the study sample into two and performing the analyses on these samples.

Missing Values

At the initial evaluation, 17 persons (31%) were unable to walk and hence could not be assigned values for gait speed or for the TUG. For gait speed, zero meters/second is a reasonable substitute. For the TUG, a comparable group was not available from which values for missing data could be imputed so values equal to twice the highest TUG score obtained in the sample was substituted. One person was legally blind and could not perform the ATPN. As no reasonable substitution could be made, this value had to be considered as missing.

RESULTS

Description of the Study Population

Out of a total of 357 patients who were identified as having had a first time stroke during the period of recruitment, 175 people met the eligibility criteria of the study. Of these, 55 (31%) agreed to participate, signed an informed consent and completed two evaluations. The reasons for not participating in the study are given in Table 4.2. Eighty six individuals were unavailable to the investigators during the ten day period of recruitment following their stroke. One patient died before the second evaluation and sixteen refused to participate in the study. The final study sample therefore was comprised of 55 patients; 42 of these also participated in the study by Salbach on the recovery of gait speed.[14]

The principal characteristics of the study sample are given in Table 4.3, along with the values for the non-participants. The age of the participants ranged between 25 and 95 years, with an average of 66 years; 64% of the participants were males. There were no statistically significant differences between the two groups for age, gender, side or type of stroke. A difference was found, however, in the severity of the stroke between the participants and the non-participants. The study sample comprised more moderate and severe strokes than did the non-participants. This can be explained by the fact that people who sustained a mild stroke were discharged from the hospital very rapidly before they could be reached by the investigators.

Table 4.4 presents the demographic and clinical characteristics of the study participants as well as their scores on the screening measures.

Recovery of Upper Extremity function: Descriptive Statistics

Tables 4.5 and 4.6 present means, medians and standard deviations (SD), as well as the range of values for both the first and second evaluations for upper and lower extremity measures. The differences in score between the first and the second evaluation are also given.

On the main outcome measure, the BBT, the maximum score is 150 and a higher number indicates a better score. The mean score on the first evaluation was 24 blocks (SD = 21) and increased to 36 (SD = 23) by the second evaluation. For the unaffected side, the mean score on the first evaluation was 49 blocks (SD = 14) and increased to 56 (SD = 12) by the second evaluation. The difference between the first and the second evaluations was significant for both the hemiplegic and the unaffected hand.

Scores on the FAT indicate a significant increase of one point out of a possible five points (SD = 1). The FAT was only performed on the affected side.

For women, the initial grip strength was 12.9 kg (SD = 10.7) on the affected side and increased significantly to 15.5 kg (SD = 12.4) by the second evaluation. On the unaffected side, the initial grip strength was 21.4 kg (SD = 8.2) and did not increase significantly by the second evaluation (21.9 kg , SD = 7.8).

For men, a similar pattern was observed. A significant increase in grip strength was only noted on the affected side (Table 4.5).

Recovery of Lower Extremity Function and Other Outcomes: descriptive statistics

Gait speed and the TUG were used to evaluate lower extremity function. At the time of admission, 53 patients were already ambulatory, 9% with the assistance of two persons, 29% with the assistance of one and 62% were independent or needed little supervision. One month later, 4% still needed the assistance of two persons, 9% the assistance of one person and 87% were independent or needed little supervision. The average gait speed at the first evaluation was 0.52 m/s and increased significantly to 0.79 m/s by the second evaluation.

For the TUG, for which lower times indicate better mobility, the average time decreased significantly from 80 (SD = 91) seconds to 43 (SD = 67) seconds within the first month. For these two evaluations, the difference between the first and the second evaluation was highly significant.

A significant increase between the first and the second evaluation was observed for the BI, the total STREAM, the upper extremity subscale of the STREAM, and the ALFI-MMSE (Table 4.6)

Only three subjects failed the ATPN demonstrating lateralized neglect on the first evaluation. On the second evaluation, one patient still showed evidence of hemineglect.

Comparing the Recovery of Upper Extremity Function to the Recovery of Lower Extremity Function

Table 4.7 presents the SRM for outcome measures for all study participants over the five-week period following stroke. SRM are ranked from the highest to the lowest SRM and 95% confidence intervals are also presented. It is possible to distinguish between three groups of outcome measures according to their SRM and C.I.. The first group is comprised of only the BBT for the affected side as it had the highest SRM. It is followed by a group of measures which includes the total STREAM, gait speed, the total BI, the BBT for the unaffected side, the lower extremity subscore of the BI and grip strength for the affected hand. This group of measures had a lower point estimate of SRM but their C.I. and overlapped to some extent that of the BBT. The third group of measures includes the upper extremity subscores of the STREAM and the BI, the FAT, the TUG and grip strength of the unaffected hand. The SRM of the measures of this group were lower than the BBT, their C.I. not overlapping with that of the BBT.

SRM for the two measures used to compare the recovery of upper extremity to the recovery of lower extremity, the BBT and gait speed, were also calculated using age- and gender-specific norms and percent predicted values This was done to create an equal

"ceiling" for comparison purposes. For example, the percent predicted values for the BBT on the affected side are 34% (SD = 28.8)and 51% (SD = 31.7) of mean age- and gender-specific normal values, for the first and second evaluations respectively. For gait speed, these values are 44% and 66%. The estimated SRM and their C.I. for percent predicted values did not differ from those using raw values.

Determining Predictors of Upper Extremity Recovery

Table 4.8 presents the predictors of upper extremity recovery according to the different models. Predictors were determined for three different models using MLR. The three groups of independent variables described earlier were modeled separately for each of the three outcomes. Perceptual neglect (n= 3)and left-hand dominance (n= 4), because they were rare, were omitted from the models. Also, because gait speed and the TUG are closely related and measure approximately the same construct, only gait speed was used. As expected, the number of rehabilitation sessions received between the first and the second evaluation was negatively correlated to the BBT and positively correlated to stroke severity as more severely disabled patients usually received more treatment than those who are only mildly affected.[53] Because this variable is a proxy to stroke severity, it was not used as a variable in the MLR analysis.

The independent variables that significantly explained the final score on the BBT included the initial score on the BBT, the total STREAM, the FAT, gait speed, and the NHPT. This model explained 92% of the variance of the final score on the BBT. Secondly, when the same model was then constructed without the initial score on the BBT

as a predictor variable, only the FAT, gait speed, and grip strength on the affected side were significant predictors. This model explained 84% of the variance.

In the third model, the STREAM, the FAT and the NHPT were significant predictors of the difference in the mean score between the first and the second evaluations on the BBT. The model explained 42% of the variance of the mean change on the BBT.

Results of the MLR showing variables that predict upper extremity function for all models as well as the parameter estimates (β) are presented in Table 4.9. The parameter estimate is the amount of change in the dependent variable expected for every one unit change in the independent variable. The parameter estimate of the initial score on the BBT is 0.75. This means that a ten block increment at initial evaluation tranlates to an increase of 7.5 blocks on the final BBT. For the change score between the first and the second evaluation on the BBT (Model 3), a person scoring over 80 out of 100 on the STREAM would be estimated to change by twelve blocks more than a person with a poor outcome on the STREAM (less than 80).

DISCUSSION

Quantifying the Recovery of the Upper Extremity

Upper extremity function as measured using the BBT, the FAT and grip strength increased significantly over the first five weeks following stroke.

On the BBT, mean scores on the first evaluation correspond to 34% of the age- and gender-specific normal values for the affected side. By the second evaluation, the

number of blocks increased by twelve. This number correspond to 51% of the mean age- and gender-specific values. An increase of 17% of the mean age- and gender-specific normal value is thus noted on the affected side.

A noteworthy finding is that on the BBT, both the affected and the unaffected hands had scores lower than age- and gender-specific normal values and both hands improved significantly over a one month period These results are in accordance with those of Desrosiers and associates[8] when the 'unaffected' upper extremity was compared to the same side of healthy subjects. Significant differences were present for fine and gross manual dexterity between the two groups.

According to McEwen,[3] the BBT is a significant predictor of physical health as measured by the Medical Outcomes Study 36-Item Short Form Questionnaire (SF-36).[23] She found that an additional seven blocks increased by 2 the Physical Component Summary Score and this amount is considered clinically relevant.[23] This implies that the improvement seen in the affected arm is clinically meaningful.

Quantifying the Recovery of the Lower Extremity

Gait speed for the first evaluation (0.52 m/s, SD = 0.37) corresponds to 44% of the mean age-and gender specific normal values for the first evaluation and increased to 0.79 (SD = 0.45) or 66% of the mean age- and gender-specific values at the second evaluation (Table 4.6).

Comparing the Recovery of Upper Extremity Function to the recovery of Lower Extremity Function

The BBT and gait speed were used to make the comparison between the recovery of the upper extremity and the recovery of the lower extremity. The difference in change between upper and lower extremity measures was estimated using a measure of responsiveness, the SRM (Table 4.7). This effect size was chosen because it is probably the best estimator with which to compare change across measures. The SRM is the mean change over the SD of the change score and it takes into account the variability of patient change, either in response to treatment or during the natural course of recovery.[50] For the BBT and gait speed, measures used to compare the recovery of the upper extremity to that lower extremity, SRM were calculated using percent predicted values. This was to create an equal "ceiling". The upper extremity being involved in activities that a much more complex than the lower extremity, the amount of recovery possible is greater. Results obained using these two procedures were identical.

It appears that the BBT improved the most with the highest SRM (Table 4.7). It is important to mention that a second group of measures, including the STREAM total, gait speed, the BI, the BBT for the unaffected side, the lower extremity subscore of the BI and grip strength for the affected side had confidence intervals that overlapped substantially with that of the BBT. The SRM of the previous measures ranged between 0.82 and 1.34 and those values are considered large according to Cohen.[50] A third group of variables, comprised of the upper extremity subscores of the STREAM and the BI, the lower extremity subscore of the STREAM, the FAT, the TUG and grip strength for the unaffected side had C.I. that did not overlap with that of the BBT. The SRM of these

measures, which range between 0.75 and 0.17 are considered small to moderate according to Cohen.[50] Although it seems that upper extremity function improved the most, there is insufficient power to detect important differences between the first two groups of outcome measures. According to these results, there is no direct evidence that the recovery of the upper extremity is vastly different from that of the lower extremity, although the point estimate of the BBT SRM was greater. Also, because of the higher 'ceiling' for upper extremity function, rapid recovery may still reflect considerable disability.

Determining Predictors of Upper Extremity Function

Upper extremity function assessed one month post-stroke is mainly predicted by upper extremity function immediately post-stroke, as estimated by the same outcome measure (the initial score on the BBT). This is followed by, global arm function (FAT), voluntary motor ability of the upper and lower extremities and basic mobility (total STREAM), gait speed and fine manual dexterity (NHPT). When the initial score on the BBT was not considered in the model, FAT explained most of the variability, followed by grip strength and gait speed. Predictors of the change in score on the BBT between the first and the second evaluation included global arm function (FAT), fine manual dexterity (NHPT) and voluntary movement of the upper and lower extremities, basic mobility (total STREAM). None of the sociodemographic variables such as age, gender, side and type of lesion were significant predictors of upper extremity function five weeks post-stroke (Tables 4.8 and 4.9).

The significance of global voluntary movements, basic mobility and lower extremity function as predictors of upper extremity function may indicate that the recovery processes

of the upper and lower extremities are not totally independent. This is easy to understand, in relation to performance of many every day activities. In order to have functional and coordinated movements of the upper extremity, a person needs a stable trunk as well as balance in sitting and standing, which implies a functional lower extremity. The change score or improvement in upper extremity function is also predicted by voluntary movements and function of both extremities The results of the current study are in accordance with a study by Dean and associates[54] who demonstrated that the improvement in the ability to use the upper extremities in a reaching task was linked to the improvement in the ability to use the affected leg for support and balance. The study showed that stroke patients can improve their performance on reaching tasks, increase the load taken through the affected foot and also increase the consistency in activation of task-related muscles in the affected leg, with a task-specific learning program that takes into account, among other things, lower limb function. As well, other studies have shown that improvement of specific tasks occurs if they are included in a task-specific rehabilitation program.[55,56] The benefits of task-specific training for reaching and manipulation have also been demonstrated. Subjects improved on tasks that they had practiced.[57]

To make a realistic prognosis of recovery of upper extremity function, an initial assessment of the severity of the upper extremity deficits is necessary. Evaluation of voluntary movements and function of the upper and lower extremities would also be recommended. A holistic approach including both upper and lower extremity task-related training in the treatment of the patient may be indicated to improve upper extremity function to its maximum level.

Limitations of the Study

It is important to point out the limitations of this study. First, the results of the analyses were based on performance by a defined group of stroke patients. This group differed significantly from the non-participants in terms of severity of stroke. The sample population may therefore not be representative of the target population so the results are only applicable to patients who meet the characteristic of the present study sample.

Secondly, because patients were only followed for a period of five weeks, the prediction of recovery is limited to this time period. Also, patients were recruited an average of eight days post-stroke and so some may have experienced recovery prior to their first evaluation. This would have lead to an underestimation of the change between the first and second evaluations of the outcome measures and may explain why certain assessments such as the BI and the STREAM, which capture change at lower levels of function were not found to be significant predictors of upper extremity recovery.

Sample size for this study was calculated to detect a simple correlation greater or equal 0.5 at 90% power, and a two-tailed alpha level of significance of 0.05. In order to detect lower correlations between the dependent and independent variables, or to capture smaller differences in mean score between the first and second evaluations, the sample size would have had to be greater.

CONCLUSION

The results of this study do not support the general belief that recovery of lower extremity function is faster than that of the upper extremity. The percentages of the

normal values attained on the measures of upper extremity function and gait speed as well as the rank ordering of the SRM for measures of upper and lower extremity function indicate that the recovery of the upper extremity is similar to the recovery of the lower extremity.

The most important predictor of upper extremity function when the initial measure of the same construct is not taken into account is global arm function as assessed by the FAT. Voluntary movements (STREAM) and function of both upper and lower extremities (gait speed, NHPT) also predict upper extremity function one month post-stroke. These results suggest the extent of upper extremity deficits at initial assessment is a good prognostic indicator of upper extremity recovery and should be used when planning treatment strategies These results also suggest that early, simultaneous task-specific training of both the upper and the lower extremity may improve upper extremity function during the first month post-stroke.

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Table 4.1: The Measurement of Study Constructs

Type of Measure	Construct	Instrument	Performance	Units /Scoring
Baseline Status	Stroke Severity	CNS[17]	Measures neurologic status in stroke patients in 2 sections: mentation and motor function.	/11.5
Screening	UE Function	Nine-Hole Peg Test[16]	Take nine dowels from table, fill nine holes on the board and take them out again. Each hand is tested.	Seconds
		Question	Compared to your level of function prior to your stroke, do you feel that the function of your arm and your hand has completely recovered?	
	Cognition	Brief MMSE[15]	Questionnaire comprised of two sections: Orientation and Recall	/18
UE measures	UE Function	Box and Block Test[21]	Total number of blocks taken from one side of a box to the other in one minute. Each hand is tested	/150
		Frenchay Arm Test[24]	Five uni- and bilateral pass/fail tasks of the upper extremity.	/5
		Grip Strength[26,27]	In a standard position, subjects squeeze the dynamometer (Jamar™) as hard as possible three times for each hand. The highest strength is retained for each hand.	Kg of force
Mobility Measures	Gait Speed	5m timed comfortable walk[29-33]	Subjects are instructed to walk a distance of 5m at a pace that is comfortable and safe for them.	Meters /seconds
	Functional Mobility	Timed 'Up and Go'[29]	Time taken to stand up from a chair, walk a distance of three meters, turn, walk back to the chair, and sit down again.	Seconds
Other Measures	ADL	Barthel Index[10]	Self or proxy questionnaire which measures three categories of function: self-care, continence and mobility.	/100
	Motor Recovery	STREAM[34]	Instrument comprised of 30 items, divided in 3 sections: voluntary movement of the upper and lower extremities and basic mobility.	/100
	Cognition	Telephone version of MMSE[36]	Questionnaire comprised of five sections including orientation, registration, attention and calculation, recall and language.	/22
	Perceptual Neglect	Albert's test of Perceptual Neglect[38]	Subjects cross-out all the lines they see on the paper. If 70% are uncrossed on the hemiplegic side, there is hemineglect.	0= No PN 1= PN

Abbreviations: CNS, Canadian Neurological Scale; UE, Upper Extremity; MMSE, Mini-Mental State Examination; ADL, Activities of Daily Living; STREAM, Stroke Rehabilitation Assessment of Movement; PN, Perceptual Neglect.

Table 4.2: The Study Sample and Reasons for Non-Participation of Eligible Subjects

Patient Characteristics	Frequency (Per Cent)
Stroke patients screened at 5 hospitals	357
Ineligible	182 (49)
Eligible	175 (51)
Of those eligible:	
Unavailable at time of recruitment	86 (49)
Refusal	16 (9)
Out of study area	16 (9)
Family distress	1 (0.6)
Deceased	1 (0.6)
Patients recruited	55 (31)

Table 4.3: Comparison of the Clinical Characteristics of Study Participants and Non-Participants

Patient Characteristic	Eligible Subjects		*p-value*[*]
	Participants (n = 55) No. (%)[†]	Non-participants (n = 120) No. (%)	
Gender			0.283
Men	35 (64)	66 (55)	
Women	20 (36)	54 (45)	
Side of lesion			0.713
Right	26 (47)	45 (38)	
Left	28 (51)	37 (31)	
Bilateral	1 (2)	1 (1)	
Not specified	--	37 (31)	
Type of CVA			0.110
Ischemic	51 (93)	65 (54)	
Hemorrhagic	4 (7)	13 (11)	
Not specified	--	42 (35)	
Severity of CVA[‡]			0.002
Mild	9 (16)	43 (36)	
Moderate	28 (51)	36 (30)	
Severe	18 (33)	18 (15)	
Not specified	--	23 (19)	
Mean age (SD)	66 (15)	70 (13)	0.1

Abbreviations: CVA, cerebrovascular accident; SD, standard deviation.

[*] p-value associated with chi-square tests or t-test (for age).

[†] Percentages may not add to 100 due to rounding.

[‡] Stroke severity was based on Canadian Neurological Scale (CNS) scores: Mild CNS ≥ 11, Moderate 9 < CNS < 11, Severe CNS < 9[17]. Otherwise it was established from medical charts.

Table 4.4: Demographic and Clinical Characteristics of Study Participants

Patient Characteristic	Mean (SD)
Time between onset of stroke and first evaluation	8 days (3)
Time between first and second evaluations	29 days (5)
Length of stay in hospital	12 (8) days
Discharge destination	
Home	26 (47)
Rehabilitation	28 (51)
Deceased	1 (2)
Number of rehabilitation sessions between first and second evaluations	24 (20)

Abbreviation: SD, Standard Deviation.

Table 4.5: Recovery of Upper Extremity Function

Upper extremity measures	Eval. #	Scores on Upper Extremity Measures			
Box and Block Test /150		**Mean**	**SD**	**Median**	**Range**
Affected side	1st	24	21	27	0-77
	2nd	36	23	42	0-80
	Δ	12*	9	11	0-38
Unaffected side	1st	49	14	47	21-81
	2nd	56	12	55	27-84
	Δ	7*	8	7	-14-29
Frenchay Arm Test /5	1st	3	2	4	0-5
	2nd	4	2	5	0-5
	Δ	1*	1	0	0-5
Grip Strength (kg)					
Affected side					
Males	1st	19.2	15.0	20.0	0.0-51.0
	2nd	24.4	15.2	27.0	0.0-52.0
	Δ	5.1*	5.6	5.0	-5.0-16.0
Females	1st	12.9	10.7	14.0	0.0-35.0
	2nd	15.5	12.4	14.5	0.0-44.0
	Δ	2.6†	4.4	1.5	-2.0-18.0
Unaffected side					
Males	1st	35.9	9.5	36.0	16.0-54.0
	2nd	36.4	9.9	38.0	16.0-54.0
	Δ	0.6	4.0	1.0	-8.0-10.0
Females	1st	21.4	8.2	20.0	10.0-45.0
	2nd	21.9	7.8	21.5	6.0-40.0
	Δ	0.5	3.1	0.2	-5.0-6.0

Abbreviations: Eval., Evaluation; SD, Standard Deviation; Δ = Mean difference between first and second evaluations.

* p value associated with paired t-test ≤ 0.0001.

† p value associated with paired t-test ≤ 0.05.

Table 4.6: Recovery of Lower Extremity and Other Measures of Stroke Outcome

Lower extremity and other measures	Eval. #	Scores on lower extremity measures and other measures			
		Mean	SD	Median	Range
5 meter comfortable walking speed	1st	0.52	0.37	0.54	0-1.32
	2nd	0.79	0.45	0.89	0-1.60
	Δ	0.26*	0.27	0.18	-0.11-1.14
TUG (seconds)	1st	80	91	25	7-212‡
	2nd	43	67	13	7-212‡
	Δ	-38*	66	-5	-201-1
Barthel Index /100	1st	71	29	85	5-100
	2nd	85	22	100	30-100
	Δ	14*	15	10	-5-50
STREAM UE† /100	1st	70	24	85	0-100
	2nd	83	34	95	0-100
	Δ	13*	17	10	-10-70
STREAM total /100	1st	72	28	86	7-100
	2nd	85	21	94	17-100
	Δ	13*	13	8	-5-57
ALFI-MMSE /22	1st	20	2	20	12-22
	2nd	21	2	21	15-22
	Δ	1†	2	0	-3-6

Abbreviations: Eval., Evaluation; SD, Standard Deviation; TUG = Timed 'Up and Go', STREAM, Stroke Rehabilitation Assessment of Movement; UE, upper extremity; ALFI-MMSE, Telephone Version of the Mini-Mental State Examination.

*p value associated with paired t-test ≤ 0.0001.

†p value associated with paired t-test ≤ 0.05.

‡Imputed value.

Table 4.7: Standardized Response Means for Outcome Measures

Groups	Outcome Measures	SRM (95% C.I.) (n = 55)
1	BBT affected*	1.34 (1.02, 1.63)
2	STREAM total	0.98 (0.74, 1.17)
	Gait Speed*	0.97 (0.74, 1.18)
	Barthel Index	0.96 (0.75, 1.16)
	BBT unaffected	0.90 (0.58, 1.20)
	Barthel Index - Lower extremity subscore	0.89 (0.67, 1.10)
	Grip Strength affected	0.82 (0.60, 1.04)
3	STREAM - Upper extremity subscore	0.75 (0.56, 0.93)
	Barthel Index - Upper extremity subscore	0.68 (0.41, 0.93)
	STREAM - Lower extremity subscore	0.63 (0.36, 0.86)
	Frenchay Arm Test	0.60 (0.42, 0.76)
	TUG	0.57 (0.43, 0.72)
	Grip Strength unaffected	0.17 (-0.11, 0.44)

Abbreviations: SRM, Standardized Response Mean; C.I., Confidence Interval; BBT, Box and Block Test; STREAM, Stroke Rehabilitation Assessment of Movement; TUG, Timed 'Up and Go'.
*Standardized Response Means and 95% Confidence Intervals calculated from percent predicted age- and gender-specific values.

Table 4.8: Predictors of Manual Dexterity Post-Stroke: Choice of Model

Outcome Measures	Model 1 Final BBT= Initial Measures	Model 2 Final BBT= Initial Measures- Initial BBT	Model 3 ΔBBT=Initial Measures-Initial BBT
BBT affected	91.2%		
STREAM	4.7%		52.8%
FAT	2.2%	89.9%	30.5%
Gait Speed	1.1%	4.7%	
NHPT affected	0.8%		16.7%
Grip Strength affected		5.4%	
R^2	0.92	0.84	0.42
Unexplained	8%	16%	58%

Abbreviations: BBT, Box and Block Test; Δ, mean difference between first and second evaluation on the BBT; STREAM, Stroke Rehabilitation Assessment of Movement; FAT, Frenchay Arm Test; NHPT, Nine-Hole Peg Test.

Table 4.9: Results of Multiple Linear Regression Showing Variables that Significantly Explain Upper Extremity Recovery Five Weeks Post-Stroke.

Outcome	Variables (Initial Eval.)	Measurement Scale.	Parameter Estimate†	Standard Error	R^2
1-Final BBT	BBT	0-150	0.75	0.10	0.92
	STREAM*	0-80	-10.86	3.20	
		81-100	Referent		
	FAT*	0-3	-13.09	3.83	
		4-5	Referent		
	NHPT	Seconds	0.02	0.01	
	Gait Speed	Meters/second	7.30	3.34	
2-Final BBT	FAT*	0-3	-21.09	5.60	0.82
		4-5	Referent		
	Gait Speed	Meters/second	15.49	4.65	
	Grip Strength*	0-20 kg	12.76	5.16	
		21-60 kg	Referent		
3-Δ I and F BBT	STREAM*	0-80	-12.42	3.27	
		81-100	Referent		
	FAT*	0-2	-11.55	3.52	
		3-5	Referent		
	NHPT	Seconds	0.04	0.01	0.42

Abbreviations: Eval., Evaluation; BBT, Box and Block Test; STREAM, Stroke Rehabilitation Assessment of Movement; FAT, Frenchay Arm Test, NHPT, Nine-Hole Peg Test; Δ, change score between first and second evaluation; I/F = Initial and Final; aff/unaff = affected/unaffected side.

*Continuous variables included as categorical variables.

† Parameter Estimate (β) over the Standard Error (SE) is equivalent to a t-test.

CHAPTER 5

SUMMARY AND CONCLUSIONS

Quantifying the Recovery of Upper Extremity Function

The first objective of this study was to quantify the motor recovery of upper extremity function and to compare the recovery of upper extremity function with the recovery of mobility, gait speed and motor impairment of the lower extremity during acute recovery post-stroke using psychometrically sound outcome measures

Upper extremity function on the affected side, as measured using the BBT, the FAT and grip strength increased significantly over the first five weeks following stroke.

On average, persons improved on the BBT from 24 blocks (SD = 21) to 36 blocks (SD = 21) for an average increase of 12 blocks (SD = 9) (Table 4.5). Mean scores on the first and second evaluation correspond to 34% and 51% of the age-specific normal values, respectively. An increase of 17% of the mean age and gender specific normal value is thus noted on the affected side.

According to McEwen,[15] the BBT is a significant predictor of physical health as measured by the Medical Outcomes Study 36-Item Short Form Questionnaire (SF-36).[107] She found that an additional seven blocks increased by 2 the Physical Component Summary Score and this amount is considered clinically relevant.[107] This implies that the improvement seen in the affected arm is clinically meaningful.

For women, the initial grip strength was 12.9 kg (SD = 10.7) which corresponds to 55% of the age and gender-specific normal value on the affected side and was 15.5 kg

(SD = 12.4) or 67% of the age and gender specific normal value on the second evaluation. Thus grip strength increased by 12% of the age-gender specific values over five weeks.

For men, the initial evaluation revealed a strength of 19.2 kg (SD = 15.0) corresponding to 49% of the age and gender-specific normal values. It increased to 24.4kg (SD = 15.2) or 62% of the age-gender specific normal value by the second evaluation. The increase between the first and the second evaluation was 13% of age and gender-specific normal values.

A noteworthy finding is that on the BBT, both the affected and the unaffected hands had scores lower than age-specific normal values and both hands improved significantly over a one month period (Table 4.5). On the other hand, grip strength was substantially below age and gender-specific normal values only for the affected hand.

A possible explanation for the decreased performance in manual dexterity of the unaffected side may be the interference of the weaker or paretic side. It may also be that grip strength as measured in this study using the Jamar™ dynamometer requires less sensorimotor input than do tasks of fine and gross manual dexterity. This explanation relies on the role of a specific area of the motor cortex called the supplementary motor area. According to Roland and associates,[108] this area is responsible for the initiation of complex movements of the fingers. These authors measured blood flow in this area while a subject was doing a simple flexion of one finger, or a sustained isometric muscular contraction such as when using the Jamar™ dynamometer, and then when he was doing a complex sequence of movements with his hands. In the first exercise, the blood flow increased only in the primary motor and sensory area contralateral to the hand. In the

more complex hand exercise however, the increased blood flow was detected not only in the contralateral motor area but also in the supplementary motor area on both the contralateral and the ipsilateral side of the hand. Hence decreased fine and gross manual dexterity was observed on the ipsilateral side of the lesion in this study.

The results of this study are in accordance with those of Desrosiers and colleagues[109] who compared the performance of the 'unaffected' UE of stroke patients with that of the same side of healthy subjects of the same age and sex. They found significant differences between the two groups for fine and gross manual dexterity, but not for grip strength.

It is important for therapists to be aware of this and to evaluate and treat the unaffected upper extremity. The 'unaffected' upper extremity plays an important role in the acquirement of independence in activities of daily living, especially for patients with initial severe upper extremity paresis. It has been shown that for these patients, independence is mostly achieved through compensation using the unaffected upper extremity.[58]

Quantifying the Recovery of Lower Extremity Function

Gait speed for the first evaluation (0.52 m/s, SD = 0.37) corresponds to 44% of the mean age-gender specific normal values for the first evaluation and increased to 0.79 (SD = 0.45) or 66% of the mean gender and age-specific values at the second evaluation (Table 4.6).

On the timed 'Up and Go', the average time decreased from 80 (SD = 91) seconds to 43 (SD = 67) seconds within the first month. For these two evaluations, the difference between the first and the second evaluation was highly significant.

Comparing the Recovery of Upper Extremity Function to the recovery of Lower Extremity Function

It was difficult to compare the recovery of the upper extremity to the recovery of the lower extremity because the instruments used were all calibrated on different scales. To overcome this, SRM were used as a basis for comparison. When SRM were compared across all measures used in this study (Table 4.7), the BBT had the highest SRM, although the confidence interval overlapped the one measure of lower extremity recovery, gait speed. This suggest that the recovery of the upper extremity was on a par with that of the lower extremity and could even be superior. However, the SRM is calculated only as a ratio of mathematical parameters and does not consider the possible range of scores. The upper extremity is involved in activities that are much more complex than the lower extremity and therefore, the amount of recovery possible is greater than the lower extremity. To create an equal "ceiling" for comparison purposes, each person's value on the BBT and gait speed was compared to age and gender-specific norms and percent predicted values calculated. From these, SRM and C.I. were also derived. The results were almost identical to those obtained when using raw values and thus no significant difference could be made between the recovery of the upper and the lower extremities.

It appears that the BBT improved the most with the highest SRM (Table 4.7). It is important to mention, however, that a second group of measures, including the STREAM

total, gait speed, the BI, the BBT for the unaffected side, the lower extremity subscore of the BI and grip strength for the affected side had confidence intervals that overlapped substantially with that of the BBT. The SRM of the previous measures ranged between 0.82 and 1.34 and those values are considered large according to Cohen.[110] A third group of variables, comprised of the upper extremity subscores of the STREAM and the BI, the lower extremity subscore of the STREAM, the FAT, the TUG and grip strength for the unaffected side had C.I. that did not overlap with that of the BBT. The SRM of these measures, which range between 0.75 and 0.17 are considered small to moderate according to Cohen.[110] Although it seems that upper extremity function improved the most, there is insufficient power to detect important differences between the first two groups of outcome measures. According to these results, there is no direct evidence that the recovery of the upper extremity is vastly different from that of the lower extremity, although the point estimate of the BBT's SRM was greater. Also, because of the higher 'ceiling' for upper extremity function, rapid recovery may still reflect considerable disability.

SRM were also calculated for each outcome measure within each stroke severity group, in order determine if the recovery patterns were similar between the three strata (Appendix E-Table E.1.0). For mild strokes, the BBT had the highest SRM (2.10) followed by gait speed (1.10) and grip strength (0.94). For moderate strokes, the BBT (1.81) and gait speed (1.17) were in first and second place and the STREAM followed with an SRM of 1.13. For severe strokes, the BI had the highest SRM (1.67), followed by the STREAM (1.50) and the lower extremity subscale of the BI (1.36). Because of the small sample sizes, it was no possible to calculate meaningful C.I..

Although it appears that upper extremity function improved faster than lower extremity function, the 95% confidence intervals for the BBT are very large and overlap substantially with the other outcome measures of the second group. The sample population (n=55) was too small to detect any important differences between the outcome measures. Moreover, when the study population was divided into three subsets according to stroke severity, small sample sizes in each of the strata were even smaller and there was insufficient power to detect statistically significant differences between the different measures.

For severe strokes, the BI, a disability measure and the STREAM, which includes items of basic mobility and voluntary movements of the upper and lower extremities seemed to have improved the most. These two measures capture changes at a lower level of function for both the upper and the lower extremity. It has been established that patients who sustain a severe stroke do not recover as rapidly and thus gait speed and the BBT, measures of higher level of function, did not capture changes for this group of patients.

Although insufficient power did not enable us to detect statistically significant differences between the outcome measures, the results of this study, shows no evidence that the lower extremity recovers faster than the upper extremity. Future research should be carried out using focusing on severe, moderate and mild stroke separately in order to determine the pattern of recovery according to the severity of the stroke. The knowledge gained would be useful for therapists planning treatment strategies.

Determining Predictors of Upper Extremity Function

The most important predictor of upper extremity function one month post-stroke is initial upper extremity function as estimated by the same outcome measure. When the latter is excluded, the FAT explained most of the variability in the final BBT score, hence the importance for clinicians to consider the extent of initial upper extremity deficits when making a decision regarding whether an individual would benefit from intensive rehabilitation. Possible benefits should be measured using adequate outcome measures that document functional change. For example, the BBT and gait speed, measures of higher level function, improved only slightly for the severe group and would not be expected to change in this particular group during the first month. In this case, use of measures such as the BI and the STREAM which are able to detect smaller changes would be recommended in order to make an adequate prognosis and to avoid wrongly classifying a patient as not benefiting from rehabilitation based solely on the severity of his/her stroke.

When comparing scores on the FAT, a test of global arm function to scores on the BBT, a test of manual dexterity, we found that persons who scored 0 on the FAT had a mean score of 3 blocks on the BBT. Persons who scored one or two moved a mean of 16 blocks and, persons who scored three or four on the FAT had a mean of 28 on the BBT. Finally, people who got a perfect score of five points of the FAT had a mean score of 51 on the BBT. This indicates that the BBT is closely related to global arm function but its continuous nature makes it more sensitive to change than the FAT which is calibrated on an ordinal scale of only five levels (Table 4.1). Therefore, the BBT can be used as an accurate estimator of arm function during the period immediately following the stroke. It is a reliable and valid assessment and can be administered in a relatively short amount of

time and requires very little equipment. Moreover, this study shows that it is a very responsive measure, especially with the mild and moderate stroke.

Predictors of upper extremity function can be used by therapists to implement effective rehabilitation programs to maximize improvement. The finding that lower extremity function predicts upper extremity function and that their rates of recovery during the first month post-stroke are similar indicates that rehabilitation programs should include tasks that involve both extremities.

Future studies should take into account the different aspects of upper extremity function such as sensation, proprioception and kinesthesia which may be important predictors of upper extremity function.. This study showed improvement of both the upper and the lower extremities during the first five weeks post-stroke, it would be important to determine if improvement of function continues beyond this critical period and if the predictors of upper extremity function remain the same or change further on in the recovery process.

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APPENDIX A

INSTRUMENTATION

A1.0 Description and Instructions for Administration of Outcome Measures

A2.0 Scoring Sheets for Outcome Measures

A1.0.1 Baseline Status and Screening Measures

A) The Canadian Neurological Scale

B) The Brief Mini-Mental State Examination

C) The Nine-Hole Peg Test

A) The Canadian Neurological Scale (CNS)

The CNS scale adheres to a few simple criteria which include (1) detection of clinically noteworthy differences in neurologic status, (2) testing of relevant modalities most commonly affected in acute stroke and having possible prognostic value, (3) ease of use and interpretation by observers with different medical training, and (4) brevity and practicality of its use in the acute stroke period. The scale measures neurologic status in stroke patients and is divided into two sections, namely mentation, and motor function. Motor function is further subdivided into two subsections, distinguished by whether the patient is able to understand the testing procedure. Content validity has been demonstrated. As well, an evaluation of concurrent validity compared the CNS with a standard neurologic evaluation, resulting in Spearman rank correlation coefficients ranging from 0.574 to 0.775 ($p<0.001$). The analysis of predictive validity demonstrated that at six months post-stroke, patients who initially scored 11 or more on the CNS experienced a rate of death of 2.1%, a rate of another vascular event of 2.1%, and were 90% independent in activities of daily living (ADL) as measured by the Katz ADL Index.[83,111] However, patients who initially scored 9 or less experienced a rate of death of 13.2%, a rate of repeated vascular event of 20.6% and were approximately 45% independent in ADL at six months post-stroke.[83]

CANADIAN NEUROLOGICAL SCALE

1) Level of Consciousness
-Alert: Normal consciousness
- Drowsy: Patient when stimulated verbally remains awake and alert for a short period of time but tends to doze even when examined.

2) Orientation
Oriented: Patient is oriented to both place (i.e. city *or* hospital) *and* to time (i.e. patient must be at least correct within 2 weeks) if early in month (i.e. first 3 days) previous month is acceptable. Speech can be dysarthric (mispronounced or slurred) but intelligible.

3) Speech (Language and Pronunciation):
a) Receptive Language:
- Patient is asked:
(i) Close eyes.
(ii) Open your mouth.
(iii) Point to the ceiling. Repeat twice if necessary.
-If patient obeys 3 commands continue to b) expressive language.
-If patient obeys only 2 or less commands, score receptive defect in Speech Scale, and then proceed directly to motor function testing.
b) Expressive Language:
-Objects needed: pencil, key, watch.
- In this section pay special attention not only to answer but also to word pronunciation (i.e. dysarthria or slurred speech).

1) Ask patient to name each object. Make sure patients see objects.
- If patient names only two or less of the objects, patient is scored expressive defect in speech Scale.
- If patient names correctly 3 objects, proceed to #2 below.

2) Ask the patient the following questions:
- What do you do with a pencil?
- What do you do with a key?
- What do you do with a watch?
- If patient answers correctly 3 questions, he/she is scored normal speech.
- If patient answers only two or less questions he/she is scored expressive defect in Speech Scale.

N.B. The above scoring system relates to language only, problems with pronunciation of words (i.e. dysarthria or slurred speech) is graded directly on Speech Scale below.
- Patient should always be scored according to worst speech deficit (i.e. language score or mispronunciation).
- Do not mimic commands in section a) on Receptive Language.

3) Speech Scale
-Normal Speech: Answers all commands and questions in speech section, patient can have slurred speech (dysarthria) but still intelligible.
- Expressive defect: Patient obeys command in receptive language section but makes one or more errors in section on expressive language and /or mispronunciation of words (slurred speech), with speech totally or partially non intelligible (severe dysarthria).
- Receptive Defect: Patient obeys only two or less commands in section on receptive language.
Motor Function
- When evaluating strength and range of motion in limbs always submit both limbs to same testing (i.e. apply same resistance at same position bilaterally).

Section A1 This section to be used if patient does no have comprehension problems (i.e. normal speech or expressive defect only).
4) Face:
- Test: Ask patient to show teeth or gums.
- Grading of deficit
- No weakness: Symmetrical grin, no asymmetry in smile.
- Weakness: Facial asymmetry. One cornier of mouth lower than other, either at rest or while showing teeth.

5) Upper Limb (Proximal)
- Patient should be tested in sitting postion if possible
-Test: Abduction arms (to 90°).
- If patient lying in bed.
- Test: Elevate arms to approximately 45° to 90°.
- Strength in both arms tested simultaneously.
Resistance applied at midpoint between shoulder and elbow at all times.
6) Upper Limb (Distal):
- Patient tested in sitting or lying position arms elevated.
- Test: Patient asked to make fists and to extend wrists.
- Compare range of movement in both wrists simultaneously.
- If full range of extension in both wrists proceed to test strength by applying resistance separately to both fists while stabilizing patient's arm firmly.
7) Lower Limb
- Patient lying in bed for testing should always be scored according to worst deficit either a) or b).
- Test: (a) Hip flexion. Ask patient to flex thighs toward trunk with knees flexed at 90°. Movement in both thighs tested separately.
8) (b) Dorsiflexion foot. Ask patient to point toes and foot upwards. Compare both feet simultaneously (i.e. complete or partial movement).
- In both a) and b) apply resistance alternately to each thigh and foot after the full movement has been completed to test strength.
- Graduation of Motor Deficit
- No weakness: No detectable weakness.
- Mild weakness: Normal range of motion against gravity, but succumbs to resistance by observer either partially or totally.
- Significant weakness: Cannot completely overcome gravity in range of motion (i.e. partial movement).
- Total weakness: Absence of motion in movement tested or only contraction of muscles without actual movement of limb.

Section A2 - This section to be used for patients with comprehension problems (i.e. receptive defect in Speech Scale).
- Motor function in this section ca be monitored in one of two ways:
a) The ability of the patient to maintain a fixed posture in upper or lower limbs for a few seconds (3-5seconds). The observer will alternately place the limbs in the desired position.
1) Upper limbs: Place arms outstretched at 90o in front of patient.
2) Lower limbs: Flexion of thighs with knees flexed at 90°.
3) Facial Power: Have patient mimic your own grin. If patient does not cooperate then one proceeds to:
b) Comparison of motor response to a noxious stimuli (i.e. pressure on nailbed of fingers or toes alternately with a pencil). Facial response (grimacing) to pain is tested by applying pressure on sternum.
4) Face (grimacing).
- Symmetrical
- Asymmetrical (note side)
5) Upper Limbs:
- Equal motor response: Patient can maintain the fixed posture equally in both upper limbs for a few seconds or withdraws equally on both sides to pain.
- Unequal motor response: Patient cannot maintain equally on both sides the fixed posture, weakness is noted on one side or there is an unequal withdrawal to pain. Note side where withdrawal not as brisk.
6) Lower Limbs:
- Equal motor response: Patient can maintain the fixed posture equally in both lower limbs for a few seconds or withdraws equally on both sides to pain.
- Unequal motor response: Patient cannot maintain equally on both sides the fixed posture, weakness is noted on one side or there is an unequal withdrawal to pain. Note side where withdrawal not as brisk.

B) The Brief Version of the Mini-Mental State Examination (Brief MMSE)

The brief version MMSE has four items and is scored out of 18. The items are orientation (10 points), recalling 3 items (3 points), and spelling WORLD (MONDE) backwards (5points). These four items have been shown to explain 98.8% of the variability of the full MMSE and a cut off of 13 or lower correctly identified 95.5% of cognitively impaired individuals (sensitivity) with a specificity of 90.5%.[112]

BRIEF MMSE

ORIENTATION

What is the

1- Year
2- Season
3- Date
4- Day of the week
5- Month

Give one point for each correct answer ___5

Where are we ?

1- Country
2- Province
3- City
4- Building
5- Your present address

Give one point for each correct answer ___5

Name 3 objects : LEMON, KEY, BALL
Take 1 second to say each word.

Ask subject to spell WORLD backwards. Give one point for each correct letter in the right order.

___5

RECALL

Ask the subject to repeat the 3 objects previously mentioned : LEMON, KEY, BALL.
Give one point for each correct response. ___3

VERSION BRÈVE DU MMSE

ORIENTATION

Indiquez-moi la

1- Année
2- Saison
3- Date
4- Jour de la semaine
5- Mois

Donnez un point pour chaque bonne réponse ___5

Où sommes nous ?

1- Pays
2- Province
3- Ville
4- Immeuble
5- Votre adresse courante

Donnez un point pour chaque bonne réponse ___5

Mentionnez 3 objets : CITRON, CLÉ, BALLON
Prenez 1 seconde pour prononcer chaque mot.

Demandez au sujet d'épeler le mot MONDE à l'envers. Donnez 1 point pour chaque lettre correcte et dans le bon ordre. ___5

RAPPEL

Demandez au sujet les 3 objets déjà mentionnés : CITRON, CLÉ, BALLON.
Donnez 1 point pour chaque bonne réponse. ___3

C) The Nine-Hole Peg Test (NHPT)

The subject takes nine dowels (9 mm diameter, 32 cm long) from the table top and puts them into 9 holes (10 mm diameter, 15 mm deep) spaced 15 mm apart on a board until all the holes are filled.[92] The subject is then asked to remove the pegs one at a time and to return them to the container. The board is centered in front of the subject, with the pegs placed in the container next to the board on the same side as the hand being evaluated. The stopwatch is started by the examiner as soon as the subject's hand touched the first peg and stopped when the last peg hits the container. The container is placed on the opposite side of the board. Both hands are tested, starting with the dominant hand. A study by Mathiowetz et al.[44] demonstrated very high interrater reliability (right: $r = 0.97$, left: $r = .99$) and a moderate to high test-retest reliability (right: $r = 0.43$, left: $r = 0.43$). Clinical norms for adults 20 to 75+ years of age for both males and females were established.[44]

NINE HOLE PEG TEST

The board is placed in front of the subject. The pegs are in a container adjacent to the board, on the side of the evaluated hand.

"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 all the holes are 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. This is a practice test. See how fast you can put all the pegs in and take them out again. Are you ready? Go!".

"This is the actual test. The instructions are the same. Work as quickly as your can. Are you ready? Go!" (During the test) "Faster" (As soon as the last peg is in the board) "Out again...faster".

LE NINE HOLE PEG TEST

La planchette de bois est placée en face du sujet; les chevilles de bois sont dans un contenant adjacent à la planchette de bois (du côté de la main évaluée).

"Prenez les chevilles, une à la fois en utilisant votre main droite (gauche) et placez-les dans les trous, dans n'importe quel ordre jusqu'à ce que tous les trous soient remplis. Puis, enlevez les chevilles une à la fois, et remettez-les dans le contenant. Stabilisez la planchette avec votre main gauche (droite). Ceci n'est qu'une pratique. Voyez à quelle vitesse vous pouvez placer toutes les chevilles sur la planchette puis les remettre dans le contenant. Etes-vous prêt? Commencez".

Ceci est le vrai test. Les instruction sont les mêmes. Travaillez aussi vite que vous le pouvez. Etes-vous prêt? Commencez". (Pendant le test) "Plus vite" (Aussitôt que toutes les chevilles sont dans la planchette) "Retirez-les maintenant, plus vite".

A1.0.2 Upper Extremity Measures

A) The Box and Block Test

B) The Frenchay ArmTest

C) Grip Strength

A) The Box and Block Test (BBT)

The main outcome of this study, upper extremity function, will be estimated by a gross manual dexterity test, the Box and Block test. Among other reasons, this test was chosen because it has normative data for the Quebec elderly.[113] The Box and Block Test evaluates gross unilateral manual dexterity. The subject is required to move, one by one, the maximum number of blocks from one compartment of a box to another of equal size within one minute. Cromwell[105] has shown that the test-retest reliability is greater than 0.9, and that the test correlated highly with another similar test of dexterity. Desrosiers et al.[113] verified the test-retest reliability and construct validity of this instrument in the elderly population with upper extremity impairment. The ICC ranged from 0.89 to 0.97, and significant correlations were verified between the Box and Block Test, an upper limb performance measure, the Action Research Arm Test (ARA) (right: $r = 0.80$; left: $r = 0.82$) and a measure of functional independence, the Functional Autonomy Measurement System (SMAF) ($r = 0.32$ to 0.48). According to McEwen,[15] the Box and Block Test is a significant predictor of physical health as measured by the SF-36 (Medical Outcomes Study 36-Item Short Form Questionnaire). She found that an amount of seven blocks increased by 2 the Physical Component Summary Score and this amount is considered clinically relevant.[107]

THE BOX AND BLOCK TEST

I want to see how quickly you can pick up one block at a time with your right (or left) hand (the examiner pointer to the hand). Carry it to the other side of the box and drop it. Make sure your fingertips cross the partition. Watch me while I show you how.

If you pick up two blocks at a time, they will count as one. If you drop one on the floor or table after you have carried it across, it will still be counted, so do not waste time picking it up. If you toss the blocks without your fingertips crossing the partition, they will not be counted. Before you start, you will have a chance to practice for 15 seconds. Do you have any questions? Place your hands on the sides of the box. When it is time to start, I will say "ready" and then "go".

This will be the actual test. The instructions are the same. Work as quickly as you can. Ready. (The examiner waited 3 seconds.) Go (After 1 minute) Stop. (Counting was recorded as described above). Now you are to do the same thing with your left (or right) hand. First you can practice. Put your hands on the sides of the box as before. Pick up one block at a time with your hand, and drop it on the other side of the box. Ready. (The examiner waited 3 sec.) Go. (after 15 sec.) Stop.
This will be the actual test. The instructions are the same. Work as quickly as you can Ready. (The examiner waited 3 seconds). Go. (After 1 minute) Stop.

LE BOX AND BLOCK TEST

Je veux voir à quelle vitesse vous pouvez prendre les blocs, un à un avec votre main droite (gauche), (l'évaluateur pointe la main). Transportez le bloc de l'autre côté de la boîte et relâchez. Le bout de vos doigts doit traverser la séparation du milieu. Regardez-moi, je vais vous montrer.

Si vous prenez deux blocs à la fois, il ne compterons que pour un. Si vous échappez un bloc par terre ou sur la table après l'avoir traversé de l'autre côté de la boîte, ils seront comptés, ne perdez pas de temps pour les ramasser. Si vous lancez les blocs sans que le bout de vos doigts ait traversé la séparation du milieu, ils ne seront pas comptés. Avant de commencer, vous aurez la chance de vous pratiquer pendant 15 secondes. Avez-vous des questions? Placez vos mains de chaque côté de la boîte. Quand ce sera le temps de commencer, je dirai "prêt" et "partez".
Ceci est le vrai test. Les instructions sont les mêmes. Travaillez aussi vite que vous le pouvez. Prêt? (L'évaluateur attend 3 secondes). Partez (Après une minute) Arrêtez. (Compter les blocs). Maintenant vous faites la même chose avec votre main gauche (droite). D'abord, vous pouvez vous pratiquer. Placez vos mains de chaque côté de la boîte comme auparavant. Prenez un bloc à la fois avec votre main et transportez-le de l'autre côté de la boîte. Prêt?. (L'évaluateur attend 3 secondes). Partez (après 15 secondes). Arrêtez.
Ceci est le vrai test. Les instructin sont les mêmes. Travaillez aussi vite que vous le pouvez. Prêt? (L'évaluateur attend 3 secondes). Partez. (Après une minute) Arrêtez.

B) The Frenchay Arm Test

This test of upper extremity function consists of five pass/fail bilateral tasks, the subject scoring 1 for each one completed successfully. The validity of this test had been demonstrated - patients scoring 5/5 are likely to use their affected upper extremity, even if they feel it is not normal. The reliability of the test has also been demonstrated.[95] The subject sits at a table with his hands in his lap, and each task start from this position. He is then asked to use his affected arm/hand to:

1- Stabilize a ruler, while drawing a line with a pencil held in the other hand. To pass, the ruler must be held firmly.

2- Grasp a cylinder (12 mm diameter, 5 cm long), set on its side approximately 15 cm from the table edge, lift is about to 30 cm and replace without dropping.

3- Pick up a glass, half full of water positioned about 15 to 30 cm from table edge, drink some water and replace without spilling.

4- Remove and replace a spring clothes peg from a 10 mm diameter dowel, 15 cm long set in a 10 cm base, 15 to 30 cm from table edge. Not to drop peg or knock dowel over.

5- Comb hair (or imitate) ; must comb across top, down the back and down each side of head.

Le Test de Frenchay

Consiste de cinq tâches bilatérales valant 1 point chacune si elles sont complétée avec succès. Le patient est assis à une table, les mains sur les cuisses. Chaque tâche commence dans cette position. L'évaluateur lui demande de faire ces tâches en utilisant son côté affecté :

1-Stabiliser une règle en traçant une ligne avec un crayon qu'il tient de son bon côté. Pour passer, la règle doit être tenue fermement.

2-Prendre un cylindre (12mm de diamètre, 5 mm de longueur), le mettre debout à 15 cm du bord de la table, le soulever de 30 cm et le replacer sans l'échapper.

3-Prendre un verre rempli d'eau à sa moitié, placé entre 15 et 30 cm du bord de la table, boire l'eau et replacer le verre sans renverser d'eau.

4-Enlever et replacer une épingle à linge d'un cylindre de 10 mm de diamètre et de 15 cm de long encré dans une base de 10 cm et placée entre 15 et 30 cm de bord de la table. Ne pas échapper l'épingle et ne pas renverser le cylindre.

5-Se peigner les cheveux. Doit peigner sur le dessus, en arrière et de chaque côté.

C) Grip Strength

Grip strength is a clinical measure that is frequently used to estimate sensorimotor deficits and monitor how they evolve over time. It is an important prerequisite for good hand function.[114] The Jamar™ dynamometer will be used to measure grip strength. Persons being evaluated will be seated on a standard height chair without armrests. Three grip strength measures of each hand was taken and the highest score was be retained. The Jamar™ dynamometer is considered to be the most precise instrument for measuring grip strength.[100] No learning effect or fatigue is present when three consecutive measures are taken.[100] The American Society of Hand Therapists (ASHT) recommended that the second handle position of the dynamometer be used when evaluating grip strength. It has been shown that two trained raters following standardized test procedures can independently evaluate hand strength and obtain essentially the same scores. This study also indicates that test-retest reliability can be achieved by using the standardized positioning and instructions. Mathiowetz et al.[115] also established clinical norms for adults aged 20 to 75+ years. Desrosiers et al.[114] have developed normative data for grip strength of elderly men and women.

GRIP STRENGTH

Subjects are seated on a standard height chair without armrests with their elbow flexed at 90 degrees, their shoulders adducted and naturally rotated, their forearm in neutral position and wrist between 0 and 30 degrees dorsiflexion and between 0 and 15 degrees ulnar deviation.. Three grip strength measures of each hand are taken using the Jamar dynamometer, the highest score will be retained.

Instructions : 'I want you to hold the handle like this and squeeze as hard as you can'. The examiner demonstrates and then gives the dynamometer to the subject. After the subject is positioned appropriately, the examiner says : 'Are you ready ?' Squeeze as hard as you can'. As the subject begins to squeeze, say, 'Harder ! ... Harder !... Relax.' After the first trial score is recorded, the test is repeated with the same instructions for the second and third trials and for the other hand.

Right hand :	1-	Left hand :	1-
	2-		2-
	3-		3-

FORCE DE PRÉHENSION

Le sujet est assis sur une chaise de hauteur standard, sans appui-bras. Le coude est placé a 90 degrés de flexion, l'épaule en adduction et en rotation neutre, l'avant-bras en position neutre et le poignet entre 0 et 30 degrés de dorsiflexion et entre 0 et 15 degrés de déviation ulnaire. Trois mesures de chaque main sont prises avec un dynamomètre Jamar, la plus haute sera retenue.

Instructions : 'Je veux que vous teniez la poignée comme ceci et serriez aussi fort que vous le pouvez.' L'évaluateur fait la démonstration et donne le dynamomètre au sujet. Une fois que le sujet est dans la bonne position, l'évaluateur dit : 'Êtes-vous prêt ? Serrez aussi fort que vous le pouvez'. Lorsque le sujet commence à serrer, dites : 'plus fort... plus fort... relâchez'. Les instructions sont les mêmes pour les deuxième et troisième mesures ainsi que pour l'autre main.

Main droite :	1-	Main gauche :	1-
	2-		2-
	3 ·		3-

A1.0.3 Mobility Measures

A) Comfortable, 5 metres Gait Speed

B) Timed 'Up and Go'

A) Comfortable Gait Speed

Gait speed is a valid and reliable measure of stroke outcome and has been shown to correlate with the level of independence in daily living,[116] as well as functional mobility.[117] Coefficients of test-retest reliability have been reported to range between 0.89 and 1.00[118-120] over different distances. This test is easy and quick to administere and does requires only limited equipment. Comfortable walking speed was determined over a distances of 5 metres (m), at a comfortable pace. This particular testing procedure has been found more responsive than the 5 m test (maximum speed), the 10 m test (comfortable speed) and the 10 m test (maximum speed).[121]

Gait speed was measured in a quiet section of the hospital corridor, of the rehabilitation department, or of the subject's home, using tape to mark the distances on the floor. Acceleration and deceleration distances, each of 2 m, were marked. Bright pylons were placed at the outer acceleration lines during testing so that the patient could easily visualize the end of the walk distance.

5 m test: (---2 m---)(-------5 m-------)(---2 m---)

* * * pylon

Test Protocol

1. **General:** Using a digital stopwatch, the time it took for the subject to traverse the central 5 m or 10 m portion of the walkway at comfortable and maximum walking speeds was measured.

2. **The Subject:** The subject wore supportive footwear, and comfortable clothing. They walked with their usual orthosis and/or ambulatory aid. The evaluator ensured that the subject wore his/her glasses when indicated.
3. **Pylon Placement:** The orange pylons were placed at the outer acceleration marks, and the subject was asked if they could visualize the pylon.
4. **Start Position and Instructions:** The subject started in a standing position, at the outer acceleration mark. The following instructions were given:

Instructions for COMFORTABLE walking speed:

> "I am going to measure your comfortable walking speed. When I say 'go', walk in a straight line at a pace which is **safe and comfortable for you**, until you reach the second pylon."
>
> "Nous allons mesurer votre vitesse normale de marche. Lorsque je vous direz "partez", vous marcherez en ligne droite à une vitesse **normale et sécuritaire pour vous,** et ce, jusqu'au second pylône."

Timing Procedure: To minimize the level of fatigue, the subject was not given a practice run. During testing, **no verbal encouragement** was given to the subject, as this will influence walking speed, and would make the test environment even more artificial. On the word 'go', the subject began to advance through the 2 m acceleration distance. The evaluator began timing when the subject's first foot crossed the start line, and stopped timing when the first foot crossed the stop line although the patient continued to walk a final 2 m. The evaluator walked beside the patient for safety, and to maximize the accuracy of timing especially as the subject was crossing the start and stop lines.

B) The Timed 'Up and Go'

The recovery of lower extremity function will be ascertained using the Timed Up and Go (TUG).[117] This test measures, in seconds, the time taken by an individual to stand up from a standard arm chair, walk a distance of three meters, turn, walk back to the chair, and sit down again. Both the intra-rater and the inter-rater reliabilities have been demonstrated and it has been shown to be correlated with the Berg Balance scale, the Barthel Index and gait speed.[15] The TUG has demonstrated excellent test-retest reliability (ICC of 0.99) and interrater reliability (ICC of 0.99) in elderly subjects.[119]

THE TIMED 'UP & GO'

Hospital_____

Subject # _____ Assessment date (year/month/day)_____

Assessment done by _____

The timed 'UP & GO' measures, in seconds the time taken by an individual to stand up from a standard arm chair (approximate seat height of 46 cm), walk a distance of 3 meters, turn, walk back to the chair, and sit down again. The subject wars his/her regular footwear and uses the customary walking aid (none, cane, or walker). No physical assistance is given. He/She starts with their back against the chair, arms resting on the chair's arms, and walking aid at hand. He/She is instructed that, on the word 'GO' they are to get up and walk at a comfortable and safe pace to a line on the floor 3 meters away, turn, return to the chair, and sit down again. **The subject walks through the test once before being timed in order to become familiar with the test.** Either a wrist-watch with a second hand or a stop-watch can be used to time the performance.

TOTAL TIME IN SECONDS _____

Comments_____

_____

_____

LE 'UP AND GO' CHRONOMÉTRÉ

Hôpital_____

Sujet # _____ Date d'évaluation
(année/mois/jour)_____

Évaluation faite par _____

Le 'UP & GO' chronométré mesure, en secondes, le temps requis pour un individu de se lever d'un fauteuil standard (hauteur approximative du siège: 46cm),de marcher une distance de 3 mètres, de se tourner, de marcher de retour au fauteuil, et de s'asseoir de nouveau. Le sujet porte ses chaussures habituelles et se sert de son aide à la marche habituelle (aucune, cane ou marchette). L'assistance physique n'est pas permise. L'individu débute avec son dos contre la chaise, les bras appuyés sur les bras du fauteuil, et son aide à la marche en main. Les directives suivantes sont données: "à la commande 'GO', levez-vous, marchez à une allure confortable et sécuritaire jusqu'à la ligne sur le plancher à une distance de 3 mètres, retournez-vous, marchez de nouveau à la chaise et asseyez-vous". **Le sujet effectue le test une fois afin de se familiariser avec le test.** La performance peut être chronométrée avec une aiguille de secondes ou un chronomètre.

TEMPS TOTAL EN SECONDES_____

Commentaires_____

_____

_____

A1.0.4 Others Measures

A) The Mini-Mental State Examination (Telephone Version)

B) Albert's Test of Perceptual Neglect

C) The Stroke Rehabilitation Assessment of Movement (STREAM)

D) The Barthel Index

A) The Telephone Version of the Mini-Mental State Examination (ALFI-MMSE)

Test scores for the original version of the MMSE and the telephone version of the test correlated strongly for all subjects (Pearson's $r = 0.85$, $p = 0.001$) and remained significant for the cognitively intact ($p = 0.02$) and questionably ($p = 0.002$), mildly ($p = 0.0001$) and moderately ($p = 0.003$) demented. Comparison of the two versions' equivalent 22 items revealed no significant difference for scores of all subjects ($p = 0.07$) but with a trend toward higher scores in the original version. Sensitivity and specificity relative to the Brief Neuropsychiatric Screening test (BNPS) were 67% and 100%.[122]

FOLSTEIN'S MINI MENTAL
(telephone version)

ORIENTATION

What is the	1. Year	_____	____ 1
	2. Season	_____	____ 1
	3. Date	_____	____ 1
	4. Day of the Week	_____	____ 1
	5. Month	_____	____ 1

Give 1 point for each correct answer.

Were are we?	1. Country	_____	____ 1
	2. Province	_____	____ 1
	3. City	_____	____ 1
	4. Building	_____	____ 1

Give 1 point for each correct answer.

REGISTRATION

Name 3 objects: LEMON, KEY, BALL
Take one second to say each word.
Then ask the subject to repeat the 3 words.
Give 1 point for each correct answer.
Repeat the exercise until he/she learns all 3.
Count the number of trials and record.

ATTENTION AND CALCULATION

Ask the subject to begin at 100 and count backward by 7. ____ 5
Stop after 5 substractions.
Give 1 point for each correct response.
If the subject cannot or will not perform this task, ask him/her to spell the word "WORLD" backward. The score is the number of letters in correct order.

RECALL

Ask the subject to repeat the 3 objects previously mentioned: ____ 3
LEMON, KEY, BALL.
Give 1 point for each correct response.

LANGUAGE

Ask the subject to repeat a phrase and name one item. ____ 1
"No ifs, ands or buts"
Ask the subject to name one item. ____ 1
"Tell me, what is the thing called that your are speaking into as you talk to me?"
Give 1 point for each correct response.

PETIT EXAMEN DE FOLSTEIN SUR L'ETAT MENTAL
(version téléphonique)

ORIENTATION

Indiquez-moi la:

1.Année	_____	____ 1
2. Saison	_____	____ 1
3. Date	_____	____ 1
4. Jour de la semaine	_____	____ 1
5. Mois	_____	____ 1

Donner 1 point pour chaque bonne réponse. ____ 5

Où sommes-nous?

1. Pays	_____	____ 1
2. Province	_____	____ 1
3. Ville	_____	____ 1
4. Immeuble	_____	____ 1

Donner 1 point pour chaque bonne réponse. ____ 5

ENREGISTREMENT

Scolarité_____

Mentionnez 3 objets: CITRON, CLÉ, BALLON. ___ 3
Prenez un seconde pour prononcer chaque mot.
Par la suite, demandez au sujet de répéter les 3 mots.
Donnez 1 point pour chaque bonne réponse.
Répétez la démarche jusqu'à ce que le sujet apprenne les 3 mots.
Comptez le nombre d'essais et notez-le

Nombre d'essais: ____

ATTENTION ET CALCUL

Demandez au sujet de faire la soustraction par intervalles de 7 à partir de 100. ____5
Arrêtez après 5 soustractions.
Donnez 1 point pour chaque bonne réponse.
Une autre épreuve serait de demander au sujet d'épeler le mot "MONDE" à l'envers.

RAPPEL

Demandez au sujet les 3 objets déjà mentionnés: ____ 3
CITRON, CLÉ, BALLON.
Donnez 1 point pour chaque bonne réponse.

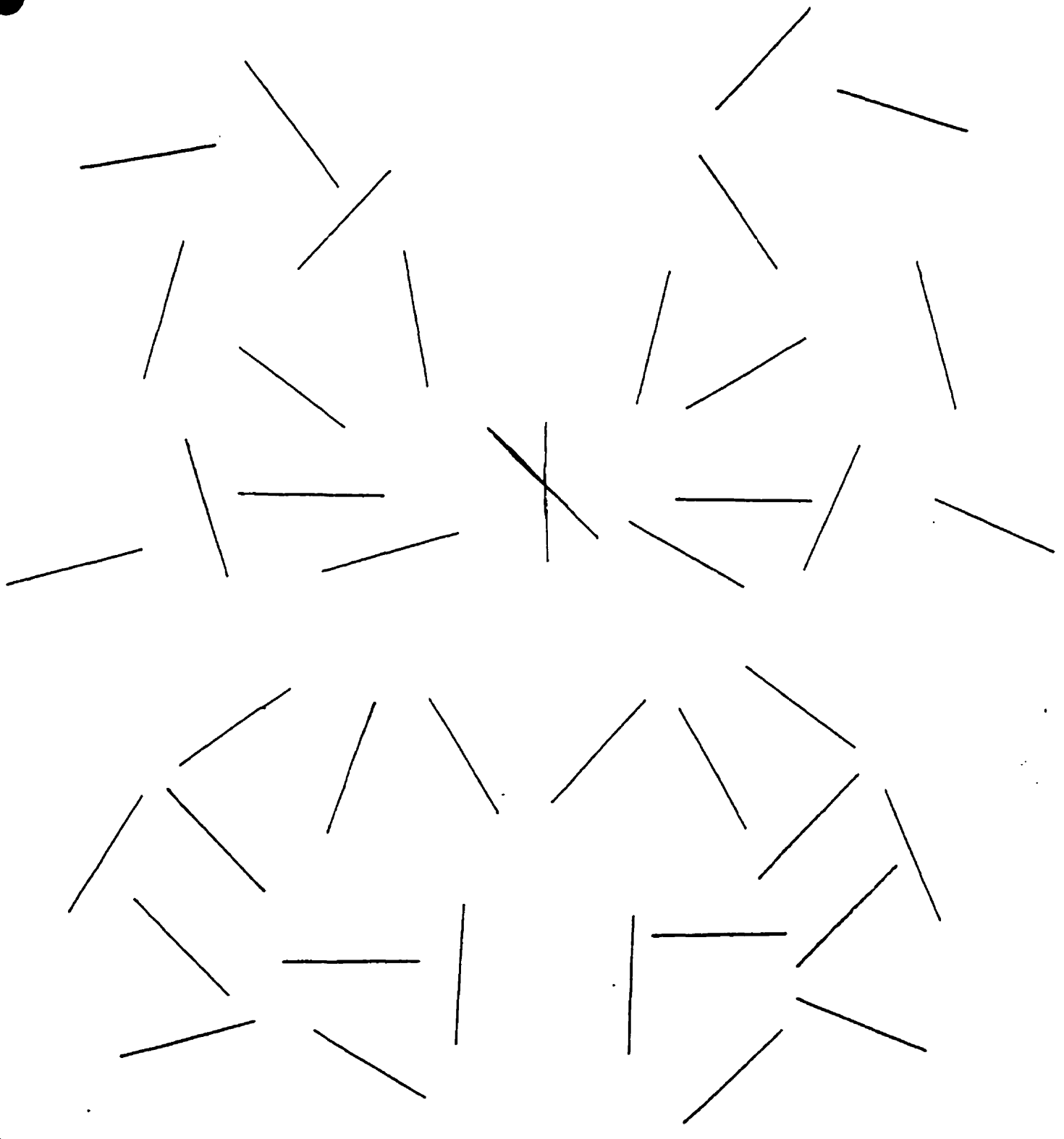
LANGUAGE

Demandez au sujet de répéter la phrase suivante: ____ 1
"Pas de si, ni de mais".
Demandez au sujet de nommer un item. ____ 1
"Dites-moi, quel est le nom de l'objet dont vous vous servez pour parler avec moi?"
Donnez 1 point pour chaque bonne réponse.

B) Albert's Test of Perceptual Neglect

Visuo-spatial neglect is an important predictor of poor outcome after stroke.[123-127.] Perception will be evaluated using Albert's Test of perceptual neglect. This test requires the subject to draw a line across all of 49 lines distributed on a sheet of paper. The score is calculated as the percentage of lines that are left uncrossed. If more than 70% of the uncrossed line are on the same side as the patient's hemiplegia, lateralized neglect is indicated. This test was found to be highly correlated to a full perception test battery, as well as being predictive of mortality and functional activity at six months.[15]

Albert's Test



The patient is instructed to cross out all of the remaining lines on the page.

C) The Stroke Rehabilitation Assessment of Movement (STREAM)

The Stroke Rehabilitation Assessment of Movement (STREAM)[84] will be used to measure voluntary motor ability and basic mobility. The STREAM consists 30 items, divided into three sections : voluntary movement of the upper extremity, voluntary movement of the lower extremity, and basic mobility. Excellent interrater and intrarater reliability were reported[85] with generalizability correlation coefficients of 0.99 for total STREAM scores, and a range of 0.963-0.998 for subscale scores. For 29 out of the 30 individual items, Kappa statistics demonstrated excellent agreement, ranging from 0.8 to 1.0, with only one showing moderate agreement (0.65).

STroke REhabilitation Assessment of Movement (STREAM)

Assessment Dates (Y/M/D)
1.
2.
3.
4.

Patient's Name:_____

Date of CVA:_____ Sex: M F Age:_____

Side of Lesion: L R Side of Hemiplegia: L R

Comorbid Conditions:_____

Type of aid(s) used:_____

Physiotherapist(s):_____

General Comments: _____

_____

_____

_____

STREAM SCORING

I. VOLUNTARY MOVEMENT OF THE LIMBS

0 unable to perform the test movement through any appreciable range (includes flicker or slight movement)
1 a. able to perform only part of the movement, and with marked deviation from normal pattern
b. able to perform only part of the movement, but in a manner that is comparable to the unaffected side
c. able to complete the movement, but only with marked deviation from normal pattern
2 able to complete the movement in a manner that is comparable to the unaffected side
X activity not tested (specify why; ROM, Pain, Other (reason))

II. BASIC MOBILITY

0 unable to perform the test activity through any appreciable range (ie. minimal active participation)
1 a. able to perform only part of the activity independently (requires partial assistance or stabilization to complete), with or without an aid, and with marked deviation from normal pattern
b. able to perform only part of the activity independently (requires partial assistance or stabilization to complete), with or without an aid, but with a grossly normal movement pattern
c. able to complete the activity independently, with or without an aid, but only with marked deviation from normal pattern
2 able to complete the activity independently with a grossly normal movement pattern, but requires an aid
3 able to complete the activity independently with a grossly normal movement pattern, without an aid
X activity not tested (specify why; ROM, Pain, Other (reason))

		AMPLITUDE OF ACTIVE MOVEMENT		
		None	Partial	Complete
MOVEMENT QUALITY	Marked Deviation	0	1 a	1 c
	Grossly Normal	0	1 b	2 (3)

SCORE					
4	3	2	1		
				/2	**SUPINE** 1. PROTRACTS SCAPULA IN SUPINE *"Lift your shoulder blade so that your hand moves towards the ceiling"* Note: therapist stabilizes arm with shoulder 90° flexed and elbow extended.
				/2	2. EXTENDS ELBOW IN SUPINE (starting with elbow fully flexed) *"Lift your hand towards the ceiling, straightening your elbow as much as you can"* Note: therapist stabilizes arm with shoulder 90° flexed; strong associated shoulder extension and/or abduction = marked deviation (score 1a or 1c).
				/2	3. FLEXES HIP AND KNEE IN SUPINE (attains half crook lying) *"Bend your hip and knee so that your foot rests flat on the bed"*
				/3	4. ROLLS ONTO SIDE (starting from supine) *"Roll onto your side"* Note: may roll onto either side; pulling with arms to turn over = aid (score 2).
				/3	5. RAISES HIPS OFF BED IN CROOK LYING (BRIDGING) *"Lift your hips as high as you can"* Note: therapist may stabilize foot, but if knee pushes strongly into extension with bridging = marked deviation (score 1a or 1c); if requires aid (external or from therapist) to maintain knees in midline = aid (score 2).
				/3	6. MOVES FROM LYING SUPINE TO SITTING (with feet on the floor) *"Sit up and place your feet on the floor"* Note: may sit up to either side using any functional and safe method; longer than 20 seconds = marked deviation (score 1a or 1c); pulling up using bedrail or edge of plinth = aid (score 2).
				/2	**SITTING** (feet supported; hands resting on pillow on lap for items 7-14) 7. SHRUGS SHOULDERS (SCAPULAR ELEVATION) *"Shrug your shoulders as high as you can"* Note: both shoulders are shrugged simultaneously.
				/2	8. RAISES HAND TO TOUCH TOP OF HEAD *"Raise your hand to touch the top of your head"*
				/2	9. PLACES HAND ON SACRUM *"Reach behind your back and as far across toward the other side as you can"*
				/2	10. RAISES ARM OVERHEAD TO FULLEST ELEVATION *"Reach your hand as high as you can towards the ceiling"*

SCORE					
4	3	2	1		
				/2	11. SUPINATES AND PRONATES FOREARM (elbow flexed at 90°) *"Keeping your elbow bent and close to your side, turn your forearm over so that your palm faces up, then turn your forearm over so that your palm faces down"* Note: movement in one direction only = partial movement (score 1a or 1b).
				/2	12. CLOSES HAND FROM FULLY OPENED POSITION *"Make a fist, keeping your thumb on the outside"* Note: must extend wrist slightly (ie. wrist cocked) to obtain full marks.
				/2	13. OPENS HAND FROM FULLY CLOSED POSITION *"Now open your hand all the way"*
				/2	14. OPPOSES THUMB TO INDEX FINGER (tip to tip) *"Make a circle with your thumb and index finger"*
				/2	15. FLEXES HIP IN SITTING *"Lift your knee as high as you can"*
				/2	16. EXTENDS KNEE IN SITTING *"Straighten your knee by lifting your foot up"*
				/2	17. FLEXES KNEE IN SITTING *"Slide your foot back under you as far as you can"* Note: start with affected foot forward (heel in line with toes of other foot).
				/2	18. DORSIFLEXES ANKLE IN SITTING *"Keep your heel on the ground and lift your toes off the floor as far as you can"*
				/2	19. PLANTARFLEXES ANKLE IN SITTING *"Keep your toes on the ground and lift your heel off the floor as far as you can"*
				/2	20. EXTENDS KNEE AND DORSIFLEXES ANKLE IN SITTING *"Straighten your knee and bring your toes towards you"* Note: extension of knee without dorsiflexion of ankle = partial movement (score 1a or 1b).
				/3	21. RISES TO STANDING FROM SITTING *"Stand up; try to take equal weight on both legs"* Note: pushing up with hand(s) to stand = aid (score 2); asymmetry such as trunk lean, trendelenburg, hip retraction, or excessive flexion or extension of the affected knee = marked deviation (score 1a or 1c).

SCORE					
4	3	2	1		
				/3	STANDING 22. MAINTAINS STANDING FOR 20 COUNTS *"Stand on the spot while I count to twenty"*
				/2	STANDING **(holding onto a stable support to assist balance for items 23-25)** 23. ABDUCTS AFFECTED HIP WITH KNEE EXTENDED *"Keep your knee straight and your hips level, and raise your leg to the side"*
				/2	24. FLEXES AFFECTED KNEE WITH HIP EXTENDED *"Keep your hip straight, bend your knee back and bring your heel towards your bottom"*
				/2	25. DORSIFLEXES AFFECTED ANKLE WITH KNEE EXTENDED *"Keep your heel on the ground and lift your toes off the floor as far as you can"*
				/3	STANDING AND WALKING ACTIVITIES 26. PLACES AFFECTED FOOT ONTO FIRST STEP (or stool 18 cm high) *"Lift your foot and place it onto the first step (or stool) in front of you"* Note: returning the foot to the ground is not scored; use of handrail =aid (score 2).
				/3	27. TAKES 3 STEPS BACKWARDS (one and a half gait cycles) *"Take three average sized steps backwards, placing one foot behind the other"*
				/3	28. TAKES 3 STEPS SIDEWAYS TO AFFECTED SIDE *"Take three average sized steps sideways towards your weak side"*
				/3	29. WALKS 10 METERS INDOORS (on smooth, obstacle free surface) *"Walk in a straight line over to ... (a specified point 10 meters away)."* Note: orthotic=aid (score 2); longer than 20 seconds =marked deviation (score 1c).
				/3	30. WALKS DOWN 3 STAIRS ALTERNATING FEET *"Walk down three stairs; place only one foot at a time on each step if you can"* Note: handrail=aid (score 2); non-alternating feet=marked deviation (score 1a or 1c).

STREAM INSTRUCTIONS -EN FRANÇAIS

1) En étendant votre main vers le plafond, levez votre épaule du lit.

2) Levez votre main vers le plafond en étendant votre coude le plus possible.

3) Pliez votre hanche et votre genou afin que votre pied repose à plat sur le lit.

4) Roulez sur votre côté.

5) Levez vos hanches le plus haut possible.

6) Asseyez-vous et placez vos pieds sur le plancher.

7) Haussez vos épaules le plus haut possible.

8) Élevez votre main pour aller toucher le haut de votre tête.

9) Placez votre main derrière votre dos en étendant la main le plus loin possible vers l'autre côté.

10) Élevez votre main le plus haut possible vers le plafond.

11) Gardez votre coude plié et proche de votre côté. Tournez votre avant-bras pour que votre paume fasse face au plafond et ensuite vers le plancher.

12) Formez un poing avec votre main en gardant votre pouce a l'extérieur.

13) Maintenant ouvrez votre main.

14) Formez un cercle avec votre pouce et index en touchant bout à bout.

15) Levez votre genou le plus haut possible.

16) Étendez votre genou en levant votre pied.

17) Glissez votre pied sous votre chaise le plus loin possible.

18) Levez votre avant-pied vers le plafond, tout en gardant votre talon sur le plancher.

19) Levez votre talon tout en gardant vos orteils sur le plancher.

20) Étendez votre genou et ramenez vos orteils vers vous.

21) Levez-vous debout en essayant de distribuer votre poids également sur les deux jambes.

22) Tenez vous debout pendant que je compte jusqu'à 20.

23) En gardant votre genou droit et vos hanches horizontales (à niveau) levez votre jambe vers le côté.

24) En gardant votre hanche droite, pliez votre genou afin de rapprocher votre talon vers votre derrière (vos fesses).

25) Levez votre avant-pied vers le plafond en gardant votre talon sur le plancher.

26) Levez votre pied et placez-le sur la marche (le tabouret) devant vous.

27) Reculez de 3 pas en plaçant un pied derrière l'autre.

28) Faites 3 pas de côté vers votre côté faible.

29) Marchez en ligne droite vers....(précisez l'endroit à 10 mêters).

30) Descendez 3 marches en essayant de placer seulement un pied à la fois sur chaque marche.

D) The Barthel Index

The validity of the Barthel Index has been established and extensive work using the Barthel Index as a predictor of outcome has shown a close relation between the score on this index at admission and outcome.[128, 129,130] It is a weighted scale measuring performance in self-care (feeding, bathing personal toilet, dressing, bowel and bladder care) and mobility (transfers, ambulation and stair-climbing). It is also a functional assessment scale with the advantages of simplicity and high interrater reliability.[131] The interrater reliability of the Barthel Index in a mixed neurological population using the Pearson product moment correlation has been shown to range from 0.884 to 0.991 ($p<0.001$) for total scores.[132] Moreover, the Barthel Index has been found to be predictive of living arrangement status in stroke,[130] as well as length of stay and patient progres.[135]

THE BARTHEL INDEX
DEFINITION AND DISCUSSION OF SCORING

1. FEEDING

10 = INDEPENDENT. The patient can feed himself a meal from a tray or table when someone puts the food within his reach. He must put on an assistive device himself if it is required, cut up the food, use salt and pepper, spread butter etc.. He must accomplish this in a reasonable time.

5 = SOME HELP IS NECESSARY. (with cutting up food, etc., as listed above)

0 = The patient cannot meet the criteria as defined above.

2. DOING PERSONAL HYGIENE

5 = INDEPENDENT. Patient can wash hands and face, comb hair, clean teeth, and shave. He may use any kind of razor but must put in blade or plug in razor without help as well as get it from drawer or cabinet. Female patients must put on own make-up, if used, but need not braid or style hair

0 = SOME HELP IS NECESSARY

0 = The patient cannot meet the criteria as defined above.

3. BATHING SELF

5 = INDEPENDENT. Patient may use bath tub, a shower, or take a complete sponge bath. He must be able to do all the steps involved in whichever method is employed without another person being present.

0 = SOME HELP IS NECESSARY

0 = The patient cannot meet the criteria as defined above.

4. DRESSING AND UNDRESSING

10 = INDEPENDENT. Patient is able to put on, remove and fasten all clothing, and tie shoe laces (unless it is necessary to use adaptive aids for this). The activity includes putting on and removing and fastening corset or braces when they are prescribed. Such special clothing as suspenders, loafer shoes or dresses that open down the front may be used when necessary.

5 = SOME HELP IS NECESSARY. Patient needs help in putting on and removing or fastening any clothing. He must do at least half the work himself. He must accomplish this in reasonable time. Women need not be scored on use of a brassiere or girdle unless these are prescribed garments.

0 = The patient cannot meet the criteria as defined above.

5. GETTING ON AND OFF THE TOILET

10 = INDEPENDENT. Patient is able to get on and off toilet, fasten and unfasten clothes, prevent soiling of clothes, and use toilet paper without help. He may use a wall bar or other stable object for support if needed. If it is necessary to use a bed pan instead of a toilet, he must be able to place it on a chair, empty it, and clean it.

5 = SOME HELP IS NECESSARY. Patient needs help because of imbalance or in handling clothes or in using toilet paper.

0 = The patient cannot meet the criteria as defined above.

6. CONTINENCE OF BOWELS

10 = INDEPENDENT. Patient is able to control his bowels and have no accidents. He can use a suppository or take an enema when necessary (as in spinal cord injury patients who have had bowel training).

5 = NEEDS SOME ASSISTANCE. Patient needs help in using a suppository or taking an enema or has occasional accidents.

0 = The patient cannot meet the criteria as defined above.

7. CONTROLLING BLADDER

10 = INDEPENDENT. Patient is able to control his bladder day and night. Spinal cord injury patients who wear an external device and a leg bag must put them on independently, clean and empty bag and stay dry day and night.

5 = NEEDS SOME ASSISTANCE. Patient has occasional accidents or cannot wait for the bed pan or get to the toilet in time or needs help with an external device.

0 = The patient cannot meet the criteria as defined above.

8. CHAIR/BED TRANSFERS

15 = INDEPENDENT. Independent in all phases of this activity. Patient can safely approach the bed in his wheelchair, lock brakes, lift footrests, move safely to bed, lie down, come to a sitting position on the side of the bed , change the position of the wheelchair, if necessary, to transfer back into it safely, and return to the wheelchair. For those not in a wheelchair, patient can transfer from chair to bed and back again.

10 = NEEDS SOME ASSISTANCE. The patient needs to be reminded or supervised for safety of one or more parts of this activity.

5 = NEEDS THE PHYSICAL ASSISTANCE OF A PERSON. The patient can come to a sitting position without the help of a second person but needs to be lifted out of bed, or if he transfers it is with a great deal of help of a person.

0 = The patient cannot meet the criteria as defined above.

9. WALKING ON A LEVEL SURFACE

15 = INDEPENDENT. Patient can walk at least 50 yards without help or supervision. He may wear braces or prostheses and use crutches, canes, or a walkerette but not a rolling walker. He must be able to lock and unlock braces if used, assume the standing position and sit down, get the necessary mechanical aides into position for use, and dispose of them when he sits. (putting on and taking off braces is scored under dressing)

10 = NEEDS SOME ASSISTANCE. Patient needs supervision in any of the above but can walk at least 50 yards with minimal help.

5 = NEEDS THE PHYSICAL ASSISTANCE OF A PERSON. The patient can not walk without a great deal of help of a person.

0 = The patient cannot meet the criteria as defined above.

10. ASCENDING AND DESCENDING STAIRS

10 = INDEPENDENT. Patient is able to go up and down a flight of stairs safely without help or supervision. He may and should use handrails, canes, or crutches when needed. He must be able to carry canes or crutches as he ascends or descends stairs.

5 = NEEDS SOME ASSISTANCE. Patient needs help with or supervision of any one of the above items.

0 is given if the patient cannot meet the criteria as defined above.

11. PROPELLING A WHEELCHAIR

5 = INDEPENDENT. If a patient cannot ambulate but can propel a wheelchair independently. He must be able to go around corners, turn around, maneuver the chair to a table, bed, toilet, etc.. He must be able to push a chair at least 50 yards. Do not score this item if the patient gets a score for walking.

0 is given if the patient cannot meet the criteria as defined above.

BARTHEL INDEX - EN FRANÇAIS

Hôpital_____

[redacted]ct # _____ Date d'évaluation (année/mois/jour)_____

L'évaluation fait par _____

Nous allons commencer par vous poser des questions sur votre fonctionnement dans la vie de tous les jours.

1. Si vous n'aviez personne pour vous aider avec votre nourriture, pourriez-vous l'accomplir seul?
(incapable = 0; besoin d'assistance = 5; complètement indépendant = 10) ____

2. Si vous n'aviez personne pour vous aider avec votre toilette, pourriez-vous l'accomplir seul?
(incapable = 0; besoin d'assistance = 5; complètement indépendant = 5) ____

3. Si vous n'aviez personne pour vous aider, pourriez-vous prendre un bain ou une douche seul?
(incapable = 0; besoin d'assistance = 0; complètement indépendant = 5) ____

4. Si vous n'aviez personne pour vous aider, pourriez-vous vous habiller seul?
(incapable = 0; besoin d'assistance = 5; complètement indépendant = 10) ____

5. Si vous n'aviez personne pour vous aider, pourriez-vous aller à la toilette seul?
(incapable = 0; besoin d'assistance = 5; complètement indépendant = 10) ____

6. Avez-vous des problèmes d'incontinence fécale?
(aucun = 0; accidents occassionels = 5; contrôle total jour et nuit = 10) ____

7. Avez-vous des problèmes d'incontinence urinaire?
(aucun = 0; accidents occassionels = 5; contrôle total jour et nuit = 10) ____

8. Pouvez transferrer d'un lit à une chaise seul?
(incapable = 0; besoin d'assistance = 5-10; complètement indépendant = 15) ____

9. Pouvez vous marcher 50 mètres sans aide ou supervision?
(incapable = 0; besoin d'assistance = 10; complètement indépendant = 15) ____

10. Pouvez vous monter et dèscendre les escaliers seul?
(incapable = 0; besoin d'assistance = 5; complètement indépendant = 10) ____

[redacted]<u>npter seulement si le client est incapable de marcher</u>

11. Utilisez-vous un fauteuil roulant?
(incapable = 0; besoin d'assistance = 0; complètement indépendant = 10) ____

A2.0 Scoring sheets for all Outcome Measures

A) Patient Status Sheet

B) Baseline Status and Screening Measures

C) Upper Extremity Measures

D) Lower Extremity Measures

E) Other Measures

PHYSICAL RECOVERY FROM STROKE

PATIENT STATUS SHEET

Subject Number _____ Hospital _____ Room Number _____

Sex M F Age _____ Name of patient_____

Complete address (Street/apt. Number/city/province/postal code)_____

_____

Telephone numbers_____

Date of stroke_____ Date of emergency

_____

Date of admission_____ Date of discharge_____

Type of stroke 1. Ischemic R L CVA
2. Hemorrhagic Site of lesion_____

No. of comorbid conditions_____ List:_____

_____

Ambulatory aid used prior to the stroke_____ No. of rehab sessions_____

Destination 1. Home 2. Rehab 3. LTC 4. Transfer 5. Deceased

Name of institution_____ Caregiver Y N

Name_____ Tel_____ Relationship_____

STUDY STATUS

Consent	Y	N	Date_____	Place_____
Refusal	Y	N	Date_____	Place_____
Assessment 1	Y	N	Date_____	Place_____
Assessment 2	Y	N	Date_____	Place_____
Assessment 3	Y	N	Date_____	Place_____
Assessment 4	Y	N	Date_____	Place_____
Assessment 5	Y	N	Date_____	Place_____

Reason for not obtaining consent_____

CANADIAN NEUROLOGICAL SCALE

Hospital_____
Study Number_____ Assessment date (year/month/day)_____
Subject_____ Assessment done by_____

SECTION A -FOR DROWSY OR ALERT PATIENTS - MENTATION

1) LEVEL OF CONSCIOUSNESS
3 = alert 1.5 = drowsy
2) ORIENTATION
1 = oriented 0 = disoriented or non-applicable
3) SPEECH
1 = normal 0.5 = expressive deficit 0 = receptive deficit
TOTAL - MENTATION SCORE ___ /5

SECTION A1 **OR** **SECTION A2**
MOTOR (NO RECEPTIVE DEFICIT) (RECEPTIVE DEFICIT)

4) FACE
0.5 = none
0 = present

5) ARM PROXIMAL
1.5 = none
1.0 = mild
0.5 = significant
0 = total

6) ARM DISTAL
1.5 = none
1.0 = mild
0.5 = significant
0 = total

7) LEG PROXIMAL
1.5 = none
1.0 = mild
0.5 = significant
0 = total

8) LEG DISTAL
1.5 = none
1.0 = mild
0.5 = significant
0 = total

TOTAL - Section A1 ___/ 6.5
TOTAL - A + A1 = ___/ 11.5

4) FACE
0.5 = symmetrical
0 = asymmetrical

5) ARMS
1.5 = equal
0 = unequal

6) LEGS
1.5 = equal
0 = unequal

TOTAL - Section A2 ___/ 3.5

B) SCREENING MEASURES DATA SHEET

BRIEF MMSE

Hospital_____ **Assessment date (year/month/day)**_____
Subject_____ **Evaluator**_____

Orientation _____/5 _____/5 _____/5
Recall _____/3
Total_____/18

Comments_____
_____
_____

NINE HOLE PEG TEST

Hospital_____ **Assessment date (year/month/day)**_____
Subject _____ **Evaluator**_____

Right hand-Time _____seconds Left hand-Time _____seconds

Comments-
_____
_____

SELF-PERCEPTION OF RECOVERY

Hospital_____ **Assessment date (year/month/day)**_____
Subject_____ **Evaluator**_____

1. Compared to your level of function prior to your stroke, do you feel that the function of your arm and your hand has completely recovered?

Yes_____ No_____

2. Compared to your level of function prior to your stroke, do your feel that your walking ability has completely recovered?

Yes_____ No_____

1. Comparé à votre niveau fonctionnel avant l'accident cérébro-vasculaire, pensez-vous que la fonction de votre bras et de votre main est complètement récupérée?

Oui_____ Non_____

2. Comparé à votre niveau fonctionnel avant l'accident cérébro-vasculaire, pensez-vous que votre capacité à la marche est complètement récupérée?

Oui_____ Non_____

C) DATA SHEET

UPPER EXTREMITY MEASURES

THE BOX AND BLOCK TEST

Hospital_____ **Assessment date (year/month/day)**_____
Subject _____ **Evaluator**_____

Number of blocks in 60 seconds - right hand _____
Number of blocks in 60 seconds - left hand_____

Comments_____
_____

FRENCHAY ARM TEST

Hospital_____ **Assessment date (year/month/day)**_____
Subject _____ **Evaluator**_____

Total score_____/5

Comments_____
_____

GRIP STRENGTH

Hospital_____ **Assessment date (year/month/day)**_____
Subject _____ **Evaluator**_____

Right hand : 1-
2-
3-

Left hand : 1-
2-
3-

Comments_____
_____

D) DATA SHEET
LOWER EXTREMITY MEASURES

GAIT SPEED

Hospital_____ **Assessment date (year/month/day)**_____
Subject _____ **Evaluator**_____

Time_____seconds

Comments_____
_____

TIMED 'UP AND GO' TEST

Hospital_____ **Assessment date (year/month/day)**_____
Subject _____ **Evaluator**_____

Time _____seconds

Comments_____
_____

E) DATA SHEET
OTHER MEASURES

ALBERT'S TEST OF PERCEPTUAL NEGLECT

Hospital_____ **Assessment date (year/month/day)**_____
Subject _____ **Evaluator**_____

Number of lines left uncrossed on the affected side:_____

Comments_____
_____

MMSE (telephone version)

Hospital_____ **Assessment date (year/month/day)**_____
Subject _____ **Evaluator**_____

Orientation _____/9 **Registration** _____/3

Attention and calculation _____/5 **Recall** _____/3 **Language** _____/2

Comments_____
_____

STREAM SCORING FORM

SUBJECT# _____ Hospital_____

Assessment date (year/month/day) Evaluator_____

						SUPINE
0	1a	1b	1c	2		1. Protracts scapula in supine
0	1a	1b	1c	2		2. Extends elbow in supine
0	1a	1b	1c	2		3. Flexes hip and knee in supine
0	1a	1b	1c	2	3	4. Rolls onto side
						CROOK LYING
0	1a	1b	1c	2	3	5. Raises hips off bed in crook lying
0	1a	1b	1c	2	3	6. Moves from lying supine to sitting
						SITTING
0	1a	1b	1c	2		7. Shrugs shoulders
0	1a	1b	1c	2		8. Raises hand to touch top of head
0	1a	1b	1c	2		9. Places hand on sacrum
0	1a	1b	1c	2		10. Raises arm overhead to fullest elevation
0	1a	1b	1c	2		11. Supinates and pronates forearm
0	1a	1b	1c	2		12. Closes hand from fully opened position
0	1a	1b	1c	2		13. Opens hand from fully closed position
0	1a	1b	1c	2		14. Opposes thumb to index finger
0	1a	1b	1c	2		15. Flexes hip in sitting
0	1a	1b	1c	2		16. Extends knee in sitting
0	1a	1b	1c	2		17. Flexes knee in sitting
0	1a	1b	1c	2		18. Dorsiflexes ankle in sitting
0	1a	1b	1c	2		19. Plantarflexes ankle in sitting
0	1a	1b	1c	2		20. Extends knee and dorsiflexes amlkle in sitting
0	1a	1b	1c	2	3	21. Rises to standing from sitting
						STANDING AND WALKING
0	1a	1b	1c	2	3	22. Maintains standing for 20 counts
0	1a	1b	1c	2		23. Abducts affected hip with knee extended
0	1a	1b	1c	2		24. Flexes affected knee with hip extended
0	1a	1b	1c	2		25. Dorsiflexes affected ankle
0	1a	1b	1c	2	3	26. Places affected foot onto first step
0	1a	1b	1c	2	3	27. Takes 3 steps backwards
0	1a	1b	1c	2	3	28. Takes 3 steps sideways to affected side
0	1a	1b	1c	2	3	29. Walks 10 meters indoors
0	1a	1b	1c	2	3	30. Walks down 3 stairs alternating feet

THE BARTHEL INDEX
FEBRUARY 22, 1996

Hospital_____

Study # _____ Assessment date (year/month/day)_____

Assessment done by_____

Activity	unable	needs help	independent
1. Feeding.	0	5	10
2. Doing personal hygiene	0	0	5
3. Bathing self.	0	0	5
4. Dressing and undressing.	0	5	10
5. Getting on and off toilet.	0	5	10
6. Continence of bowels.	0	5	10
7. Controlling bladder.	0	5	10
8. Chair/bed transfers.	0	5	10	15
9. Walking on a level surface.	0	5	10	15
10. Ascending and descending stairs.	0	5	10

Evaluate only if the individual is incapable of walking

11. Propelling a wheelchair.	0	0	5

_____

APPENDIX B

FRENCH AND ENGLISH CONSENT FORMS

The ethics committees of the five Montreal hospitals from which patients were recruited approved an English and a French version of the consent form written for this study. Only the consent forms for the Royal Victoria Hospital are presented.

ROYAL VICTORIA HOSPITAL
(English version)

PATIENT CONSENT FORM
Department of Medicine
ROYAL VICTORIA HOSPITAL
McGill University

Title of the Study: PHYSICAL RECOVERY FROM STROKE

Introduction: Researchers at the Royal Victoria Hospital and McGill University are conducting a study about the health and activity level of persons during the three month period following a stroke. This study will assess functional, manual and walking ability for persons who have had a stroke. We realize that you may be involved in other studies. Your participation in this study will not affect your participation in the other studies.

Procedures: We are asking if you would like to participate in this study. If you agree we will assess your ability to function after the stroke while you are still in the hospital. Once you have left the hospital we will assess you in your home or wherever else you may be staying after discharge. Each assessment usually takes about 60 to 75 minutes to complete, depending on the individual. This time includes rest periods. While you are in the hospital, the assessment may be broken up into 2 sessions of 35 minutes each so as to minimize fatigue.

The assessment of your function throughout the study will be performed by a trained health professional who will assess your balance, how well you move your arms and legs and how well you can do activities like walking, climbing stairs, washing and dressing. These tests will be done during the first week, the fifth week and three months after your stroke. If you are unable to walk initially after your stroke, we will wait until you are able to walk to perform the tests of walking ability. The walking tests will be repeated four weeks later and at the final assessment at three months. To summarize, three assessments will be done for people who can walk immediately after their stroke and a maximum of five assessments will be done for people who recover their walking ability later on.

In addition to these tests, we need to obtain some basic information about your medical history and your stroke from your medical chart.

Once you are discharged from the hospital, we will make appointments to visit you at your home or wherever you may be staying to continue the assessments as scheduled, at your convenience. During these visits, we will reassess you on the same tests that were done previously (balance, the movement of your arms and legs, walking and climbing stairs). These assessments will also be done by a trained health professional.

PATIENT CONSENT FORM
Department of Medicine
ROYAL VICTORIA HOSPITAL
McGill University

Title of the Study: PHYSICAL RECOVERY FROM STROKE

Participation and Confidentiality: Participation is voluntary. You may refuse to participate or withdraw from the study at any time without this having an effect on the care you receive while in the hospital or after. All of the information that we obtain from you will be kept strictly confidential. The data will be kept in a locked filing cabinet in the investigator's office. You will be assigned a study number and this will be the only identifying mark that will appear on your results. The results of the study will be published in scientific journals but your data will appear as numbers in statistical summaries.

Risks: We do not anticipate any risks or inconvenience to you if you participate in the study.

Benefits: The results of this study will help us better understand how stroke affects the physical function of an individual.

Contact Numbers: If you have any questions about the research, please contact the investigator, Dr. Nancy Mayo at (514)-842-1231 ext. 6925 or Claudette Corrigan at (514)-842-1231 ext. 6906.

By signing this consent form you acknowledge that the study has been explained to you and that you understand the contents of this consent form. You agree that you have had the opportunity to ask questions, that your questions have been answered to your satisfaction and you agree to participate in the study.

Declaration of the Participant: I understand what is involved in the study that I have been invited to join and I agree to participate in this study "Physical Recovery From Stroke ".

A copy of this consent form has been given to the participant named below.

Signatures	**Print Name**	**Date**
Participant		
Witness		
Investigator		

HÔPITAL ROYAL VICTORIA
(Version française)

FORMULAIRE DE CONSENTEMENT
POUR LE PATIENT
Service de médecine
HÔPITAL ROYAL VICTORIA
L'Université McGill

Titre de l'étude: **RÉCUPÉRATION DE LA MOTRICITÉ APRÈS UN ACCIDENT CÉRÉBRO-VASCULAIRE.**

Introduction: Les chercheurs de l'Hôpital Royal Victoria et de l'Université McGill ont entrepris une étude visant à évaluer la santé et le niveau d'activités des personnes atteintes d'un accident cérébro-vasculaire pendant les trois premiers mois suivant cet accident. Cette étude évaluera les capacités fonctionnelles, manuelles, ainsi que l'habileté à la marche chez les personnes ayant subit un accident cérébro-vasculaire. Nous sommes conscients que vous participez présentement à d'autres études. Toutefois, votre participation à cette étude n'affectera pas votre participation aux autres études.

Processus: Nous vous invitons à participer à cette étude. Si vous acceptez d'y participer, nous évaluerons vos capacités de fonctionnement après votre accident cérébro-vasculaire, pendant votre séjour hospitalier. Après votre départ du centre hospitalier, nous vous évaluerons chez-vous ou encore à tout autre endroit où vous allez habiter après avoir quitté l'hôpital. La durée d'une évaluation complète est habituellement de 60 à 75 minutes, dépendemment de l'individu. Cette période d'évaluation comprend des pauses. Pendant que vous êtes à l'hôpital, cette période d'évaluation peut être divisée en deux périodes de 35 minutes afin de minimiser la fatigue.

L'évaluation de votre fonctionnement tout au long de l'étude sera effectuée par un professionnel de la santé. Cette personne évaluera votre équilibre, le degré de mobilité de vos bras et vos jambes et la façon dont vous vous tirez d'activités telles que marcher, monter les escaliers, faire votre toilette et vous habiller. Ces tests seront effectués pendant la première et la cinquième semaine ainsi que trois mois après l'accident cérébro-vasculaire. Si vous n'êtes pas en mesure de marcher immédiatement après votre accident, nous attendrons que vous en ayez la capacité avant d'effectuer les évaluations de la marche. Ces évaluations de la marche seront effectuées quatre semaines plus tard ainsi qu'à l'évaluation finale à trois mois. En résumé, les personnes qui peuvent marcher immédiatement après l'accident seront evaluées trois fois et celles qui retrouvent l'habilité de marcher plus tard, seront évaluées un maximum de cinq fois.

En plus de ces évaluations, nous devons obtenir des renseignements de base à partir de votre dossier médical concernant vos antécédents médicaux et votre accident cérébro-vasculaire.

FORMULAIRE DE CONSENTEMENT
POUR LE PATIENT
Service de médecine
HÔPITAL ROYAL VICTORIA
L'Université McGill

Titre de l'étude: **RÉCUPÉRATION DE LA MOTRICITÉ APRÈS UN ACCIDENT CÉRÉBRO-VASCULAIRE.**

Une fois que vous aurez quitter l'hôpital, nous prendrons rendez-vous avec vous afin de poursuivre les évaluations à votre domicile ou à tout autre endroit où vous habiterez selon l'horaire mentionné ci-haut. Ces tests seront effectués à un moment qui vous conviendra. Les évaluations seront les mêmes que celles effectuées a l'hôpital (équilibre, degré de mobilité des bras et des jambes, marcher et monter des escaliers) et seront effectuées par un professionnel de la santé à votre domicile ou à tout autre endroit où vous aller demeurer une fois que vous aurez quitter l'hôpital.

Participation et confidentialité: La participation est volontaire. Vous pouvez refuser de participer ou vous retirer de l'étude n'importe quand, sans que votre décision ait un effet quelconque sur vos soins hospitaliers ou par la suite. Tous les renseignements que vous nous transmettrez seront strictement confidentiels. Les données seront entreposées dans un classeur fermé à clé dans le bureau du chercheur. Le numéro qui vous sera attribué sera la seule identification qui paraîtra sur les résultats de vos tests. Les résultats de l'étude seront publiés dans des publications scientifiques, mais vos données ne paraîtront que sous forme de tables statistiques.

Risques: Nous ne prévoyons pas que votre participation à l'étude présente un risque quelconque.

Bénéfices: Les résultats de cette étude nous aideront à mieux comprendre la façon dont un accident cérébro-vasculaire touche l'individu, la famille et les amis au fil des années.

Numéros ressources: Pour obtenir des renseignements supplémentaires sur l'étude, veuillez communiquer avec le chercheur principal Nancy Mayo PhD. au 842-1231, poste 6925 ou avec Claudette Corrigan au 842-1231, poste 6906.

En signant ce formulaire de consentement, vous reconnaissez que l'étude vous a été expliquée et que vous en comprenez le contenu. Vous confirmez également que vous avez eu l'occasion de poser des questions, qu'on y a répondu à votre satisfaction et que vous acceptez de participer à l'étude.

FORMULAIRE DE CONSENTEMENT
POUR LE PATIENT
Service de médecine
HÔPITAL ROYAL VICTORIA
L'Université McGill

Titre de l'étude: **LA RÉCUPÉRATION DE LA MOTRICITÉ APRÈS UN ACCIDENT CÉRÉBRO-VASCULAIRE**

Déclaration du participant:

Je comprends les détails de l'étude à laquelle on m'a invité(e) à participer et j'accepte de participer à cette étude sur "La Récupération de la Motricité Après un Accident Cérébro-Vasculaire". Je comprends également qu'en signant ce formulaire, je n'abandonne aucun de mes droits légaux.

Un exemplaire de ce formulaire de consentement a été remis au participant indiqué ci-dessous.

Signatures	**Nom en majuscules**	**Date**
Participant		
Témoin		
Chercheur		

APPENDIX C

ADDITIONAL METHODOLOGICAL INFORMATION

C.1 Inclusion Criteria

C.2 Exclusion Criteria

C.3 Sample Size Calculation

C.4 Calculation of Standardized Response Means (SRM)

Table C.1: Inclusion Criteria

Criteria	Operational Definition
First-time stroke	A first-time stroke was defined as having no documented evidence of a non-reversible ischemic deficit. The WHO defines a stroke as: *"Rapidly developing clinical signs of focal (or sometimes global) disturbances of cerebral function lasting more than 24 hours or leading to death with no apparent cause other than that of vascular origin".*[48]
Upper Extremity Deficit	Answering **No** to the question: *"Compared to your level of function prior to your stroke, do you feel that the function of your arm and hand have completely recovered?"*
Mental Competency	Score of 14 or above on the Brief Version of the Mini-mental State Examination.[134]

Table C.2: Exclusion Criteria

Criteria	Operational definition
Disabling Comorbid Conditions	Any medical condition which prevented participation in rehabilitation therapy.
Complete recovery of function of Upper Extremity	Answering **Yes** to the question presented in Table A.1.1
Receptive Aphasia	A score of 0 on the speech section of the mentation portion of the Canadian Neurological Scale.[83]

C.3 Sample Size Calculation

A sample size of 48 subjects was required. This number is based on sample size calculations for simple correlation with additional subjects to allow for the estimation of more than one parameter. For a correlation of 0.50 between two measures of stroke outcome, for 90% power and an alpha level of significance of 0.05, thirty-eight subjects are required.[135] In order to adjust the sample size for additional variables, the formula n=v + p + 1 from Kraemer[136] is used where v is the sample size for simple correlation (v = 38), and p is the number of additional variables included in the model (p = 9). Thus, 48 subjects was sufficient for the simultaneous consideration of up to 9 additional variables.

C.4 Calculation of Standardized Response Means (SRM)

$$SRM = \text{mean } \Delta / SD_{\text{change scores}}$$ [136]

where: mean Δ = mean change score between first and second evaluation

SD = standard deviation of the change score

APPENDIX D

Table D.1: Peason Correlation Coefficient for Outcome Measures (n = 55)

Measures	BBT 1 aff.	BBT 1 unaff.	NHPT aff	NHPT unaff	Grip Strength aff	Grip Strength unaff	Gait Speed	TUG	STREAM	Barthel Index	ALFI-MMSE	Frenchay Arm Test	BBT2 aff
CNS	**0.79**	**0.39**	**-0.74**	-0.12	**0.78**	0.20	**0.65**	**-0.75**	**0.92**	**0.72**	**0.30**	**0.80**	**0.84**
BBT aff		**0.46**	**-0.84**	-0.21	**0.79**	0.23	**0.59**	**-0.69**	**0.78**	**0.74**	0.30.	**0.87**	**0.92**
BBT unaff			**-0.30**	**-0.57**	0.32	**0.36**	**0.64**	**-0.56**	**0.45**	**0.62**	**0.39**	**0.40**	**0.51**
NHPT aff				0.11	**-0.77**	-0.25	**-0.48**	**0.67**	**-0.75**	**-0.72**	-0.25	**-0.84**	**-0.76**
NHPT unaff					-0.13	-0.22	**-0.40**	**-0.36**	-0.26	**-0.40**	-0.25	-0.25	**-0.28**
Grip Strength aff						**0.51**	**0.58**	**-0.69**	**0.76**	**0.71**	**0.33**	**0.80**	**0.80**
Grip Strength unaff							**0.48**	**-0.44**	0.24	**0.45**	0.25	**0.33**	**0.30**
Gait Speed								**-0.81**	**0.73**	**0.78**	**0.37**	**0.64**	**0.70**
TUG									**-0.82**	**-0.86**	**-0.34**	**-0.78**	**-0.80**
STREAM										**0.78**	**0.29**	**0.84**	**0.87**
Barthel Index											**0.48**	**0.80**	**0.79**
ALFI-MMSE												**0.30**	0.30
Frenchay Arm Test													**0.87**

Abbreviations: BBT, Box and Block Test; aff/unaff; affected/unaffected side; NHPT, Nine-Hole Peg Test; TUG, Timed Up and Go'; STREAM, Stroke Rehabilitation Assessment of Movement; ALFI-MMSE, Telephone Version of the Mini-Mental State Examination; CNS, Canadian Neurological Scale.
Bold values indicate significant correlations ($p < 0.05$).

APPENDIX E

Table E.1: Standardized Response Means for Outcome Measures According to Stroke Severity

Outcome Measures	Stroke Severity					
	Mild		Moderate		Severe	
	R*	SRM (95% C.I.)	R*	SRM (95% C.I.)	R*	SRM (95% C.I.)
BBT affected†	1	2.10 (-0.11, 3.82)	1	1.81 (1.14, 2.34)	9	0.80 (0.38, 1.11)
Gait Speed†	2	1.10 (0.23, 1.91)	2	1.17 (0.75, 1.53)	11	0.68 (0.40, 0.91)
Grip Strength affected	3	0.94 (0.17, 1.45)	7	0.84 (0.45, 1.21)	10	0.70 (0.43, 0.96)
STREAM total	4	0.84 (0.00, 1.61)	3	1.13 (0.80, 1.41)	2	1.50 (0.70, 2.16)
STREAM UE	5	0.82 (0.28, 1.34)	8	0.71 (0.34, 1.06)	4	1.17 (0.64, 1.66)
Barthel Index UE	6	0.67 (0.13, 1.26)	10	0.60 (0.18, 0.98)	7	0.94 (0.43, 1.38)
BBT unaffected	7	0.65 (-0.30, 1.51)	4	1.01 (0.55, 1.39)	8	0.91 (0.80, 1.61)
Barthel Index	8	0.61 (0.15, 1.05)	6	0.85 (0.58, 1.10)	1	1.67 (0.86, 2.41)
TUG	9	0.61 (0.11, 1.15)	12	0.45 (0.34, 0.53)	6	0.95 (0.50, 1.40)
Barthel Index LE	10	0.33 (0.21, 0.43)	5	0.88 (0.56, 1.21)	3	1.36 (0.77, 1.84)
Frenchay Arm Test	11	0.33 (0.28, 0.35)	9	0.69 (0.41, 0.92)	12	0.60 (0.30, 0.89)
STREAM LE	12	0.29 (-0.38, 1.15)	11	0.48 (0.00, 0.70)	5	1.12 (0.51, 1.64)
Grip Strength unaffected	13	0.29 (-0.49, 1.12)	13	0.25 (-0.13, 0.64)	13	0.03 (-0.56, 0.47)

Abbreviations: R, Rank; SRM, Standardized Response Mean; C.I., Confidence Interval; BBT, Box and Block Test ; STREAM, Stroke Rehabilitation Assessment of Movement; UE, Upper Extremity; LE, Lower Extremity; TUG = Timed 'Up and Go'.

*According to Friedman's test, rankings of the measures according to stroke severity are statistically different ($\chi r2$ = 16.7, p = 0.054).

†Standardized Response Means and 95% Confidence Intervals calculated from percent predicted age- and gender-spedific values.

APPENDIX F

Table F.1: Distribution of Scores on Outcome Measures

Outcome Measures	Eval.	Distribution % of Total Study Sample (n = 55)*				
Level of Performance†		**1**	**2**	**3**	**4**	**5**
UE measures						
BBT	1st	36.4%	16.4%	29.1%	14.5%	3.6%
	2nd	23.6%	10.9%	10.9%	40.0%	14.5%
FAT	1st	38.2%	1.8%	1.8%	14.5%	43.6%
	2nd	25.4%	7.3%	1.8%	1.8%	63.6%
Grip Strength	1st	30.9%	7.3%	20.0%	14.5%	27.3%
	2nd	20.0%	9.1%	9.1%	29.1%	32.7%
LE measures						
Gait Speed	1st	29.1%	18.2%	23.6%	16.4%	12.3%
	2nd	20.0%	5.4%	7.3%	27.3%	40.0%
TUG	1st	30.9%	0.0%	1.8%	0.0%	67.3%
	2nd	12.7%	0.0%	0.0%	9.1%	78.2%
Others						
Barthel Index	1st	5.4%	18.2%	14.5%	10.9%	50.9%
	2nd	0.0%	7.3%	12.7%	9.1%	70.9%
STREAM	1st	7.3%	7.3%	10.9%	14.5%	60.0%
	2nd	3.6%	3.6%	5.4%	12.7%	74.5%

Abbreviations: Eval., Evaluation; UE, Upper Extremity; BBT, Box and Block Test; FAT, Frenchay Arm Test; LE, Lower Extremity; TUG, Timed 'Up and Go'; STREAM, Stroke Rehabilitation Assessment of Movement.

*Percentages may not add to 100 due to rounding.

†1 corresponds to scores ≤ 20.0%; 2 = scores > 20% to ≤ 40%; 3 = scores > 40% to ≤ 60%; 4 = scores > 60% to ≤ 80%; 5 = scores > 80% to 100% of age- and gender-specific normal values (BBT, gait speed and grip strength), or of total possible score (FAT, Barthel Index and STREAM). Values 1 through 5 correspond to quintiles for the TUG.