Developing and Implementation of an Acute Stroke Dashboard to Meet Reporting Requirements for Status as a Tertiary Care Stroke Center

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ABSTRACT

Background:

Best-practice guidelines for acute stroke recommend the use of a care pathway, but there is limited evidence that this has an impact on functional outcomes. Care pathways typically focus on process, and do not track elements directly targeting improvement in patient function. If function is not documented and the information ignored, implementing a stroke care pathway may not improve functional outcomes.

Objective:

The overall objective of this study was to develop and test the feasibility and impact of a patient-centered Acute Stroke Dashboard to track the functional recovery indicators of patients post-stroke, where feasibility relates to the ease with which the Dashboard can be populated with routinely collected data, and impact is change in documentation frequency.

Methods:

Three theories supporting best practices for Knowledge Translation were used to inform the processes around the development of the Dashboard: the Problem Solving model, the model of Territorial Rights and Boundaries, and the PARiHS model.

This study had 4 steps. In Step A, a chart review (n=240) identified the extent to which functional outcomes were routinely documented by the staff in a ultra-specialized neurological hospital as stroke care evolved from general neurological ward care to care in an organized Stroke Unit. This step motivated that a different documentation system was needed.

In Step B, researchers were integrated within the Stroke Team to build a reporting system to track clinical outcomes while providing research-quality data. The result was the Acute Stroke Dashboard, which was implemented, in a paper-based version, for 25 patients.

In Step C, the staffs were supported to engage with the Dashboard and take ownership of the content to meet their needs.

In Step D, an electronic version was developed and deployed by the Stroke Unit staff. Use is ongoing; this thesis reports on data from the first 117 patients assess using the electronic APP version of the Dashboard.

Results:

For Phase A, documentation over three time periods, revealed consistent documentation of only three functional areas: bladder control, swallowing, and ability to eat independently. Capacity for independent mobility and activities of daily living were rarely documented except for walking capacity when the Stroke Unit was operational which increased from 18% to 59%.

For Phase B, the content for the Dashboard was established from information discussed at weekly Stroke Rounds, the items were worded, and ordering and response options selected. Algorithms were created to calculate total scores from the functional recovery indicators. Twelve iterations were carried out over 3 months.

For Phase C, during the deployment of the paper-based Dashboard, it was evident that this format could not be adopted by the Stroke Team as it was inflexible and resided on the medical chart duplicating existing required reporting. The Research Team had to complete almost all content. An electronic APP version was developed on mobile devices distributed to each of the nursing stations. The research team facilitated transfer of the electronic charting to the clinical team.

For Step D, the APP version deployed by the Stroke Unit staff. Two Nurse Champions self-identified and took on the daily use of the APP Dashboard during daily huddles. Over a 6 month period, 20 iterations of the Dashboard occurred to cover emerging needs. Data from 117 patients revealed that nursing content, some 50 data fields, were completed in more than 90% of patients. Content for other team members was less often completed: PT (10 fields) range of completion ~23%; OT/SLP range 5% to 13%.

Conclusions:

This Dashboard provided better systematic data on function than routine charting. The Knowledge Translation process was effective to engage Nursing Managers and assistant Nurse Managers in the process of creating a viable electronic charting system to meet the requirements set out by the Ministry of Health in Quebec for designation as a Tertiary Stroke Center.

Keywords

Acute Stroke Dashboard, Knowledge Translation, Mobile Devices, Functional Recovery Indicator, Care-pathways.

ABRÉGÉ

Contexte :

Selon les directives des meilleures pratiques suite à un accident cérébrovasculaire (AVC) en phase aigue, il est recommandé d'utiliser une trajectoire de soins. Par contre, il y a peu de preuves que cela a un impact sur les résultats fonctionnels. Les trajectoires de soins se concentrent généralement sur le processus et ne détectent pas directement les éléments visant l'amélioration de la fonction du patient. Si la fonction n'est pas documentée et que l'information est ignorée, la mise en place d'une trajectoire de soins suite à un AVC pourrait ne pas améliorer les résultats fonctionnels.

Objectif :

L'objectif global de cette étude était de développer et de tester la faisabilité et l'impact d'un tableau de bord, centré sur le patient, suite à un AVC en phase aigue. Ceci est fait afin de suivre les indicateurs de récupération fonctionnelle des patients suite à un AVC. La faisabilité fait ici état de la facilité à laquelle le tableau de bord est systématiquement utilisé comme outil de collecte de données et influence un changement dans la fréquence de documentation.

Méthodes :

Trois théories se basant sur les meilleures pratiques pour la transmission des connaissances ont été utilisées pour informer le processus concernant l'élaboration du tableau de bord : le modèle de résolution de problème, le modèle sur les droits de territoire et de limites, et le modèle PARiHS.

Cette étude avait 4 étapes. Dans l'étape A, la révision des dossiers (n=240) a identifié la mesure à laquelle les résultats fonctionnels ont été systématiquement documentés par le personnel d'une clinique neurologique ultra-spécialisée, car les soins suite à un AVC évolue d'un service de soins neurologiques généraux à une unité spécialisée en AVC. Cette étape a soulevé l'importance qu'un système de documentation différent était requis.

Dans l'étape B, les chercheurs ont été intégrés au sein de l'équipe traitant les AVC afin de créer un système d'information intégrant les résultats cliniques et procurant des données de qualité pour la recherche. Le résultat a été le tableau de bord suite à un AVC en phase aigue, qui a été implanté dans une version papier auprès de 25 patients.

Dans l'étape C, le personnel a été encouragé d'utiliser le tableau de bord et de se l'approprier afin de répondre à leurs besoins.

Dans l'étape D, une version électronique a été développée et déployée par le personnel de l'unité des soins suite à un AVC. L'utilisation est en cours. Cette thèse rapporte les données des 117 premiers patients évalués utilisant l'application électronique du tableau de bord.

Résultats :

Pour l'étape A, la documentation collectée sur trois périodes de temps révèle une documentation cohérente pour seulement trois domaines fonctionnels : le contrôle de la vessie, la déglutition et la capacité de manger indépendamment. La capacité indépendante de mobilité et les activités de la vie quotidienne étaient rarement documentées, à l'exception de la capacité à marcher lorsque l'unité des soins suite à un AVC était en opération, ce qui augmente de 18% à 59%.

Pour l’étape B, le contenu du tableau de bord a été établi à partir de l’information discutée lors des rencontres hebdomadaires avec l’unité des AVC. Les items ont été rédigés, classés et les choix de réponses sélectionnés. Des algorithmes ont été créés afin de calculer les scores totaux des indicateurs de récupération fonctionnelle. Douze itérations ont été effectuées sur une période de 3 mois.

Pour l’étape C, pendant le déploiement de la phase papier du tableau de bord, il était clair que ce format ne serait pas adopté par l’équipe, car il était inflexible et restait sur le dossier médical, dupliquant les rapports déjà requis. L’équipe de recherche a dû terminer la quasi-totalité du contenu. Une version électronique via une application a dû être développée sur des appareils mobiles distribués à chaque station d’infirmières. L’équipe de recherche a facilité la transition vers les dossiers électroniques auprès de l’équipe clinique.

Pour l’étape D, l’application électronique a été déployée par le personnel de l’unité de soins suite à un AVC. Deux infirmières se sont portées volontaires afin de prendre en charge l’utilisation quotidienne du tableau de bord. Sur une période de 6 mois, 20 itérations du tableau de bord se sont produites pour combler les besoins émergents. Les données de 117 patients ont révélé que le contenu infirmier, environ 50 champs de données, a été complété auprès de plus de 90% des patients. Le contenu des autres membres de l’équipe était moins fréquemment complété : physiothérapeutes (10 champs) ont complété ~ 23%; ergothérapeutes et orthophonistes varient entre 5% et 13%.

Conclusion :

Ce tableau de bord a procuré de meilleures données systématiques sur la fonction que la tenue de dossier habituelle. Le processus de transmission des connaissances a été efficace pour engager les infirmières en chef et leurs assistantes dans le processus de créer un système de tenu de dossier électronique rencontrant les exigences énoncées par le Ministère de la santé du Québec pour les centres tertiaires suite à un AVC.

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my supervisor Dr. Nancy Mayo for the continuous support and encouragement she gave me. I am thankful for the patience and understanding over these past three years. She was always available for my questions and her guidance helped me through all the phases of this study. She gave me the opportunity to learn under her supervision and her immense knowledge enlightened my journey as I learned the complex process of good research. I am grateful for providing all the necessary facilities for my research and helped me to improve my knowledge.

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I would like to thank Jonas Briedis who helped out with the early chart reviews, and Christine Dery who helped me early on to recruit patients.

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I am also very appreciative of the help from the team in the Clinical Epidemiology unit. My sincere thanks to Carolina Moriello, who helped in the data collection and was always there to address questions and concerns around data quality. Also, Ms. Susan Scott, Biostatistician, helped tremendously with learning SAS and Lyne Nadeau who helped with the analysis. I would not have survived a survival analysis without her. My fellow graduate student, Kedar Mate, oversaw the data collection while I was away for a short period of time. Thanks mate.

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This work would have never been possible without the work that MNH stroke unit staff especially Rosa Sourial, Christine Bouchard, Rick Sanchez, and Maxime Boutin-Caron offered. I am truly grateful for their cooperation and support and I really appreciate the time and effort spent to complete this study.

And to all my friends and lab mates at the Division of Clinical Epidemiology. It was great to work with you. Thank you for all your inspiration, motivation, and support, you made me feel part of a family.

I would like to thank my parents who supported me through my entire life. And at the end, I must acknowledge my wife, Mahsa, without your love, patience, and support I would not have finished this thesis.

Table of contents

Index of Tables

Index of Figures

PREFACE

This is a manuscript-based thesis developed in several steps. The thesis topic was a piece of larger project funded by Heart and Stroke Foundation of Canada (HSFC), led by Dr. Nancy Mayo and Dr. Lesley Fellows. The aim of the larger project was to estimate the extent to which outcomes following acute stroke can be improved through the implementation of acute stroke care-pathways. My contribution was to develop a way of engaging the clinical team in adopting a new documentation system as part of an acute-care stroke pathway.

One part of the project required ethical approval for using routinely collected data for purposes of research without direct consent by patient but rather "opt-in" or "opt-out" which could be decided upon by a family member.

At the time of my protocol presentation, this ethical approval had not yet been granted. Thus, the protocol I presented described only one aspect of the project, a medical chart review, which did not rely on this approval. As ethical approval was granted promptly, I was able to expand the project and the result is presented here.

All of the parts of this thesis were conducted and written by Behtash Bakhshinategh, under the supervision of Dr. Nancy Mayo. Specifically I conducted the literature review, chart review, and developed and implemented the new documentation system (Acute Stroke Dashboard), and data collection, and analyses.

Then thesis was written by Behtash Bakhshinategh with considerable structuring and editing from Dr. Nancy Mayo. I learned a tremendous amount from this process.

Organization of thesis

Developing and implementing a new documentation system for acute stroke patients was the primary objective of this study. The objective is addressed in single manuscript "Developing and Implementation of an Acute Stroke Dashboard to Meet Reporting Requirements for Status as a Tertiary Care Stroke Center" to be submitted to an "implementation science" journal for publication. Extra chapters have been merged into this thesis to meet the regulations of the Graduate and Postdoctoral Studies (GPS).

Chapter 1 describes stroke and Chapter 2 presents a review on the current recommended medical and rehabilitation management of people with stroke. The literature on early mobilization and on care pathways was emphasized.

Chapter 3 presents the rationale and objectives.

Chapter 4 includes the text, figures, tables and references for the manuscript formatted following the requirements for the journal "Implementation Science".

Chapter 5 is an overall discussion.

CHAPTER 1

Overview of stroke

In Canada, an estimated 50,000 people are hospitalized for stroke each year and over 13,000 die from stroke. The mortality at first year post stroke ranges from 15% to 25 % and the prevalence of stroke survivors with incomplete recovery has been estimated at 460/100 000 population [1].

People older than 65 years are at highest risk of stroke, but stroke can occur at any age [2]. According to 2011 Statistics Canada, ~ 315,000 Canadians are living with the effects of stroke [3].

Stroke affects physical, cognitive, and emotional functioning of patients and each stroke experience is different and depends on the type of stroke and the areas of the brain damaged [4]. The deficits of stroke arise from the death of brain cells caused by interrupted blood flow as a result of blockage or rupture in the supplying vessel [5]. The main types of stroke are ischemic and hemorrhagic; ischemic events can be transient in nature in which they are labelled transient ischemic attack (TIA) [4].

Stroke is a medical emergency; its outcome depends on the person and family members acting FAST to get the optimal medical care. The main presenting signs of stroke are given as part of the "FAST" campaign of the Heart and Stroke Foundation of Canada [6].

This campaign was started to increase the number of people who get to the Emergency in time to take advantage of new treatments for stroke include tPA [7] and thrombectomy [8] which are time sensitive. The window for tPA is 3 to 4 hours and, for thrombectomy, within 6 to 12 hours after stroke onset[7, 9].

The clinical consequences of stroke are wide ranging and include deficits in motor control, mobility, dexterity, speech and language, swallowing, perception, vision, and cognition. In addition, stroke can result in pain, fatigue, depression, and apathy [10]. Hemiplegia or motor deficits in the extremities affect the majority of people (57-92%). Estimates of the prevalence of dysphasia or aphasia range from 46% to 57%; and dysphagia, 30% to 40% [11].

Six months post stroke, 39% of a stroke population recruited as an inception cohort (n=434) reported a limitation in basic activities of daily living, 54% reported limitations with higher-level activities of daily living such as housework and shopping, and 65% reported restrictions in reintegration into community activities [12]. More than 50% indicated that their life lacked for meaningful activity. The building blocks for meaningful activity start early after stroke as shown by studies of early supported discharge [13, 14].

These building blocks are also important for health-related quality of life [15]. A study of a large inception cohort (n=678) found that, even 3 months post-stroke, co-morbid health conditions and residual stroke impairments were strong contributors of more global health outcomes [16].

CHAPTER 2

Overview of stroke rehabilitation and management

2.1 Medical and Rehabilitative Management

In Canada, approximately 639,000 days of acute care per year are attributed to stroke care [17]. This is a significant burden for patients, family members, and health care system. The goal of medical management in acute care is to stabilize the patient, assess deficits, identify the cause, and initiate treatment as fast as possible [18]. One effective treatment for ischemic stroke is time sensitive, tissue plasminogen activator(tPA) [7]. It acts by dissolving blood clots in the affected vessel and improves the blood flow to the brain almost immediately. The optimal time of tPA administration is within first 3 to 4 hours post-stroke, a window shown to increase the chance of recovery and minimize adverse bleeding events [19, 20]. The most recent advance in reperfusion is the use of thrombectomy with a slightly wider window for effectiveness, within 6 hours but could be up to 12 hours[8, 21].

Since the availability of effective methods for reperfusion, the stroke community has emphasized rapid access to care. As far back as 1995, stroke rehabilitation guidelines has also emphasised the need for rapid access to rehabilitation [22, 23]. The notion of "time is brain" applies to rehabilitation interventions because rehabilitation not only improves function; it promotes neuroplasticity [9].

2.2 Role of Early Mobilization during Acute-Care for Stroke

Early mobilization (EM) is a program of early intensive out-of-bed activity for people with acute stroke used in many centres to prevent complications of immobility and improve functional outcomes [24]. Early mobilization refers to out of bed activity starting from 24 hours post-stroke and this has been integrated into stroke care plans in many countries, even starting in the intensive care unit (ICU). This concept has received considerable attention in clinical and scientific literature over the past several years [25].

Table 1, from the work of Bernhardt, et al. (2015), summarizes the results of the four trials done to date using either early or very early mobilization, where the latter starts within 24 hours. The first two studies and the last (Bernhardt: AVERT; Langhorne: VERITAS; Sundseth: AKEMIS) were of very early mobilization; the samples sizes for these trials were modest (n=71, n=32, n=65). Only one of the reported studies (Langhorne) showed an advantage, using the Modified Rankin Scale (MRS) as the outcome at 3 months, an advantage to very early mobilization; the others either found no effect (Bernhardt) or a disadvantage (Sundseth). Adverse events occurred at the same rate between the two groups but in the Bernhardt study and the Sundseth study there was an excess of deaths in the very early group in comparison to controls (aggregated: 15 vs. 5).

The Diserens (Lausanne Trial) study was of early mobilization (after 24 hours) with a combined sample of 50 randomized and 42 with intervention (25 vs. 17, intervention vs. control). With MRS as the outcome, there was no advantage to intervention, but there was a much higher rate of severe complications including death in the control group (47% vs. 8%).

There were additional outcomes reported from AVERT study at 3 and 12 months. After adjusting for differences in age, sex, diabetes, stroke severity between the 2 groups, there was a statistically significant advantage from the very early mobilization on motor outcomes and basic activities of daily living (Barthel Index), and on time-to-achieve capacity to walk 50m. (3.5 vs. 7 days, intervention vs. control) [26].

The evidence for early or very early mobilization is still inconclusive. Apart from conducting more randomized trials, evidence for effectiveness can be gathered from observational studies (with the appropriate methodological and statistical control for biases) which would be greatly facilitated by access to research quality data routinely collected as part of clinical care.

2.3 Care-Paths for Acute Stroke

As defined by De Bleser et al. [27], a clinical pathway is a method for the patient-care management of a well-defined group of patients during a well-defined period of time. A clinical pathway explicitly states the goals and key elements of care based on Evidence Based Medicine (EBM) guidelines, best practice and patient expectations by facilitating the communication, coordinating roles and sequencing the activities of the multidisciplinary care team, patients and their relatives; by documenting, monitoring and evaluating variances; and by providing the necessary resources and outcomes. The aim of a clinical pathway is to improve the quality of care, reduce risks, increase patient satisfaction and increase the efficiency in the use of resources [27]. More simply said: “Care pathways are organisational interventions that aim to promote evidence- and guideline-based care, improve the organisation and efficiency of care, and reduce cost” [28].

There has been interest for decades in improving documentation of clinical processes and outcomes and, in stroke, several studies have evaluated whether these clinical pathways achieved intended benefits. Eleven randomized controlled trials (RCTs), involving 913 stroke patients, were found on this topic and summarized in a 2015 systematic review by Huang et al [29]. The overall results showed a shorter average length of stay (-2.92 days; 95% CI: -4.06, -1.78) and lower inpatient expenditures (-1.64 standardized units; 95% CI: -1.80, -1.48) were achieved for clinical pathway groups compared with the usual care groups. The higher score of patient satisfaction was also seen in clinical pathway groups. This systematic review included 10 studies done in Asia and published in inaccessible journals; the review did not report on patient outcomes and, as the articles were not retrievable, additional analyses could not be carried out.

However, one of the strongest studies in this review was a clustered randomized trial done in Italy (reported in 2012) involving 14 centers with 238 patients randomized to each group, care pathway or usual care. The results indicated a benefit to the care path group on 7-day mortality (OR 0.42; 95%CI; 0.15-1.11) and on return to pre-stroke function in activities of daily living ($OR_{adjusted}$: 2.70; 95%CI; 1.50-4.88).

The most recent study was from India published in 2016. A total of 162 people stroke were randomized to a stroke care pathway (*n* = 77) or conventional care (*n* = 85). The care pathway group had a lower incidence of complications: aspiration pneumonia (OR: 0.42, 95%CI: 0.16-1.14) and need for mechanical ventilation (OR: 0.39; 95%CI: 0.14-1.07). Death at 90 days was significantly lower in the care path group (7.8% vs. 20%) but values on the Barthel Index and Modified Rankin Scale among survivors were similar in both the groups. A combined outcome of death and dependency would be a better way of reporting on these data [30].

There is emerging support from the most recent literature that establishing an acute stroke care path is worth the effort. Canada has developed best-practice recommendations for stroke[31] to be incorporated into an acute stroke care-path and Quebec is implementing this care path in strokes centres throughout the province. This created an opportunity for evaluating the implementation process.

2.4 Canadian Stroke Best Practice Recommendations (CSBPR)

The 2015 update of the *Canadian Stroke Best Practice Recommendations (CSBPR)* [31] Acute Inpatient Stroke Care recommendations emphasizes the value of organized stroke units with inter-professional stroke teams on optimizing patient outcomes following stroke. Acute stroke care refers to the key interventions involved in the assessment, treatment, management, and early recovery in the first days after stroke onset, and these recommendations refer to inpatient hospital settings. New updates are included around early mobilization and preventing complications including venous thromboembolism.

Specific highlights of the updates and additions include:

- Focus on the core elements and components of stroke unit care, and advocacy that the elements should be implemented as fully as possible within resource capability.
- Edits to the section on reducing complications – specifically venous thromboembolism prophylaxis based on the results of the CLOTS trial and early mobilization based on the most recent release of the AVERT trial.
- Expanded guidance on addressing palliative care issues in patients with severe stroke.
- Emphasis within recommendations on initiating advance-care planning discussions with patients and family members.
- Further development of a ***Taking Action Towards Optimal Inpatient Stroke Care*** resource kit including creating a stroke unit with staffing models, stroke care

information, educational modules, summary tables of implementation tools, outcome measures, and resource links.

- Updated patient order set templates for initial ED evaluation, tPA administration, acute inpatient admission, and management of intracerebral hemorrhage.

The theme for the 2014 – 2015 updates is ***Working Together with Stroke Survivors and their Caregivers to Achieve Optimal Outcomes***, emphasizing the need for a committed inter-professional team approach to stroke care across the continuum, and for ensuring patient-centered care. Patients and family caregivers particularly should receive education and be empowered as active participants throughout their journey of recovery to ensure meaningful contributions to goal setting and treatment planning.

CHAPTER 3

Rationale and objectives

This study was embedded within a larger study that aimed to estimate the extent to which outcomes following acute stroke can be improved through the implementation of acute stroke care-pathways.

The objective of this study was to develop and test the feasibility and impact of a patient-centered acute stroke Dashboard to track the functional recovery indicators of patients post-stroke, where feasibility relates to the ease with which the Dashboard can be populated with routinely collected data, and impact is change in documentation frequency and interpretability over time.

In the beginning, estimating the extent to which the effective components of functional recovery indicators routinely and consistently documented through the course of acute-care was done. The rationale behind doing this was the hypothesis that if functional recovery indicators were not written down in regular charting, they were not assessed, and if not assessed they might not have been treated. The main aim of this study is to develop a new system of documentation "Acute Stroke Dashboard" to track the key functional outcome indicators during hospitalization of stroke patients in order to meet the requirements from Quebec government to receive designation as a tertiary care stroke center. The context of the implementation was the Montreal Neurological Hospital (MNH) at the time where they were transitioning to a tertiary care stroke center. "Dashboard" is a termed coined for the information technology era: "a user interface that, somewhat resembling an automobile's Dashboard, organizes and presents information in a way that is easy to read. However, a computer Dashboard is more likely to be interactive than an automobile Dashboard [32].”

In health care, Dashboards are tools used to summarize and integrate key health data in a manner that promotes effective information recording and sharing [33]. Evidence is emerging that implementing Dashboards into the care plan could help to improve patient outcomes by providing better accessibility of patients' information for clinicians [34].The deliverable for this project, beyond developing the infrastructure for the Acute Stroke Dashboard, was to have a new tool to provide better systematic data on functional recovery indicators than is currently available through routine charting which would facilitate monitoring of outcomes in compliance with the guidelines from the Canadian Stroke Strategy.

CHAPTER 4

4.1 Manuscript: Developing and Implementation of an Acute Stroke Dashboard to Meet Reporting Requirements for Status as a Tertiary Care Stroke Center

Abstract

Background:

Best-practice guidelines for acute stroke recommend the use of a care pathway, but there is limited evidence that this has an impact on functional outcomes. Care pathways typically focus on process, and do not track elements directly targeting improvement in patient function. If function is not documented and the information ignored, implementing a stroke care pathway may not improve functional outcomes.

Objective:

The overall objective of this study was to develop and test the feasibility and impact of a patient-centered Acute Stroke Dashboard to track the functional recovery indicators of patients post-stroke, where feasibility relates to the ease with which the Dashboard can be populated with routinely collected data, and impact is change in documentation frequency.

Methods:

Three theories supporting best practices for Knowledge Translation were used to inform the processes around the development of the Dashboard: the Problem Solving model, the model of Territory Rights and Boundaries, and the PARiHS model.

This study had 4 steps. In Step A, a chart review (n=240) identified the extent to which functional outcomes were routinely documented by the staff in a ultra-specialized neurological hospital as stroke care evolved from general neurological ward care to care in an organized Stroke Unit. This step motivated that a different documentation system was needed.

In Step B, researchers were integrated within the Stroke Team to build a reporting system to track clinical outcomes while providing research-quality data. The result was the Acute Stroke Dashboard, which was implemented, in a paper-based version, for 25 patients.

In Step C, the staffs were supported to engage with the Dashboard and take ownership of the content to meet their needs.

In Step D, an electronic version was developed and deployed by the Stroke Unit staff. Use is ongoing; this thesis reports on data from the first 117 patients assess using the electronic APP version of the Dashboard.

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For Phase A, documentation over three time periods, revealed consistent documentation of only three functional areas: bladder control, swallowing, and ability to eat independently. Capacity for independent mobility and activities of daily living were rarely documented except for walking capacity when the Stroke Unit was operational which increased from 18% to 59%.

For Phase B, the content for the Dashboard was established from information discussed at weekly Stroke Rounds, the items were worded and ordering and response options selected. Algorithms were created to calculate total scores from the functional recovery indicators. Twelve iterations were carried out over 3 months.

For Phase C, during the deployment of the paper-based Dashboard, it was evident that this format could not be adopted by the Stroke Team as it was inflexible and resided on the medical chart duplicating existing required reporting. The Research Team had to complete almost all content. An electronic APP version was developed on mobile devices distributed to each of the nursing stations. The research team facilitated transfer of the electronic charting to the clinical team.

For Step D, the APP version deployed by the Stroke Unit staff. Two Nurse Champions self-identified and took on the daily use of the APP Dashboard during daily huddles. Over a 6 month period, 20 iterations of the Dashboard occurred to cover emerging needs. Data from 117 patients revealed that nursing content, some 50 data fields, were completed in more than 90% of patients. Content for other team members was less often completed: PT (10 fields) range of completion ~23%; OT/SLP range 5% to 13%.

Conclusions:

This Dashboard provided better systematic information on function than routine charting. The Knowledge Translation process was effective to engage Nursing managers and assistant Nurse Managers in the process of creating a viable electronic charting system to meet the requirements set out by the Ministry of Health in Quebec for designation as a Tertiary Stroke Center.

Keywords

Acute Stroke Dashboard, Knowledge Translation, Mobile Devices, Functional Recovery Indicator, Care-pathways.

Background

Decades of clinical research has provided extensive evidence to guide the care of people with acute stroke. The interventions that are crucial during the acute period are time-sensitive, and rely on the efficient interaction, first of the health care system to get the right patients to the right clinical setting, and then among members of the stroke team. Care pathways are widely used to organize this complex sequence of events, to ensure that evidence informs clinical practice, and in some cases to contain costs. These tools, first introduced into health care in the mid-1980s, range in sophistication from simple paper-based protocols with manual charting and checkboxes, to elaborate computerized systems [35, 36]. They are increasingly used in stroke care around the world.

Such pathways have an intuitive appeal to those charged with implementing best practice guidelines. Although it seems reasonable to suppose that implementing best practices will improve patient outcomes, there is limited evidence for this. A 2010 Cochrane Review of 27 trials of care pathways for a variety of conditions found evidence that, compared to usual care, care pathways significantly improved the documentation of care, and may have reduced some in-hospital complications [37]. However, there was no effect on in-hospital mortality. Some studies reported reductions in length of stay or hospital-based costs, but this was not consistent. Care pathways also have been studied specifically in acute stroke: here, the evidence is even more mixed [38, 39]. Another Cochrane review of 10 studies, including 3 randomized controlled trials, found evidence for both positive and negative effects of care pathways for stroke: There is no evidence that such pathways, compared to usual care, affect death, disability or discharge destination. There is some evidence from non-randomized studies that such pathways may reduce certain stroke complications (such as UTI), increase the rate of certain diagnostic tests (such as CT head), and reduce readmission rate [39]. There is also some evidence of negative effects, with reduced patient satisfaction and quality of life, and reduced staff satisfaction in the care pathway groups [38-40]. In general, even when effectiveness is shown, there is little information about what specific aspects of the pathways are critical for that effectiveness [39].

Care pathways were largely developed to solve “process” challenges: aiming to ensure that each patient gets the right treatment at the right time, from the right care team member. Evidence to date suggests that care pathways are most successful in improving processes: better documentation of care, and more frequent and timely delivery of diagnostic tests.

We hypothesize that care pathways have failed to improve the most important outcomes in acute stroke because they do not focus effectively on these outcomes. Typical paper-based stroke care pathways (including those at our local sites) have a process emphasis, limited capacity to allow individualization of care goals, and do not explicitly provide timely, outcome-focused feedback [35, 41].

The context for this study is that the Quebec Ministry of Health has mandated the implementation of the Quebec Stroke Strategy, which has brought a renewed clinical and institutional focus to efficiently implementing evidence-based stroke care across the province of Quebec. Stroke units in the McGill Health Region are in the midst of making major changes to their practice. Not only has this provincial mandate sparked review and updating of stroke care plans; it has also led to a readiness to change the way stroke care is delivered amongst in-patient stroke teams, and a requirement to carefully track the quality of care, which provide a unique window of opportunity to introduce and study novel tools. This study will leverage these efforts to assure that these changes will lead to better outcomes for stroke patients.

The purpose of this study is to develop a documentation system that would cover all of the mandated processes of care, include the mandated outcome measures, but with a focus on documenting patients' progress towards outcome milestones.

Successful development and implementation of such a system requires knowledge about how behaviour change in an institutional context comes about. The context for this study was a university teaching neurological hospital that was seeking designation as a Tertiary Care Centre for Stroke from the Ministry of Health. This designation was contingent on meeting a set of 30 Quality Care Indicators related to stroke interventions and documentation of key process and outcomes.

The technology to be implemented was an Acute Stroke Dashboard which would provide real time capture of the key process and functional recovery indicators.

Several theories of knowledge translation were used to develop the implementation approach for this study[42]. The Problem Solving model [43] was felt to apply because the desire to achieve status as a Tertiary Care Centre for stroke would act as a strong incentive to meet the government imposed criteria. The problem to be solved was how to meet the informational needs required for this status. The implication of the research team would be seen as a means to an end, a way of contributing to a solution to the problem.

The model of Territory Rights and Boundaries [44] was also applicable in this context because there was an existing way of practicing, designed primarily to minimize the need for the staff for complex and time consuming documentation so that more time could be spent with patient care and therapy. As the existing documentation system would likely be inadequate to cover the assessment of functional outcomes with the granularity needed for accurate outcome measurement, a new way of documentation would be needed. Implementing an Acute Stroke Dashboard could be perceived as threatening to the current way of practicing.

Finally, the PARiHS model [45] was considered to apply. In this model, successful implementation (SI) is shown to be a function (f) of the nature and type of evidence (E), the qualities of the context (C) in which the evidence is being introduced, and the way the process is facilitated (F); SI = f (E, C, F) [46]. The PARiHS model stipulates that there needs to be a simultaneous and equal interplay between the strength and presentation of the evidence (here that current documentation was inadequate), the context (busy Acute Stroke Unit with existing team processes), and the ways in which the process is to be facilitated (research team, implementation team, and eventual electronic system).

Methods

An historical study of an admission-to-discharge cohort was conducted followed by a prospective implementation phase of the new technology. Access to historical chart data was granted from the Director of Professional services and ethical approval was obtained for the implementation phase. All patients admitted to the stroke unit during the implementation phase were informed that a quality assurance program was being carried out requiring use of routinely collected clinical data for evaluation purposes. Patients and/or their family members consented to have clinical data used for this purpose.

Our global approach was four-fold: (A) show that existing documentation system falls short of new requirements and that a more modern approach to data acquisition would yield useable knowledge; (B) develop a knowledge tool that would most to closely follow current practice; (C) engage staff in ownership of the content; and (D) modify knowledge tool to be responsive to actual needs during every day deployment. Table 2 presents a summary of the steps undertaken for this project.

A. *Illustrate that current methods of documentation of functional recovery indicators fall short of what is required*

A review of the current methods of documentation of processes and outcomes in stroke unit of Montreal Neurological Hospital (MNH) was carried out. The information extracted focused on variables typically used for case-mix adjustment [47]when comparing across time periods or sites is the question of relevance, and variables related to assessments needed to guide care and to track functional recovery.

Three time periods were of interest as evolution towards a formal Stoke Unit was occurring. The three time periods were: (i) prior to 01/2014: usual stroke care at MNH; (ii) 01-09/2014: new stroke program began at MNH; (iii) after 09/2014: dedicated Stroke Unit established at MNH. For the first two time periods, mostly paper charts were in existence; for time period (iii), coinciding with the evolution to a dedicated Stroke Unit, the existing paper-based chart was scanned and available for viewing electronically. An electronic medical record (OACIS) was also put in place over this period for documenting patient information, order entry, drug prescribing, and viewing of results of tests and procedures.

In this study, no statistical comparisons are made as the data were used to support change in clinical practice and not inference. However, there was keen interest by the clinical team to see how length-of-stay changed during this evolution to a stroke unit. Therefore, we carried a statistical analysis of these data only to demonstrate the advantage of having data to support quality of care developments. Time to discharge for each person was modeled as a function of time using Cox proportional hazards model with adjustment for age, gender, severity of stroke, comorbidities, side of lesion, and type of stroke. The clinical team could produce mean length of stay, would not be able link this statistically to factors that may have changed over the time that changes were being implemented. This model yields estimates of the hazard ratio (HR) and 95% confidence intervals (CI). The HR is interpreted as the probability of being discharged at any one point in time for people with stroke admitted during time 1 and 2, relative to people admitted in time 3 (reference category).

B. Develop a knowledge tool that most closely followed current practice:

The first step was to observe current practice for documenting the required elements. To do this, the research team attended weekly Stroke Rounds and daily "huddles" taking on the "fly-on-the-wall" role. The team listened to what the clinicians reported on about their patients and drafted a list of key indicators from the clinical team's perspective. A paper-based version was then used by the research team to document outcomes on all patients either by direct observation or by talking with the responsible health professional. After each weekly Stroke Round, modification to the paper-based version was carried out until all elements usually spoken about were listed.

The development team was as inconspicuous as possible so as not to appear threatening_ the "fly-on-the-wall" role. One of the members of the research team was already well known to the stroke team and the presence of this opinion leader facilitated acceptance of the project. Barriers to adoption of the new Dashboard technology were well known from the model of Territorial Rights and Boundaries: clinicians had no time for additional documentation and did not welcome outsiders interfering with their current practice.

C. Engage Stroke Unit Team in ownership of the content:

The continued presence of the Research Team on the Stroke Unit served as a continual reminder that a new process was being developed. The Stroke Unit Nurse Manager was instrumental in reminding the team of the Dashboard project and invited the team to make regular updates on progress. After one progress report, two nurse Managers, one from each of the stroke unit stations, volunteered to attempt implementation in their respective stations. A key break though came when the nursing managers realized that the content was specific to team members and that nursing was responsible for a finite number of fields. They felt that they could undertake to complete those nursing-specific fields. The fact that the existing charting system already had different reporting forms for the different team members provided a way forward to reduce the documentation burden. Each team member recorded their assessment of the patient on a different colored page. The nurses identified that his would be helpful.

A total of 25 patients were assessed, facilitated by the research team using the paper-based version.

D. Modify knowledge tool to be responsive to actual needs during every day deployment:

As the Dashboard was designed as a daily tracking tool for patients' health and recovery status, it needed to be responsive to daily processes of care and outcomes. A customized application was designed for use on a mobile device (Acute Stroke Dashboard App). Two smart phones were purchased, one for each unit, and a locking device installed at each nursing station. The telephone functionality was disabled; the devices had Wi-Fi capability to transmit data to a secure server. With the mobile devices in hand, the Nurse Managers identified that passing these around during daily huddles would be a way of updating the data when each patient was discussed and a way of engaging other health professionals in the process. With each experience, changes were made to improve simplicity and efficiency as identified by the Nurse Managers.

Results

A. Current Methods of Documentation:

A total of 240 patients with stroke been admitted to MNH between 06/2013 and 02/2015. Of these, 16 charts were not retrievable from medical archives and 25 were missing the sheets from health care professionals and, as a result, little useable functional information was accessible. Table 3 presents personal and stroke-related information on the 199 patients with accessible data, according to the period of admission. Length of stay is described using means and SD, the median, and the number patients-days. At T1, 50 charts were reviewed and the mean length of stay was 23 days (SD: 21; median: 16; patient-days: 1191); at T3, 46 patient charts were reviewed and the length-of stay parameters were: mean 12 days (SD: 12); median 9.5 days; patient-days 572. In comparison to T3 when the stroke unit commenced, people admitted at T1 and T2 were much less likely to be discharged at any point in time (HR_{T1}: 0.12; 95% CI: -3.7, -0.4; HR_{T2}: 0.19; 95%CI: -3.3,-0.1).

Table 4 presents the proportion of bed-days for which each of the functional recovery indicators was documented through standard charting. Swallowing, bladder control, toileting, and feeding were consistently tracked for ~80 to 90% of patient-days. Bed-mobility and capacity to transfer were rarely tracked (<12%). Capacity for walking and sit-to-stand were noted but never frequency (performance). At the last period that represented the evolution to the formal stroke unit, the documentation of functional recovery indicators was greatest.

B. Knowledge Tool (Dashboard):

Based on the content discussed during weekly rounds and the experience of the research team in daily documentation, a paper-based version of the "Acute Stroke Dashboard" was created. The project started in January 2015 and 12 iterations of the paper version were carried out over a 3 month period. As desired by the stroke team, each health professional had a dedicated section which avoided the issue of who is responsible for what data.

Figure 1 presents the final paper version of Acute Stroke Dashboard. The content for the Nursing team included; lines and leads (PEG, NG Tube, O2, IV, Foley, and CPAP); one field for behavioral concerns covering agitation, impulsivity, irritability, emotional hyper-reactivity; and one field each for confusion, bladder control, and estimated hours out of bed for day shift only.

One section was for OT and SLP content and included fields to record results for digit span [48], MMSE [49]or MOCA [50],capacity to follow a 2-step command. Fields were also provided for clinician- assessed indicators of neglect, verbal communication, swallowing, feeding, dressing, and kitchen skills. Capacity of each was rated on a 3-point scale: none, partial, full, which was the terminology usually used by the team. Also were included on the request of the Nursing management team the fields for the patient-reported outcomes (PROs) of motivation, mood, pain, fatigue, measured on a 7-point pictorial scale, Delighted Terrible Faces Scale [51, 52] (Smiley Faces Scale). This response scale was produced on a plasticized pocket card and given to all stroke team members (see Appendix); a similar card was prepared to digit span which had four different number sets.

The section for the PT included indicators of capacity of physical function. The PT was very involved in choosing the desired fields where were: left arm movement, right arm movement, movement in bed, lie to sit, sitting unsupported, sit to stand, stand unsupported, lifts unaffected leg while standing, lifts affected leg while standing, and walking. The rating scale was as for the OT/SLP section: none, partial, full capacity.

The functional outcome indicators were chosen because they could be used to create summary scores for two key outcomes desired by the Quebec Stroke Strategy. When the study started, a measure of basic activities of daily living was a key outcome, although no particular measure had been named. As the Barthel Index [53] was the most basic and most widely used clinically as well as for research and did not require licensing or specialized training, the items from this scale were chosen. One of the items were assigned to the Nursing content (bladder control) and as this item is highly correlated with bowel control, one field completed two of the Barthel items. Two items were assigned to the OT content, feeding and dressing; Three items were assigned to the PT content, transferring (sit-to-stand), walking, and stairs (using two proxy indicators, lift affected and unaffected leg while standing). From these seven indicators a Barthel total score could be estimated. A second required outcome was the Berg Balance Scale and with 5 items (sitting unsupported, standing unsupported, sit-to-stand, and lift each leg while standing) a total score could be estimated. The algorithms for these estimations are given in the appendix.

C. Engage Stroke Unit Team

To engage the team in the data, the Dashboard was used on daily basis to assess 25 patients. The patients being assessed were identified on the communication board in each nursing station. The paper-version of the Dashboard, which was formatted to a single sheet of paper, was inserted into the usual chart in the unit along with a poster indicating the patient was part of the project. The Nurse Managers took responsibility to ensure that the nursing content was filled out. The PT completed the content either alone or facilitated by the research team. The OT/SLP content was completed only by the research team.

The 25 patients (mean age 68 years) contributed a total of 198 patient-days of observation. Half of the sample were diagnosed with ischemic stroke, half with hemorrhagic stroke; 16 of the 25 were discharged either directly home or a rehabilitation center.

Table 5 presents the status of the sample on the functional recovery indicators at admission. Some of the indicators were rated on capacity (full, partial, and none); the PROs were rated using the “Smiley Faces Scale”, and digit span was a count of the number of digits correctly repeated. The first column is the proportion of people with the highest levels on these indicators, the middle column is the proportion with partial capacity or mid-range ratings, and the last column is proportion with the poorest ratings. For example, for bladder control 14 people (56%) had full control at admission, 28% had partial continence, and 16% were incontinent. For the patient reported outcomes (PROs)[54], rated on the “Smiley Faces Scale”, few chose the poorest category; fatigue was the PRO most often rated in the poorest range. Of the motor recovery indicators, 37% had capacity to walk even on the first day of admission, and 50% could transfer from sitting to standing, leaving 50% to 63% with motor deficits restricting mobility at admission.

Table 6 presents change in the functional recovery indicators between admission and discharge. To track improvement, only persons without capacity at admission are included and this differs for each indicator. For example, 11 people did not have full bladder control at admission, and of these 27% improved. A rank was assigned [in square bracket] according to the proportion improved. The first rank was for following a 2 step command for which 62 % of the 8 people unable to do this at admission improved. The second rank was assigned to capacity to do sit-to-stand for which 42 % of the 12 people improved. The highest degree of deterioration was observed on the PRO measures of motivation (32 %), pain (26%); and fatigue (12%). The third column gives the proportion of people with fluctuating status and PROs showed the highest degree of fluctuation.

D. *Modify knowledge tool (Facilitate its use by migrating if from paper to an electronic device which was supplied to each of the two units):*

From the experience with completing the paper-version, the nurses identified a number of other fields they wanted included and modifications to the response options. At this stage, the need to move away from a paper-based version to a more flexible electronic version emerged. A key desire was to be able to visualize change in patient status over time. The content of the Dashboard was designed to cover the indicators needed to estimate total scores for the Barthel Index and Berg Balance Scale which could be shown over time. Because of the computing capacity of the electronic version of the Dashboard, we were able to meet this need.

Table 7 presents the estimated Barthel Index, at admission and over all patient-days, calculated using the algorithm embedded in the Dashboard APP. The total score on the Barthel Index can be interpreted as degree of dependency [55]. A score of 0 to 20 indicates total dependency (21 to 60, severe dependency) and 5 (4) people at admission were so classified and there were over 97 (24) patient-days with people in these two categories. No patients or patient-days showed greater than moderate dependency (BI: 61-90).

Similarly, the Berg Balance scale has established cut-points for indicating fall risk [56]. As score of ≤49 is considered to indicate a high risk of falls and Table 8 shows that 65 % of all patients were thus classified at admission and during 155 patients-days.

Figure 2 shows how the estimated Barthel Index can be used to track daily progress. The trajectories of four different patients are shown. Patient 1 (shown in blue line) came in with total dependence and remained so over the 11 days of tracking, with a slight improvement after day 7. The only way this could be achieved is by changing one level of capacity (none, partial, full) on one item as on the Barthel Index, one level change is equivalent to 5-point change. As the items on the Barthel Index have a hierarchy in terms of progression, for a patient to be so dependent, change could only occur on the lowest item, bladder control. Patient 3 (green line) was similar to patient 2 in terms of dependence but deteriorated, because of a cardiac event. Patient 2 (red line) come in with severe dependence and also deteriorated because of a second stroke at day 4. Patient 4 (purple line) came in with moderate dependence and improved to almost full independence by day 4.

More than 20 updates to the APP were carried out in response to emerging needs. One key update was to add a page for physicians who had noted that there was, in fact, no physician page.

The first item desired was a measure of stroke severity and the content of the Canadian Neurological Scale (CNS) [57] was added with a algorithm for calculating the total score and its translation to produce an NIHSS (National Institutes of Health Stroke Scale) score [58]. Also desired was a classification of stroke type using TOAST [59], a list complications arising during course of stay, the Charlson Comorbidity Index [60] for case-mix adjustment [47], and Modified Rankin Scale (MRS) [61] as a global outcome indicator.

In reality, physicians never used the APP to enter these desired fields. However, the nurses identified that they already they complete the CNS as part of their assessment at admission and, hence, the NIHSS score was also easily estimable. They also indicated that they knew all relevant co-morbidities and complications arising and, hence, the Charlson Index could be derived and they could complete the content for complications. At discharge they also completed the Modified Rankin Scale. Thus, the only field that the physicians uniquely need to complete is the TOAST.

The nurses now identified that, as they had to make regular status reports on the patients in their unit, some administrative fields were needed; these were added. The last update was done March 2016 and the project started January 2015.Figure 3 presents all variables included in the final version.

The first 117 patients assessed using the APP from 09/2015 to 02/2016 and their characteristics are presented in Table 9. The mean age was 69.5 years and 63 % were diagnosed with ischemic stroke; 56% of all patients were discharged home or to a rehabilitation center.

Table 10 presents the status at admission of the Dashboard assessed sample on selected functional recovery indicators, each graded on capacity as Full, Partial, or None. For example 56

(54%) patients at admission had full bladder control, and 22 (21% were incontinent). Results also show that, except bladder control which is recorded by nurses, status on other functional recovery indicators were rarely recorded consistently.

Table 11 presents information on the Dashboard APP assessed sample that the nurse's identified as illustrating burden of care. For example 3% patient had PEG, 23% patients had IV, and 3% patient had CPAP at admission.

Discussion

The main findings of study are summarized in Table 2 and indicated that the new APP Dashboard added value to the documentation process and was adopted by Nursing staff more so than other members of the stroke team (PT, OT, SLP, MD).

There is considerable literature on implementation of electronic health records (EHR), of which the APP Dashboard is an example [62-66]. The main impetus for EHR is to improve safety and efficiency, key elements of quality of care [67]. Results on safety vary but there is evidence that documentation time does not decrease with the use of EHR [62]. In addition, the up-take by clinicians has been less than enthusiastic [68], particularly if used during patient encounters. When deployed on the wards, documentation time has been reported to increase with the introduction of EHRs but improves over time with familiarity [62]. Technical features of electronic health records such as speed and value-added functionalities (graphs and automated reports) have been associated with a higher rate of use [69-72]. User-focused training is also an important element that affects uptake[72]. To optimize the integration of new technology into routine clinical use, integration of the users into the planning of EHR is crucial [62].

The visual and organized manner in which EHR presents key information can aid with faster decision making and reporting [73, 74]. For example, during the development of the Dashboard, the research team noted that at Stroke Rounds, which took one hour weekly, only verbal information was presented to the group. The screens from the EHR could easily be displayed making communication more objective, visual, and more engaging to the group. Administrative reports, which are required routinely, could easily be automated and produced regularly. This information could be displayed to inform staff and patients alike as to the activities and outcomes of the stroke unit. To take advantage of the EHR capability, it needs to be seen as a mechanism that can transform work processes and support innovation in care delivery [75, 76]

Use of EHR would be optimized by considering how KT theory can inform changes. The study started by considering several theories: the Problem Solving model, the model of Territorial Rights and Boundaries, and the PARiHS model. In retrospect, all of these theories held true in this context. There was a problem to be solved (documentation to meet new governmental requirements) and this was recognized by the Stroke Unit mangers and, thus, the research team was viewed as a potential solution. This value of the research team was enhanced in the eyes of the users of the new technology as one of the research team was considered an opinion leader in the field of stroke care, research, and outcomes.

The model of Territorial Rights and Boundaries applied and the research team, recognizing their potential negative impact, minimized their intrusiveness to the team by starting off with a “fly-on-the-wall” role and gradually integrating into the clinical team. The team also used the existing way of documentation to structure the Dashboard and modified it based on feedback from the users. Early on in the development, the two Assistant Nurse Managers self-identified to lead the implementation of the Dashboard. Now the Dashboard became their tool and not exclusively the tool of the research team. As a result, 20 iterations of the APP version were realized, in response to their needs as they emerged with use.

The PARiHS framework also applied for this implementation for a number of reasons. The content to be implemented had strong evidence, including face validity, for importance to the stroke care process. The environment was ripe for implementation as there was an opportunity to achieve a prestigious status as a Tertiary Care Stroke Center, if the processes and outcomes could be rigorously documented. Finally, the method to facilitate the process was also evidence based with integration of the research team into the clinical team, the modification-feedback loop established to meet the needs of the clinical team, the provision of the mobile devices with the APP Dashboard, and providing data from the APP to illustrate usefulness.

Conclusion

Implementing the APP version of the Acute Stroke Dashboard provided much better documentation of critical information to guide decision making and track outcomes than routine charting. Although much was learned, much still needs to be done. Only the nurses effectively engaged in the process, other team members did not or did to a lesser extent. A different KT approach needs to be applied for greater participation of PT, OT, SLP, and Physicians for using the Dashboard. This project was a first step and points out directions for further research.

Tables and Captions

Table 1.Completed Trials of Early and Very Early Mobilization After Stroke

Publication (Trial Name)	Randomized Sample	Intervention Protocol	Time (Hours) Between Stroke and Mobilization	Outcome*
Bernhardt et al 2008[3] (AVERT)	71	• Recruited within 24 h of stroke, goal to start mobilization within 24 h of stroke • Emphasis on patient being upright and out of bed (sitting or standing) • At least twice a day for first 14 days or until discharge	Intervention (n=38): Median=18.1, IQR=12.8–21.5 Control (n=33): Median=30.8, IQR=23.0–39.9	Complications/safety Deaths: intervention=8/38, SC=3/33, absolute risk difference=12%, ns. Serious adverse events†: intervention =15, control=14, ns. Nonserious adverse events: intervention =61, control=76, P=0.04 Falls: intervention=27, SC=28, ns. Functional outcome mRS 0–2: intervention=39.5%, control =30.3%, adjusted‡ OR=4.10, P=0.05
Langhorne et al 2010[8] (VERITAS)	32	• Recruited within 24 h of admission, with goal to start mobilization within 24 h of stroke • Goal for patient to be sitting, standing or walking (adjusted to patient needs) • Continued at least four times a day, during the inpatient stay, or for one week after recruitment	Intervention (n=16): Mean=27.3 Range=26–29 Control (n=16): Mean=32.0 Range=22.5–47.3	Complications/safety Deaths: EM=0%, control=6% Complications§: EM=8, control=17 Complications (days 5–90): EM=8, control=8 Complications of immobility (days 0–5): intervention=0, control=3 Functional outcome mRS 0–2: intervention=75%, control =44%, adjusted‖ OR=2.3, (P=0.44)
Diserens et al 2011[10] (Lausanne trial)	50 (42 included in analysis)	• Recruited within 12 h of admission, with protocol started 24 h after stroke • Patient's head of the bed kept at 0° for first 24 h poststroke, followed by 45° for 24 h, then 90° for 4 h • At 52 h poststroke, patients were moved out of the bed to either sitting or standing	Intervention (n=25): Not reported Control (n=17): Not reported	Complications/safety Deaths: intervention=0%, control=6% Severe complications including death¶ (during hospitalization): intervention=8%, control=47% Minor complications (during hospitalization): intervention=20%, control=0%, ns. Functional outcome mRS 0–2: intervention=40%, control=30%, ns.
Sundseth et al 2012[9] (AKEMIS)	65 (56 included in analysis)	• Recruited if admitted to hospital within 24 h of stroke, with mobilization out of bed within 24 h of admission • No predefined mobilization protocol. Mobilization, defined as any out of bed activity, followed the stroke unit's standard routine for mobilization, adjusted to patients' needs • Mobilization occurred several times per day	Intervention (n=27): Median=13.1 IQR=8.5–25.6 Control (n=29): Median=33.3 IQR=26.0–39.0	Complications/safety Deaths: intervention=7/27, control =2/29, adjusted# OR=5.26, ns. Patients who experienced ≥1 complication: intervention=67%, control=66%, ns. Functional outcome mRS 0–2: intervention=40%. control=60.7%, adjusted** OR=2.7, ns.

IQR indicates interquartile range; mRS, modified Rankin Scale; ns, nonsignificant; and OR, odds ratio.
*Outcome data are at 3 months, unless otherwise stated.
†Serious adverse events included stroke progression, pneumonia, recurrent stroke, myocardial infarction, atrial fibrillation, and other (does not include death).
‡Adjusted for age, baseline National Institutes of Health Stroke Scale (NIHSS), premorbid mRS (modified Rankin Scale).
§Complications included chest infection, falls, fatigue, and stroke progression. Complication of immobility was a subset including deep vein thrombosis, urinary tract infection.
‖Adjusted for age, baseline NIHSS, cointervention.
¶Severe complications included hospital acquired pneumonia, acute coronary syndrome, and pulmonary embolism. Minor complications were those that did not affect the autonomy of the patient (eg, allergic reactions, bed sores).
#Adjusted for age, NIHSS on admission, and mortality.
**Adjusted for age and admission NIHSS.

Table 2. Steps used to facilitate successful implementation of new documentation system

Finding	Action point
Step A: Chart Review is insufficient to document key stroke outcomes	
• 92% documentation of swallowing, bowel and bladder control • <12% documentation of bed mobility, and transfers • <1% documentation of capacity for walking and sit-to-stand • 0% documentation of frequency of transitions or time spent walking	Another way of routinely documenting outcomes of stroke is needed
Step B: Paper-based version of the Dashboard (Time line: 3 months)	
Quality indicator list required for designation as a Tertiary Stroke Centre informed the content	Apart from key processes of care, documentation of key functional recovery indicators is needed
Research team identified the key elements presented about stroke patients at weekly stroke rounds and daily stroke huddles	Worded the items, selected ordering and response options
Nursing staff identified the need for process and outcome elements to be matched to each professional group responsible	Information sorted by health professional
~12 iterations of a 3 month period	Modifications occurred after each weekly round
Barthel Index and Berg Balance Scale are the two main functional outcomes that are used in stroke units	Create mathematical algorithm from functional recovery indicators currently on the Dashboard to estimate total scores
Step C. Engagement of Staff in Ownership of Content	
Needed majority of documentation done by researcher and needed to engage the health professionals	Deployed paper-based Dashboard for 25 patients
Paper-based Dashboard was endorsed by the team but the team was unable to complete the elements of it as it was an additional piece of paper and they already had a documentation system mandated by their respective professional associations.	Create an electronic version of Dashboard (APP) which could be used easily on mobile device is needed
The data elements for the different professionals color coded using the existing color scheme from the paper based chart.	Transfer data from 25 patients' paper-based Dashboard to APP
Step D. Modify APP version of the Dashboard to meet actual need	
Data elements mostly completed by Nursing staff	Nurse champions identified using the APP during daily "huddles" where each patient is discussed and to pass the mobile device around so that the relevant health professional can update the needed information in real time
Nurse champions started to identify refinements to the existing items and additional elements that they are routinely concerned about and may or may not document The APP has capability of covering features to simplify documentation practice but some key elements missing	Weekly updates to the APP were carried out

Some key elements related to stroke missing	Add physicians page with complications, Charlson Comorbidity Index, TOAST, MRS, CNS, NIHSS
The Nurse champions identified that they needed to make regular status reports on their patients with using APP version of the Dashboard	Administrative fields were added to the APP to facilitate this reporting
More than 20 updates to the APP were carried out in response to emerging needs.	Deployed APP version of the Dashboard for 6 month (117 patients)
Nursing fields completed in majority of patients, OT/SLP rarely completed; PT sometimes completed	Need to develop different plan to engage OT/SLP and PT

Table 3. Characteristics of patients included in chart review (Step A)

Characteristics	Before Jan 2014	Jan to Sep 2014	After Sep 2014
Number of patients	50	103	46
Mean age ± SD (y)	76±12	69±17	72±17
Men, n (%)	22 (44)	49 (48)	27 (59)
Type of stroke, n (%)			
Ischemic	44 (88)	91 (88)	37 (80)
Hemorrhagic	6 (12)	12 (12)	9 (20)
Side of lesion, n (%)			
Right	22 (44)	42 (41)	10 (22)
Left	18 (36)	44 (43)	26 (57)
Bilateral	1 (2)	1 (1)	1 (2)
Midbrain	1 (2)	2 (2)	1 (2)
Unknown	8 (16)	14 (13)	8 (17)
Comorbidities, n (%)			
Hypertension	23 (45)	45 (43)	21 (45)
Diabetes	12 (23)	17 (17)	10 (21)
Atrial fibrillation	6 (12)	11 (11)	6 (13)
Cancer	5 (10)	9 (9)	5 (11)
Renal disease	3 (6)	9 (8)	5 (10)
Vascular comorbidities, (%)	(47)	(27)	30
Non-vascular comorbidities, (%)	(21)	(17)	16
Charlson Index≥ 2, (%)	(41)	(39)	39
Length of stay			
Mean ± SD	23±21	20±24	12±12
Median	16	12	9.5
Total patient-days	1191	2018	572

Table 4. Proportion of patient-days with documentation of Functional Recovery Indicators in the medical chart

Functional recovery indicators	Before Jan 2014 [# Patient-days:1191] %	Jan to Sep 2014 [#Patient-days:2018] %	After Sep 2014 [#Patient-days:572] %
Bladder control	97	100	98
Toileting	83	100	100
Swallowing	88	81	90
Feeding	81	62	97
Walking	18	18	59
Sit to stand/Stand to sit	9	10	18
Bed movement	7	7	15
Dressing	3	2	7
Bowel control	0	0	0

Table 5. Functional Recovery Indicators at admission for paper-based version of Dashboard (N=25)

Functional recovery indicator	Full/ [Rating scale/ digit span: 7/6] n (%)	Partial/ [Rating scale/ digit span: 5,4,3] n (%)	None/ [Rating scale/ digit span: 2,1] n (%)	Not recorded
Bladder Control	14 (56)	7 (28)	4 (16)	0
2 step command	16 (67)	6 (25)	2 (8)	1
Digit span	5 (24)	16 (76)	0(0)	4
Motivation	10 (48)	9 (43)	2 (9)	4
Mood	8 (38)	11 (53)	2 (9)	4
Pain	10 (48)	9 (43)	2 (9)	4
Fatigue	4 (19)	13 (62)	4 (19)	4
Walking	9 (37)	10 (42)	5 (21)	1
Sit to stand	12 (50)	11 (46)	1 (4)	1

Table 6. Change in Functional Recovery Indicators from admission to discharge for 25 patients

Functional recovery indicator	Improvement among those without full capacity n (%)[Rank]	Deterioration among those with full or partial capacity n (%)[Rank]	Fluctuating among all patients (N=25) (%)[Rank]
Bladder Control	11 (27) [8]	21 (5) [7.5]	(8) [5.5]
2 step command	8 (62) [1]	22 (5) [7.5]	(4) [7.5]
Digit span	16 (25) [3]	21 (10) [5]	(8) [5.5]
Motivation	11 (18) [5]	19 (32) [1]	(24) [4]
Mood	12 (17) [6.5]	19 (5) [7.5]	(48) [2]
Pain	11 (9) [9]	19 (26) [2]	(25) [3]
Fatigue	17 (12) [6.5]	17 (12) [3]	(50) [1]
Walking	15 (20) [4]	18 (11) [4]	(0) [9]
Sit to stand	12 (42) [2]	23 (5) [7.5]	(4) [7.5]

Table 7. Estimated Barthel Index (BI) from 198 patient-days for the 25 patients' paper-based version of the Dashboard

Estimated Barthel Inedx	At admission n (%)	Patient-days n (%)
0 to 20 [Total dependency]	5 (24)	97(49)
21 to 60 [Severe dependency]	4 (19)	24(13)
61 to 90 [Moderate dependency]	12 (57)	55(27)
91 to 99 [Slight dependency]	0 (0)	0(0)
100 [Independent]	0 (0)	0(0)
Missing	4 (19)	22(11)

Table 8. Estimated Berg Balance Scale (BBS) from 198 patient-days for the 25 patients' paper-based version of the Dashboard

Estimated Berg Balance Scale	At admission n (%)	Patient-days n (%)
≤ 49 [Higher risk of fall]	15 (65)	155(78)
> 49 [Lower risk of fall]	8 (35)	39(20)
Missing	2(5)	4(2)

Table 9. Characteristics of patients were assessed using the app from 09/2015 to 02/2016

Characteristics	
Number of patients	117
Mean age ± SD (y)	69.5±13.5
Proportion men, n (%)	62 (68)
Type of stroke, n (%)	
Ischemic	61 (63)
Hemorrhagic	36 (37)
Unknown	20
Side of lesion, n (%)	
Left	47 (57)
Right	31 (38)
Diffuse	4 (5)
Unknown	35
Discharge destination, n (%)	
Rehabilitation	25 (23)
Home	31 (29)
Long-term care	33 (31)
To other units	13 (12)
Death	5 (5)
Unknown	10

Table 10. Functional recovery indicators of 117 patients at admission

Functional recovery indicator	Full n (%)	Partial n (%)	None n (%)	Not recorded
Bladder Control	56 (54)	26 (25)	22 (21)	13
2 step command	4	1	1	101
Swallow	9	3	3	102
Feeding	8	5	3	111
Walking	8	9	8	92
Sit to stand	11	12	5	89

Table 11. Nursing burden of care for 117 patients at admission

Burden of care (Nurse session)	n (%)	Not recorded
PEG	3 (3)	10
IV	24 (23)	13
Bed bar	47 (46)	14
Restraint	13 (12)	11
Bladder control		13
Toilet	56 (54)	
Bed pan	6 (6)	
Diaper	12 (11)	
Condom	8 (8)	
Foley	22 (21)	
Confusion	18 (17)	9
CPAP	3 (3)	12
O2	7 (7)	13

Figure 1. The paper-based version of Acute Stroke Dashboard

Centre universitaire de santé McGill / McGill University Health Centre

Acute Stroke Outcome Dashboard

Date of Stroke:

Date of admittance:

		Date									
	DAY	1	2	3	4	5	6	7	8	9	10
Nurse	**PEG** *(Yes/No)*										
	NG tube *(Yes/No)*										
	O2 *(Yes/No)*										
	IV *(Yes/No)*										
	Foley *(Yes/No)*										
	CPAP *(Yes/No)*										
	Restraint *(Yes/No)*										
	Behavioral issue (E.g. Agitation, Impulsivity, Emotional hyper-reactivity, irritability) *(Yes/No)*										
	Confusion *(Yes/No)*										
	Bladder control *(Yes/Partial/No)*										
	Estimated hours of out of bed *(Day shift)*										
OT/SLP	**Neglect***(Yes/No)*										
	Digit span *(1-7)*										
	MMSE/MOCA *(score)*										
	Follows commands *(None=0, 1 step= 1, 2 step=2)*										
	Verbal communication *(None or not understandable=0/ Some=1/Full=2)*										
	Motivation *(1-7)*										
	Mood *(1-7)*										
	Pain *(1-7)*										
	Fatigue *(1-7)*										
	Swallow *(None=0, Partial=1, Full=2)*										
	Feeding *(None=0, Partial=1, Full=2)*										
	Dressing *(None=0, Partial=1, Full=2)*										
	Kitchen *(None=0, Partial=1, Full=2)*										
PT	**Left arm movement** *(None=0, Partial=1, Full=2)*										
	Right arm movement *(None=0, Partial=1, Full=2)*										
	Movement in bed *(None=0, Partial=1, Full=2)*										
	Lie to sit *(None=0, Partial=1, Full=2)*										
	Sitting unsupported *(None=0, Partial=1, Full=2)*										
	Sit to stand *(None=0, Partial=1, Full=2)*										
	Stand unsupported *(None=0, Partial=1, Full=2)*										
	Lifts unaffected leg standing *(None=0, Partial=1, Full=2)*										
	Lifts affected leg standing *(None=0, Partial=1, Full=2)*										
	Walking *(None=0, Partial=1, Full=2)*										

Figure 2. Estimated Barthel Index at each day of assessment for four different patients

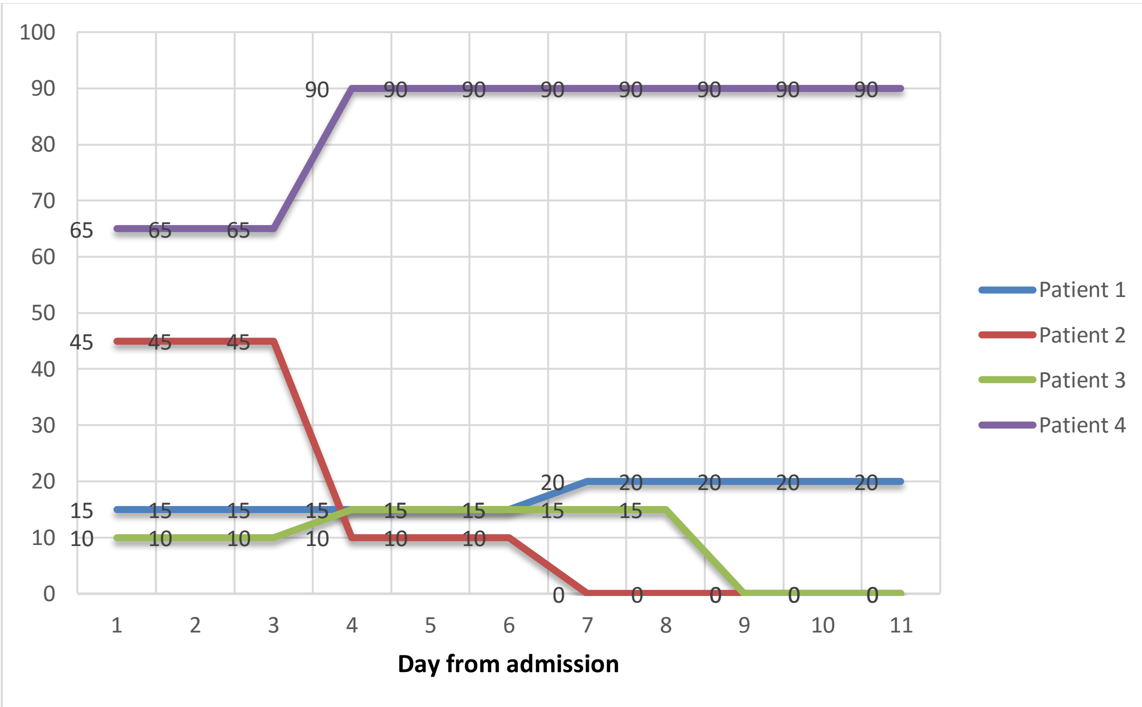

Figure 3. List of all Variables in the APP version of the Dashboard

ADMISSION PAGE	27. Venous line	DAILY PT PAGE
1. Patient's ID	28. CPAP/Vent/Trach	54. Left arm movement
2. MRN number	29. EVD/LD	55. Right arm movement
3. Date of admission	30. Sleep Apnea	56. Movement in bed
4. Age	31. Restraint	57. Lie to Sit
5. Gender	32. Bed bars	58. Sitting unsupported**
6. First Language	33. Fall occurrence	59. Si t to stand*'**
7. Stroke type	34. Behavioral issue	60. Stand unsupported
8. CNS form	35. Confusion	61. Lift unaffected leg standing*'**
9. First stroke?	36. Bladder control*	62. Lift affected leg standing*'**
10. Side of lesion	37. Hours out of bed	63. Walking*
11. Side of hemiplegic	38. Date of long term care declared	**PYSSICIAN PAGE**
12. Level of consciousness	39. Date of DSIE sent	64. Charlson
13. Patient orientation	40. Date of repatriation declared	65. Modified Rankin Scale
14. Visual impairment	**DAILY OT/SLP PAGE**	66. CNS score
15. Hearing aid	41. Neglect	67. NIHSS score
16. Hearing assessed	42. Digit span	68. TOAST
17. Aphasia	43. MMSE/MOCA	69. Major medical complications
18. Fall risk	44. Follows commands	**DISCHARGE PAGE**
19. Level of intervention	45. Verbal communication	70. MOCA
20. Depressed	46. Motivation	71. Custom assessment
21. Provenance	47. Mood	72. Date of discharge
22. Date of first OT assessment	48. Pain	73. Discharge planning
23. Date of first Swallowing	49. Fatigue	74. Level of intervention
24. Date of first PT assessment	50. Swallow	75. Total OT sessions
DAILY NURSE PAGE	51. Feeding*	76. Total SLP sessions
25. PEG/RIG/NG tube	52. Dressing*	77. Total PT sessions
26. O2	53. Kitchen	78. Barthel/Berg graphs

* Items used to estimated Barthel Index
** Items used to estimated Berg Balance Scale

CHAPTER 5

Overall discussion

Participating in this project as a Physical Therapist was an amazing learning opportunity. I gained real work experience with a variety of KT approaches. Apart from applying KT theories and designing the implementation strategy using these theories, I also experienced the value of other, more traditional, approaches to KT.

The first occurred when it was clear, even at the paper-based stage, that the material was unique to how the MNH was implementing the stroke pathway and the research team was invited to integrate the prototype Dashboard into a presentation made to delegates form Ministry of Health to support the status of a Tertiary Care Stroke Center. Several slides on the Dashboard were added to the final presentation and Dr. Mayo was invited to present this content.

I also experienced the value of traditional KT strategies which, in my case, were presentations at the 6th Canadian Stroke Congress (09/2015). Three abstracts were accepted for this Conference: (i) "Development and implementation of an acute-stroke Dashboard to meet reporting requirements for status as a tertiary care stroke centre; (ii) "APP for an Acute Stroke Dashboard"; and (iii) "Using Accelerometers to Monitor Activation of Patients in an Acute Stroke Unit".

The "Development and implementation of an Acute-Stroke Dashboard to meet reporting requirements for status as a tertiary care stroke centre" was selected for highlighted oral poster presentation. This provided an opportunity for discussion with attendees. I prepared a poster designed to attract interest using the “Guidelines to Maximize Effectiveness of Poster Presentations” a knowledge tool developed by Dr. Nancy Mayo. Perhaps, as a result of the compelling visual presentation of my poster [Appendix 5], there was always a huddle around my poster. During these “huddles”, several physicians asked about their contribution in the Dashboard, which at this time stage, did not have any physician-specific content. Several suggestions emerged , complications, Charlson Comorbidity Index [60], CNS [57], NIHSS [58], TOAST [59] ,and Modified Rankin Scale [61]; all of these were incorporated in the APP. Traditional KT, in this context was very useful.

Designing the implementation approach using the three KT theories that most applied in the context (the Problem Solving model, the model of Territorial Rights and Boundaries, and the PARiHS model) was a clear strength and contributed to its, at least partial, success. After implementation of APP Dashboard, the added value to the documentation process, at least from the perspective on nursing management, emerged. In the end, the APP was adopted by Nursing staff more so than other members of the stroke team (PT, OT, SLP, MD), but as the majority of the data fields Nursing relevant content, this was a substantial win.

List of abbreviations

APP: Application

MNH: Montreal Neurological Hospital

LOS: Length of stay

VAS: Visual analog scale

ADL: Activity of daily living

NIHSS: National Institutes of Health Stroke Scale

TOAST: Trial of Org 10172 in Acute Stroke Treatment

SLP: Speech language pathologist

OT: Occupational therapist

PT: Physical therapist

OASIS: Outcome and Assessment Information System

RUIS: Le Réseau universitaire intégré de santé

CT: Computed tomography

UTI: urinary tract infection

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Appendices

A1. Barthel index algorithm according to acute stroke Dashboard indicators

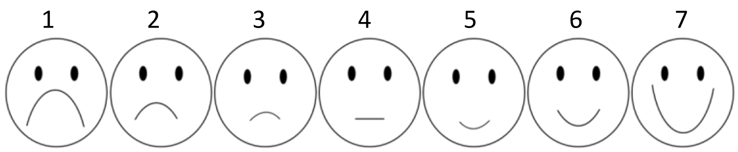
	Barthel algorithm		
1	If Dashboard **Feeding** = 0	then Barthel 1	=0
	If Dashboard **Feeding** = 1	then Barthel 1	=5
	If Dashboard **Feeding** = 2	then Barthel 1	=10
2	If Dashboard **Feeding** = 0	then Barthel 2	=0
	If Dashboard **Feeding** = 1	then Barthel 2	=0
	If Dashboard **Feeding** = 2	then Barthel 2	=5
3	If Dashboard **Feeding** = 0	then Barthel 3	=0
	If Dashboard **Feeding** = 1	then Barthel 3	=0
	If Dashboard **Feeding** = 2	then Barthel 3	=5
4	If Dashboard **Dressing** = 0	then Barthel 4	=0
	If Dashboard **Dressing** = 1	then Barthel 4	=5
	If Dashboard **Dressing** = 2	then Barthel 4	=10
5	If Dashboard **Sit to stand** and **Walking** = 0	then Barthel 5	=0
	If Dashboard **Sit to stand** and **Walking** = 1	then Barthel 5	=5
	If Dashboard **Sit to stand** and **Walking** = 2	then Barthel 5	=10
6	If Dashboard **Bladde**r= Foley/Diaper/ Condom (0)	then Barthel 6	=0
	If Dashboard **Bladde**r= bedpan (1)	then Barthel 6	=5
	If Dashboard **Bladde**r= toilet (2)	then Barthel 6	=10
7	If Dashboard **Bladde**r= Foley/Diaper/condom (0)	then Barthel 7	=0
	If Dashboard **Bladde**r= bedpan (1)	then Barthel 7	=5
	If Dashboard **Bladde**r= toilet (2)	then Barthel 7	=10
8	If Dashboard **Sit to stand** = 0	then Barthel 8	=0
	If Dashboard **Sit to stand** = 1	then Barthel 8	=5
	If Dashboard **Sit to stand** = 2	then Barthel 8	=10
9	If Dashboard **Walking** = 0	then Barthel 9	=0
	If Dashboard **Walking** = 1	then Barthel 9	=5
	If Dashboard **Walking** = 2	then Barthel 9	=10
10	If Dashboard **Lifts unaffected leg standing &Lifts affected leg standing** = 0	then Barthel 10	=0
	If Dashboard **Lifts unaffected leg standing &Lifts affected leg standing** = 1	then Barthel 10	=5
	If Dashboard **Lifts unaffected leg standing &Lifts affected leg standing** = 2	then Barthel 10	=10

A2. Barthel index algorithm according to the acute stroke Dashboard indicators

	Berg Balance Scale algorithm		
1	If Dashboard **Lifts unaffected leg standing andLifts affected leg standing** =2	then Berg	=51
2	If Dashboard **Lifts unaffected leg standing orLifts affected leg standing** =1	then Berg	=44
3	If Dashboard **Sit to stand** = 2	then Berg	=20
4	If Dashboard **Sit to stand** = 1	then Berg	=18
5	If Dashboard **Stand unsupported** = 2	then Berg	=8
6	If Dashboard **Stand unsupported** = 1	then Berg	=6
5	If Dashboard **Sitting unsupported** = 2	then Berg	=4
6	If Dashboard **Sitting unsupported** = 2	then Berg	=2

A3.The plasticized pocket card

How is your **Motivation** today?
Mood
Pain
Fatigue



Comment estvotre**Motivation**aujourd'hui?
Humeur
Douleur
Fatigu*é*

I want you to repeat a set of numbers for me: (Just say what I say.)

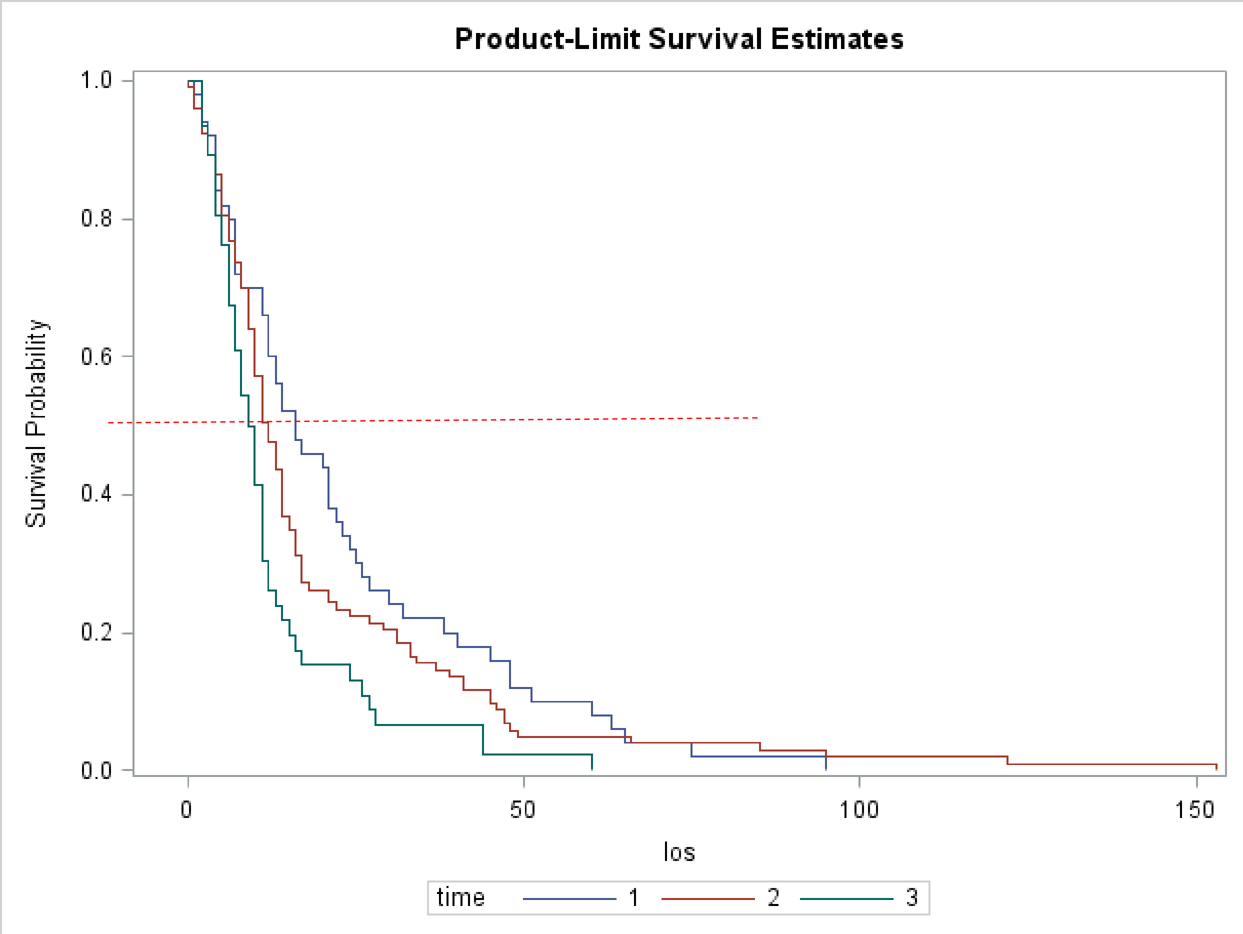
1	2	4	3	8
2	3-6	2-6	7-4	1-9
3	4-9-5	2-6-8	3-6-2	7-1-5
4	5-1-9-3	7-2-1-4	5-7-9-2	1-5-2-8
5	6-2-9-8-5	3-1-7-4-9	2-9-3-5-7	9-2-6-3-8
6	3-6-1-9-7-4	4-6-2-9-8-3	3-8-5-1-9-2	2-6-9-3-4-1
7	1-6-2-9-5-8-3	3-7-2-9-6-1-5	3-8-4-9-1-2-6	6-4-1-8-2-9-3

A3. Analysis of cox regression for the 3 time periods of patients length of stay at acute stroke unit

Analysis of Maximum Likelihood Estimates

Parameter		**DF**	**Parameter Estimate**	**Standard Error**	**Chi-Square**	**Pr > ChiSq**	**Hazard Ratio**	**Label**
time	**1**	1	-2.08581	0.84054	6.1578	0.0131	0.124	time 1
time	**2**	1	-1.67511	0.83417	4.0326	0.0446	0.187	time 2
Age		1	-0.01678	0.01055	2.5321	0.1116	0.983	

A4. Comparison of Patients length of stay in 3 different time periods of implementing stroke unit at MNH



A5. The Modified Rankin

Modified rankin scale

Category	Score
No symptoms at all	0
No significant disability despite symptoms	1
Slight disability	2
Moderate disability, but able to walk without assistance	3
Moderate disability, but unable to walk without assistance	4
Severe disability	5

Legend: Modified Rankin Scale measures independence rather than performance of specific tasks. Scale consists of six grades from 0 to 5; 0 denotes no symptoms and 5 indicates severe disability. For clinical purpose, mild disability range is from 0 to 2; moderate disability ranges from 3 to 4 and 5 indicates severe disability.

[Source: Sulter G, Steen C, Keyser JD. Use of the Barthel Index and Modified Rankin Scale in acute stroke trials. Stroke 1999;30:1538-41].

A6. The Poster selected for highlighted oral-poster presentation at the 6th Canadian Stroke Congress 2015: "Development and implementation of an acute-stroke Dashboard to meet reporting requirements for status as a tertiary care stroke centre".