The Impact of Stroke Assessment on Patient Outcomes following an Initial Transient Neurological Event (TNE)

by

Jaclyn Morrison
BSc, University of Victoria, 2008

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Supervisory Committee

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Dr. Scott Macdonald (School of Health Information Science)
Supervisor

Dr. Elizabeth Borycki (School of Health Information Science)
Departmental Member

Abstract

Dr. Scott Macdonald (School of Health Information Science)
Supervisor
Dr. Elizabeth Borycki (School of Health Information Science)
Departmental Member

Context: As one of the major causes of death and disability in Canada, research into the treatment and prevention of acute cerebrovascular syndrome (ACVS) remains a priority for clinicians, researchers and the general public. Understanding the relationship between current treatment practices of a rapid stroke clinic and patient outcomes is an essential part of measuring success and considering opportunities for quality improvement.

Objective: This study compared the 90-day and 1-year hospital admission and mortality outcomes of patients who were referred to and seen in a rapid stroke clinic (**the shows**) following an initial transient neurological event (TNE) with those who were referred to but not seen in the same clinic (**the no-shows**). The specific outcomes examined were stroke events, cardiovascular events and all other hospital events.

Methods: In this post-test only non-equivalent group design, data on patient outcomes was collected in the Victoria-based Stroke Rapid Assessment Unit (SRAU) between 2007 and 2013. Analysis included an assessment of group equivalency for possible confounders (age, sex and severity score) and two sets of multivariate logistic regressions were conducted on nine outcomes.

Results: An independent t-test revealed there was a statistically significant difference between the mean age of the shows ($\bar{X}$=68.26) and no-shows ($\bar{X}$=69.90) ($p<0.01$). While the proportion of males and females in each of the groups was similar (Fisher's Exact test, $p = 0.831$, ns), the severity score of the treatment group ($\bar{X}$=3.64) was statistically more severe in the show group than the no-show group ($\bar{X}$=3.50; $t = 2.137$, $p<0.05$). Controlling for age, sex and severity score, the odds ratios (ORs) were calculated to compare the odds of various outcomes in the treated (shows) versus the untreated (no-shows) patients groups. ORs for the 90-day and 1-year hospital admissions for stroke-related events were 0.071

($p<0.01$) and 0.091 ($p<0.01$), respectively; the OR for 1-year stroke deaths was 0.167 ($p<0.01$), indicating a strong protective factor related to attending the clinic appointment. For the cardiovascular outcomes, the ORs for hospitalizations were 0.967 (ns) at 90-days and 0.978 (ns) within 1-year and the OR for the 1-year cardiac-related deaths was 0.391 (ns). For all other outcomes, the ORs were 0.525 ($p<0.01$) for hospitalizations within 90-days, 0.579 ($p<0.01$) for hospitalizations within 1-year and 0.299 ($p<0.01$) for deaths within 1-year. These findings remained consistent with re-analysis excluding subjects who had an event within 5.4 days of their initial TNE. These latter finding largely rules out the possibility that the primary reason the no-shows did not make their clinic appointment, was due to a subsequent hospital event.

Conclusion: The ORs for the outcomes show a protective effect of stroke and all other hospital outcomes (but not cardiac events) for patients treated in the rapid assessment clinic. The exclusion of patients who experienced an outcome while waiting for a clinic appointment, lowered the protective effect of the treatment and emphasized the need for rapid assessment but did not alter the main study conclusions. Future research that explores factors influencing appointment adherence and patient attitudes towards acute treatment of TNEs might reveal strategies that could help to reduce the number of patients that remain untreated and at a higher risk for poor outcomes.

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Introduction

Stroke is often described as the leading cause of disability in Canada. According to research by the Heart and Stroke Foundation, Canadians collectively suffer approximately 50,000 strokes each year (Statistics Canada, 2012; Hakim, Silver, & Hodgson, 1998). In addition to these strokes, there are another 15,000 individuals who experience a transient ischemic attack (TIA) that can progress to stroke over time (Statistics Canada, 2012; Field et al., 2004). While the majority of these stroke/TIA patients survive, many of them are faced with disabilities or challenges that require additional care in hospitals, long-term healthcare facilities or in their own homes (Statistics Canada, 2012). It has been estimated that the annual cost of stroke in the Canadian healthcare system is nearly $3 billion (Mittman et al., 2012).

It is clear that the burden and cost of acute cerebrovascular disease/syndrome (ACVS) is significant and should remain a priority for clinicians, researchers and the general public. In fact, as our population continues to age and the prevalence of age-related chronic disease continues to rise, the incidence of stroke-related events may also increase. Understanding how the treatment practices impact patient outcomes is a critical component of any health system. Outcome-based research can not only inform health system budgets and resource allocation, but can also provide a framework for measuring success and identifying possible opportunities for quality improvement.

Previous outcomes research in the field of stroke has involved the use of both administrative and clinical datasets. The research has highlighted the importance of providing timely care that can prevent these debilitating and costly health crises (Lovett et

al., 2003; Rothwell et al., 2007; Luengo-Fernandez et al., 2009). However, much of the outcomes literature to-date has focused on comparing the non-equivalent outcomes of patients initially diagnosed with minor stroke to those who have been diagnosed with a transient ischemic attack (TIA) (Gladstone et al, 2004; Hill et al, 2004).

Using data collected through a local stroke assessment clinic and building on outcomes literature published to-date, the aim of this research was to compare the 90-day hospitalizations and 1-year hospitalizations and deaths of patients referred to and seen in a rapid stroke clinic (the shows) with those who were referred to but not seen in the same clinic (the no-shows). Three diagnostic outcome categories were examined, including stroke, cardiac and all other hospital admissions/deaths, resulting in nine different analyses. This outcome comparison between participants in the treated (the shows) and untreated cohorts (the no-shows) was preceded by a brief exploration of some potential confounders, including age, gender and severity score.

Background & Literature Summary

Acute Cerebrovascular Syndrome (ACVS)

A stroke, also known as an acute cerebrovascular accident, is a sudden loss of brain function caused by an interruption of flow of blood to the brain (Heart and Stroke Foundation, 2014). The lack of blood flow effectively starves the brain tissue of both oxygen and nutrients and can result in permanent damage to the downstream neurons (specialized brain cells); if the interruption of blood flow is temporary, the event is known as a transient neurological event (TNE) or transient ischemic attack (TIA) (Heart and Stroke, 2014). The effects of a stroke depend on where the blood flow was impacted, what part of the brain was injured and how much damage occurred. While the symptoms of TNEs/TIAs are typically short lived and accompanied by little or no permanent deficits, the impacts of larger strokes can affect a patient's physical, mental and cognitive processes.

As one of the leading causes of disability in Canada, it has recently been suggested that acute cerebrovascular events (ACVS events) are becoming increasingly more common than their cardiovascular counterparts known as acute coronary events (Rothwell et al., 2005). Canadians collectively suffer approximately 50,000 strokes each year (Statistics Canada, 2012; Hakim, Silver, & Hodgson, 1998) and while some of these stroke patients do not survive (25%), a majority of them (75%) live with the effects of their stroke in hospitals, long-term healthcare facilities or in their own homes (Statistics Canada, 2012).

In addition to these strokes, there are another 15,000 individuals in Canada (per year) who experience a TIA or TNE that can progress to stroke over time (Statistics Canada, 2012; Field et al., 2004). While research by Johnston et al. (2000) suggests the

progression of TIAs to strokes occurs in about 10% of cases within the first 90 days, other studies propose that this disease progression could be as high as 15% in the first month (Coull et al. 2004). Regardless of the percentages, recent studies have suggested that earlier intervention, with imaging and treatment, can significantly reduce the rates of progression.

The aforementioned evidence on the benefits of rapid TIA management has emerged through a large, prospective, population-based study in the United Kingdom known as the EXPRESS trial (Early Use of Existing Preventative Strategies for Stroke). The results from Rothwell et al. (2007) suggest there is an 80% relative risk reduction (from ten percent to two percent) in stroke progression when patients are treated in a rapid assessment clinic versus the implementation of treatment plans by general practitioners. In Paris, Lavallée et al. (2007) introduced a 24hour hospital-based clinic in order to compare the actual prognosis of patients visiting their clinic with their expected outcomes based on their stroke severity score ($ABCD^2$ score); their research showed relative risk reduction of a similar percentage (79 percent-- that is from 6% to 1.4%) when comparing the actual 90 day stroke rate to the predicted rate from $ABCD^2$ score. In 2009, Luengo-Fernandez et al. extended the EXPRESS trial results to show a subsequent and related reduction of hospital bed-days, hospital costs and disability scores following the introduction of the early assessment clinic.

In response to these and other findings, the following key recommendation was included in the third edition of the Canadian Best Practice Recommendations for Stroke Care:

> *"Patients presenting to a family physician's office or walk-in clinic with a suspected transient ischemic attack or non-disabling ischemic stroke should be immediately referred to a designated stroke prevention clinic with an interprofessional stroke team, or to a stroke specialist"* (Lindsay et al., 2010).

While these best practices have since been updated (fourth edition 2012; fifth edition 2014) to reflect new treatment options, management protocols and assessment tools, the best practice guidelines produced by the Canadian Stroke Network still heavily emphasize and promote the notion of rapid access to stroke services (Lindsay et al., 2013). These recommendations have led to the evolution of systems of care that address the need for TIA rapid assessment. Several different delivery models have been employed in various countries around the world, some of which have been highlighted in the stroke literature:

i. A specialized in-patient TIA service (Wu et al., 2009)
ii. A neuroscience referral program within the emergency department (Chang et al., 2002)
iii. An ED TIA observation unit (Stead et al., 2009)
iv. An outpatient TIA clinic to serve ED referrals (Wasserman et al., 2010)
v. An outpatient TIA clinic to serve a geographic area or defined population (Rothwell et al., 2007; Lavallée et al., 2007)

Stroke Rapid Assessment Unit (SRAU)

The Stroke Rapid Assessment Unit (SRAU) at Victoria General Hospital on Vancouver Island (British Columbia) would be an example of the last category of delivery

models listed above. The clinic currently receives all General Practitioner and Emergency Department referrals within the defined geographic region (Vancouver Island) and provides rapid access to neuroimaging tests and neurological consults for patients with acute cerebrovascular syndrome (ACVS). The clinic began serving the Victoria population in 2005 but quickly flourished into a high-volume unit for Vancouver Island population of 760,000 (Statistics Canada, 2012b). The clinic relies upon the use of an unlinked electronic charting application known as the Stroke Guidance System (SGS). As described by Lau et al. (1998), this unique computer program was developed in the late 1990s in order to record patient information and provide clinicians with some access to information on stroke literature, guidelines and best practices. Although it exists as a stand-alone record-keeping system (unlinked to the broader hospital records), the SGS does provide some support to clinicians and therefore could be considered a primitive clinical decision support system (CDSS).

In health informatics literature, clinical decision support systems have been defined as "computer-based tools that use explicit knowledge to generate patient specific advice or interpretation" (Wyatt & Spiegelhalter, 1991). According to Shortliffe and Cimino (2006), these tools are designed to help healthcare professionals make clinical decisions through three main functions: managing information, focusing user attention, and/or providing patient-specific recommendations. While the earliest reference to CDSS can be found in a pioneering paper by Ledley and Lusted (1959), historical support systems usually focused on retrospective analyses of administrative data (Berner, 2007). The more recent explosion of computers, electronic devices and health-related technology has allowed the field of CDSS to focus on assisting clinician decision-making at the point-of-care.

The potential impacts of CDSS are multifaceted and involve many different stakeholders within health authorities: clinicians, patients, healthcare management teams and administration (Mack et al., 2009). While it is easy to see the potential benefits of systems through improved quality of care, there are many other important considerations in implementing CDSSs. While issues of usability, application speed and EMR integration are important for clinicians to avoid impact on their current workflow (Bates et al., 2003), healthcare organizations have to balance the benefits of CDSS with the financial implications of these systems; that is, while the systems may improve care and contribute to better patient outcomes, the upfront costs of system, clinician training time and provision of technical support have significant financial implications for health systems as a whole (Sim et al., 2001; Moxey et al., 2010). Balancing the needs of diverse stakeholders can be challenging; the importance of understanding the perspectives of all stakeholders before implementing a CDSS cannot be overstated.

Because of this complexity, much of the literature on CDSS seems to suggest that although these systems can improve performance and have significant benefits on patient outcomes and the quality of care provided/received, many systems have not been effective due to various implementation challenges experienced across many different clinical areas (Kaplan, 2001; Bates et al., 2003; Stultz & Nahata, 2012). In 2005, Bates et al. addressed these barriers and succinctly described the following *Ten Commandments* for effective clinical decision support:

i. Speed is everything
ii. Anticipate needs and deliver in real time
iii. Fit into the user's workflow

iv. Little things can make a big difference (usability matters)
v. Recognize that physicians will strongly resist stopping
vi. Changing direction is easier than stopping
vii. Simple interventions work best
viii. Ask for additional information only when you really need it
ix. Monitor impact, get feedback and respond
x. Manage and maintain your knowledge-based systems

Despite these implementation challenges, recent literature reviews suggest that CDSS as a whole have positive impacts on care delivery (Kaplan, 2001) and have the potential to change the way that medicine has been taught and practiced (Berner, 2007; Mack et al., 2009; Kawamoto et al., 2005). The breadth of CDSS literature is indicative of the fact that there is a wide range of primary support functions provided by these types of systems. While some focus on supporting clinicians through reminders/alerts (for interventions, appointments, contraindications etc.), others systems focus more heavily on prescribing, dosing and/or diagnostic accuracy or efficiency (Shortliffe & Cimino, 2006). These systems also vary widely in their underlying decision-making frameworks; according to Garg et al. (2005), the most predominant frameworks include Bayesian modeling, rule-based approaches, artificial intelligence, fuzzy logic as well as neural networks and pattern recognition. Specific use of these frameworks will depend highly on how the CDSS will be used in clinical practice.

In the Victoria-based Stroke Rapid Assessment Unit (SRAU), the electronic record keeping system used by the clinical staff would be considered a limited CDSS that simply

provides neurologists (or other clinicians) with access to a structured clinical assessment. The SGS is not a sophisticated or dynamic system that can respond to patient-specific information and provide detailed alerts or diagnostic recommendations; it does not respond to the content that is entered into any of its specified data fields. The support it provides to clinicians centers on the provision of a template for a structured patient examination; the layout of the system essentially guides clinicians through a patient examination beginning with the chief complaint and ending with patient management decisions. The current design of the SGS dates back to the late 1990s when Lau et al. (1998) conducted a participatory research study to explore the diffusion of the application in clinical settings. The initial interface design (and the synthesis of the supporting evidence embedded in the system) was composed by an international panel of academic faculty including several neurologists and was loosely based on the best practice guidelines of that time. The participatory study by Lau introduced an iterative process by which the SGS was adopted, used and updated over time. Through this study, content and interface improvements were based on the deliberations among the researchers, designers and users as active participants; these deliberations and discussions led to the structured assessment of the SGS that is still used today. Table 1 (next page) summarizes the main components of this structured assessment and corresponding screen shots of the user interface have been included in Appendix A. While many of the system fields are free text, the drop-down fields are customizable for each individual user and may or may not contain the suggested menu items introduced during the initial development of the SGS system.

Table 1: Structured Examination Embedded in the Stroke Guidance System (SGS)

COMPONENTS OF STRUCTURED INTERVIEW	Description of Field	Type of Field
RISK FACTORS & HISTORY		
Risk Factors	Indicates the presence/absence of risk factors including hypertension, hyperlipidemia, atrial fibrillation, smoking etc.	Drop-down menu (Yes, No, Unknown)
Chief Complaint	The primary complaint(s) of the patient as recorded by SRAU staff during phone triage of patient referrals.	Drop-down Menu AND Free Text
History of Presenting Illness	Displays the history (story) of present illness for recorded by SRAU clinicians.	Drop-down Menu AND Free Text
Past Medical History	Lists the past medical events (conditions, surgeries etc) of the SRAU patient.	Drop-down Menu AND Free Text
Medications	Lists current medication for the SRAU patient.	Search Medical Database to populate field
Allergies	Lists any allergies for the SRAU patient.	Drop-down Menu AND Free Text
Social History	Describes living situation, marital status and activity level of any given SRAU patient.	Drop-down Menu AND Free Text
Family History	Describes family history of major chronic diseases (e.g. diabetes, stroke, cardiovascular disease, etc.) for a given SRAU patient.	Drop-down Menu AND Free Text
Review of Systems	Displays results of a generalized head-to-toe assessment including general appearance and basic systems overview.	Drop-down Menu AND Free Text
PHYSICAL EXAMINATION		
Neurological Exams	Includes exams re: mental and motor status, cranial nerve conduction, sensation and gait.	Drop-down Menu AND Free Text
Other Exams	Include blood pressures (supine, sitting/standing), pulse, and assessment of carotid arteries, auscultation of heart, and respiratory system.	Drop-down Menu AND Free Text
GENERAL/SUMMARY		
Physician Impression	Displays the clinician's consult notes.	Drop-down Menu AND Free Text
Patient Diagnosis	Documentation area for clinical diagnosis including DWI results, causative subtypes and localization.	Drop-down menu
Progress Notes	Displays the clinician's consult notes related to any follow-up appointments that a patient has with the SRAU.	Drop-down Menu AND Free Text
PATIENT MANAGEMENT		
Patient Orders	Includes imaging/laboratory/pharmacy orders and results, as well as consultation referrals and orders for discharge.	Specified fields
Outcome Assessment	Embedded links to risk assessment tool (e.g. NIHSS, TOAST classification, Modified Rankin score)	N/A

In addition to providing CDSS (in the form of a structured assessment) at the user interface level, the SGS used in the Victoria clinic is rooted in a large database that stores a variety of clinical information such as basic demographics (names, address, phone number, gender, date of birth), history of illness, disease management decisions, clinical notes and subsequent hospitalizations (patient outcomes). While these 14,000 individual prospectively-collected records provide a unique opportunity to conduct analyses that can assess patient outcomes and support quality improvement, the very existence of the dataset highlights the importance of electronic records (EMRs) in the collection of data for research. Without this fully integrated electronic system at the point-of-care, clinical data

captured through assessments in the Stroke Rapid Assessment Unit would otherwise remain strictly part of paper-based charts that would require time-consuming translation into an electronic format prior to any analysis. This notion of using electronic record-keeping systems to improve opportunities for research and quality improvement has been widely supported in the health informatics literature (Shortliffe & Cimino, 2006; Baron 2007) and is something that many health authorities, including Island Health, are working towards.

Even with established rapid assessment clinics, there are many challenges to treating TIA in a timely fashion. First, the condition is very complex with many underlying causes for cerebrovascular disease; this complexity contributes to the extremely variable clinical presentation of TIA (Johnston et al, 2000). Second, sorting the true TIAs from the many conditions that can mimic TIA can be difficult and often depends on the use of imaging technology that may or may not be readily available. Furthermore, the lack of public awareness regarding the need to seek immediate attention when experiencing symptoms of TIA/stroke is also a major contributor to delays in care that result in the provision of treatment beyond the 48-hour window of maximum effectiveness (Chandratheva et al., 2010; Sprigg et al., 2009).

Understanding how to improve the quality of care for patients with acute cerebrovascular syndrome often includes the tracking of patient outcomes following their release from a clinic or treatment facility (Bohannon et al., 2003). In the Victoria-based clinic, these patient outcomes are captured through electronic chart reviews. Research staff utilize the island-wide hospital information management system, known as Cerner PowerChart®, to monitor and record hospitalizations or deaths of all patients referred to the

ambulatory clinic. As described by Penn et al. (2012), this detailed outcome tracking is made possible by the fact that the clinic population comes from a defined geographic area (single health authority) with one electronic medical record system. However, the concept of outcome tracking is not new and has been well documented in the stroke literature. The databases PubMed, Medline and Web of Science were used to search for relevant articles.

Outcomes Research

Some of the earlier work on outcomes research related to ACVS appears in published literature through the 1990s and often involved the analysis of data collected in the 1970s and 1980s. Much of this research focused on traditional mortality rates and often included international comparisons of mortality rates over time (Dennis et al.,1990; Reitsma et al, 1998; Asplund et al.,1995; Bonita et al.,1990). The results from many of these studies suggest that clinicians and researchers already recognized the need for timely TIA treatment. The research by Asplund et al. (1995) featured the work of the World Health Organization's MONICA Project (Monitoring Trends and Determinants in Cardiovascular Disease) that involved a comparison of stroke incidence and mortality across fourteen sites in eleven different countries. The authors of this paper argue that while multinational comparisons are possible, meaningful interpretation of results requires the use of high data quality standards.

Another significant part of the stroke outcomes research to date has relied on the use of administrative or claims data coded with International Classification of Disease, or ICD, codes (Bohannon et al., 2003; Gladstone et al., 2004; Johansen et al., 2006; Hill et al., 2004). While the research by Bohannon et al. (2003) was based on data from the United

States at the Hartford Hospital in Connecticut, the work of Johansen et al. (2006) and Gladstone et al. (2004) involved datasets retrieved from and/or linked to the Canadian Institute for Health Information (CIHI). Both of these papers examine cohorts of patients in Ontario who were diagnosed with TIA or stroke. Johansen et al. (2006) used a single patient cohort and examined the incidence of various stroke types, comorbid conditions, length of stay and subsequent readmission rates (within 28days). Gladstone et al. (2004), on the other hand, compared use of diagnostic imaging, the prevalence of comorbid conditions and the provision of antithrombotic therapies between patients diagnosed with TIA versus stroke and also examined the 30-day readmissions rates for those diagnosed with TIA. Although the study was not designed to examine outcomes following treatment in a rapid stroke clinic, Gladstone et al. (2004) found the 30-day stroke risk was 5% overall and 8% for those with first ever TIA; interestingly, the authors noted that a majority of these stroke outcomes occurred within the first 2 days of a patient's initial event, once again emphasizing the importance of timely intervention.

Similar to Gladstone et al. (2004), Hill et al. (2004) examined the incidence of stroke following TIA in Alberta in order to determine whether or not this stroke outcome could be predicted by clinical or demographic factors such as age, diabetes, hypertension or socioeconomic status. This research on the predictors of stroke recurrence and/or readmission rates formed the basis of the systematic review by Lichtman et al. in 2010. Their research identified sixteen studies that examined predictors of readmission after stroke. In addition to noting that these studies had significant variability in terms of case definitions, outcome definitions, follow-up periods and model covariates, Lichtman et al. (2010) found a variety of analytical models were used in the research studies (i.e. logistic

regression, proportional hazards regression and log-linear analysis). These findings allowed them to conclude that although research into readmission rates following initial TIA/stroke have been well-studied, the current literature provides little guidance for the development of risk-standardized models suitable for the public reporting of stroke readmission rates.

While these studies have made valuable contributions to the stroke literature as a whole, it is important to acknowledge the limitations of research based on claims data. Although administrative data are computer readable, readily available, inexpensive to acquire and encompassing of large populations, there are often significant clinical information gaps or coding inaccuracies that compromise the ability to derive valid insights/conclusions from data collected primarily in the context of medical billing (Iezzoni, 1997; Tirshwell and Longstreth, 2002). As described by Hill et al. (2004), some of the most important limitations of administrative datasets related to stroke include the fact that 5.6% of ICD-9 diagnosis of TIA could be refuted based upon chart reviews and the fact that these administrative datasets provide no opportunity to assess the severity of stroke.

However, not all stroke outcomes research to date has relied on administrative datasets. In fact, several research groups have conducted outcomes-based studies using datasets derived from specialized stroke clinics (like the Stroke Rapid Assessment Unit described above) or from specific regional stroke registries. For example, in 2003, Lovett et al. completed an analysis of data collected as part of the Oxfordshire Community Stroke Project (OCSP) in order to estimate the early risk of stroke after TIA and to understand the potential effects of delays before specialist assessment. The group performed three analyses

of stroke-free survival starting from the date of first TIA, the date of referral to TIA service and the date seen by neurologist. As predicted, the authors found the risks of stroke decreased as time elapsed, once again supporting the need for rapid assessment and consideration of the timelines used in outcome studies.

The research by Coull et al. (2004) is another example of a study relying on the use of non-administrative datasets. This second UK-based study involved the analysis of Oxford Vascular Study (OXVASC) data. Established in 2002, the well-known OXVASC study was one of the first population-based studies of all acute vascular events in the world (NIHR, 2010). As described on the National Institute for Health Research website, the study was designed to provide information on the incidence, cause and outcome of all acute vascular events, such as strokes and heart attacks, in a population of nearly 100,000 people (Oxfordshire residents). While there have been many publications using this dataset, the outcomes research by Coull et al. (2004) compared the rates of recurrent stroke for those diagnosed with TIA versus those with minor stroke. The reoccurrence rates were estimated at seven days, one month and three months following the initial ACVS event.

Although much of the comparative outcomes research in the field of stroke has involved looking at the outcomes of patients diagnosed with TIA versus those diagnosed with stroke, other types of comparative research have also been published in the literature. These include studies that examined differences in short-term and long-term readmission rates across racial groups and across those living in urban/rural settings (Kleindorfer et al., 2005; Hartmann et al., 2001; Lisabeth et al., 2004; Correia et al., 2006).

To date, however, there is little or no published literature comparing the outcomes (readmissions or deaths) of patients referred to and seen in rapid assessment clinics (the shows) versus those who were referred to but not seen in these clinics (the no-shows). As described above, the majority of the research highlighted in the current stroke literature focuses on the outcomes TIA versus stroke patients; these papers feature various methodologies including regression, Kaplan Meier survival curves (and Log Rank test) and basic reporting of incidence and rates (in the presence or absence of age and gender standardization). The dataset from the Victoria-based stroke clinic offers a unique opportunity to contribute to the literature and examine the impact of the Stroke Rapid Assessment Unit (the intervention) simply because it contains data for both shows (treated patients) and no-shows (untreated patients).

Research Questions

Many research studies in the existing stroke literature support the notion that rapid access to treatment reduces progression of TIA to stroke (Rothwell et al., 2007; Lovett et al., 2003). As a result, it was hypothesized that the treatment group (the shows), composed of individuals receiving specialized clinical care and follow-up over the outcome period, would have fewer stroke-related outcomes than the individuals in the no-show group. While most of the published literature has focused on stroke-related outcomes, some studies expanded their outcome measures to include hospital readmissions or deaths for any other cause (Gladstone et al., 2004; Johansen et al., 2006).

While stroke outcomes are a very important measure of treatment success, it is also valuable to consider related events of the cardiovascular system. The hardening of arteries, also known as atherosclerosis, occurs when the inner walls of arteries become narrower due to a buildup of plaque (fatty deposits); this build-up can limit the flow of blood to the heart and brain (American Heart Association, 2012). If the blood vessels become too narrow or the plaque ruptures/dislodges from its collection site, blood clots can form. These clots can travel through the body, block the flow of blood to the heart and brain and lead to heart attacks and strokes (American Heart Association, 2012). In fact, as described by the Canadian Center for Disease Control (2014), heart disease (in addition to hypertension, high cholesterol, smoking and diabetes) is recognized as one of the major risk factors for stroke and transient neurological events (TNEs). The interrelatedness of these two fields (cardiology and neurology) supports the need to monitor and examine the outcome of patients with respect to cardiovascular events.

In light of this, the outcome measures for this study focused on hospitalizations and deaths related to stroke, cardiovascular and other events. The study was designed in order to address the following research questions:

(1) Is there a significant difference between the age, gender and severity scores (ABCD score) of the patients who are referred to and seen in the Stroke Rapid Assessment Unit (the shows) and those who are referred to but not seen in the clinic (no-shows)?

(2) Controlling for age, gender and severity, is there a significant difference between the outcomes of the shows and no-shows following an initial transient neurological event? The outcome measures for this study included the following:

    a. Stroke Outcomes:
        i. 90-day hospital admissions
        ii. 1-year hospital admissions
        iii. 1-year deaths
    b. Cardiovascular Outcomes:
        i. 90-day hospital admissions
        ii. 1-year hospital admissions
        iii. 1-year deaths
    c. Other Outcomes:
        i. 90-day hospital admissions
        ii. 1-year hospital admissions
        iii. 1-year deaths

(3) Do the findings for Question 2 (above) differ when excluding all events that occurred within 5.4 days (average time for a clinic appointment) of a patient's initial transient neurological event (TNE)?

Methodology

Study Design

This research involved a secondary analysis of aggregate outcomes data from the Stroke Rapid Assessment Unit (SRAU). In order to include a comparison group, the dataset was divided into the following two cohorts:

(1) Patients who were referred to and assessed in the Victoria-based stroke clinic (i.e. the SRAU shows)

(2) Patients who were referred to but not assessed in the clinic (i.e. the SRAU no-shows).

Since the cases included in the second cohort (the no-shows) were not exposed to the study intervention (that is, an assessment at a specialized stroke clinic), they served as the study comparison group for the evaluation study.

At the broadest level, this research can be described as a quasi-experiment with non-equivalent groups. As some of the most frequently used designs in social research, quasi-experiments are well suited to situations where randomization is not feasible (e.g. health research). In the health research context, true randomization of patients often requires withholding treatment for the experimental control group and therefore, can be seen as unethical practice. Quasi-experimental designs, however, provide an opportunity to conduct comparative research between groups differing in geographical locations (or health services available), individual treatment choices or past medical history.

There are many different types of quasi-experimental research designs and while most of them are structured with both pretest and posttest experimental measures, the design of this particular study included only post-test measurements (90-day and 1-year outcomes) as shown in Figure 1. This type of research design is post-test only with non-equivalent groups.

	Initial Transient Neurological Event	Intervention (clinic assessment)	Measurement 1 (90days)	Measurement 2 (1 year)
Group 1- SRAU Shows (Treated group)	E	X	O_1	O_2
Group 2- SRAU No-Shows (Untreated group)	E		O_1	O_2
	Time ---------->			

Figure 1: Non-equivalent Groups Post Test Only Design

This type of research design typically utilizes intact groups that have similar baseline characteristics (e.g. age distributions, gender ratios etc.); however, the lack of random assignment makes it difficult to be sure that this is the case for any particular dataset. As a result, this study began with an examination into some of the relevant characteristics of the control and treatment groups (see Research Question 1).

These initial analyses explored the impact of both age, gender and severity of illness on the rates of 90-day and 1-year outcomes for both patient groups (the shows and no-shows). While both age and gender standardization strategies are common in the stroke literature (see Literature section), recent research by Fonarow et al. (2012) emphasizes the importance of considering stroke severity scores when analyzing outcomes. At the outset of the project, it was decided that if the show and no-show groups were found to be

significantly different with regards to some of these baseline characteristics, the age, sex and severity scores would be controlled for in subsequent logistic regression calculations.

Data Source

The Stroke Rapid Assessment Unit (SRAU) at Victoria General Hospital receives all general practitioner and Emergency Department referrals on Vancouver Island. The clinic provides rapid access to neuroimaging tests and neurological consults for patients who have experienced transient neurological events (TNEs). The clinic uses this electronic charting application known as the Stroke Guidance System (SGS) to record clinical and research information for every SRAU-referred patient. The resulting database currently contains over 13,000 records captured between 2005 and 2013 and collected for the purposes of quality improvement.

In addition to serving as an electronic health record and documentation system for patients seen in the SRAU, the SGS also supports doctors, nurses and other healthcare professionals by providing them with a structured assessment that guides them through the history and physical exams as well as management decisions and future orders; Table 1 summarizes the primary components of this structured assessment and Appendix A includes screen shots of the user interface. While the SGS does have the capability to provide clinician support by linking them to relevant treatment guidelines, publications and stroke best practices, the knowledge base for these links has not been updated since the initial development of the system. As a result, these dated information links that exist in the current SGS have the potential to inform clinical practice but are not readily accessed or consulted by current users. The maintenance and management of a CDSS knowledge base is one of the *Ten Commandments* for effective clinical decision support outlined by Bates et

al. (2005) (see Literature Review section). If updated to reflect current best practices and stroke treatment guidelines, the existing links could have a greater impact on clinical practice and provide a greater level of support to the practitioners (see Limitations section).

In the SGS, patient outcomes are collected through electronic chart reviews at 90 days and 1 year (minimum). This outcome data is entered into the database and focuses on hospital readmissions and deaths in three primary categories: stroke, cardiovascular and other. In addition to exploring the salient characteristics of the patients referred to the ambulatory clinic, the outcome data included in the database was the primary source of information for this study.

Sample and Selection

The data contained in the Stroke Guidance System database was collected under a quality improvement/assurance study called *The Natural Experiment in Rapid TIA Care with Knowledge Transfer and Exchange* (2007-2013) and funded by the Canadian Institute for Health Research (CIHR) and the Heart and Stroke Foundation (HSF). The purpose of this project was to estimate incidence rates of acute stroke on Vancouver Island, to examine the impact of an intervention (rapid assessment unit) and to establish a quality assurance framework for integrating clinical research into practice and a "rapid learning healthcare environment" (see Institute of Medicine, 2007).

All patients who are referred to the SRAU are included in the clinical observations database/dataset regardless of whether or not they attended their SRAU appointment. This collection of data has become standard of care in the operational workflow of the SRAU

and is currently housed on the Island Health Information Management and Information Technology platform or infrastructure.

Following the completion of ethics approval and a required Island Health Operational Review (see Ethics section below), this study utilized existing aggregate dataset in the Stroke Guidance System for secondary data analysis. The requested dataset was composed of two primary cohorts in order to provide both treatment and comparison groups for the quasi-experimental design:

(1) SRAU Shows (treatment group--- intervention):

i. General Description*: Patients who are referred to and assessed in the Stroke Rapid Assessment Unit between January 1, 2007 and December 31, 2013.*

ii. Inclusion criteria:

- Seen in SRAU between Jan 2007 and Dec 2013 (first TNE encounter only)
- Minimum 90-day outcome completed
- Valid ABCD score, time of initial TNE, time of arrival, age and gender

(2) SRAU No-Shows (comparison group--- no intervention):

i. General Description*: Patients who were referred to the Stroke Rapid Assessment Unit between January 1, 2007 and December 31, 2013, and who should have been assessed by a neurologist but never made it to their appointment.*

ii. Inclusion criteria:

- Referred to SRAU between Jan 2007 and Dec 2013 (first TNE encounter only)
- Minimum 1-year outcome completed
- Valid ABCD score, time of initial TNE, referral date, age and gender

- Reason for no-show cannot be *Inappropriate Referral* or *Referred to Specialist*

Patients in these defined cohorts have vastly different treatment trajectories. Individuals who receive care at the SRAU (the *shows*) get access to neurological work-ups, imaging and evidence-based therapies for stroke prevention. These can include a variety of imaging modalities (e.g. computed tomography scans, computed tomography angiography, magnetic resonance imaging, carotid dopplers, cardiac monitoring) as well as prescriptions for stroke anticoagulation and prophylaxis (e.g. aspirin, warfarin or the new oral anticoagulants). However, in addition to this medical intervention, the patients get the added benefit of being given a structured and thorough examination by a trained physician/nurse using the Stroke Guidance System. The results of these examinations and tests (which generally involve input from a team of inter-professional clinicians) are recorded in the SGS; the electronic consults generated from the system are added to the existing hospital-based record system and are easily shared with a patient's family practitioner in order to inform future care. The fact that the SGS is partially integrated and can communicate with the greater hospital system highlights its value and increases its contributions to improved patient care.

Patients who are referred to but not seen in the SRAU (the *no-shows*) do not have access to the specialized services offered by the clinic/unit. In fact, the care they receive for their transient neurological event (if any) would most often be left in the hands of their general practitioner (assuming they have one[1]). Unlike the *shows*, this care would not include rapid access to imaging or to a specialist clinician for risk assessments and stroke

[1] A recent report by Statistics Canada (2013) suggests that over 15% of British Columbians do not have access to a regular medical doctor to address their ongoing health concerns.

prevention treatments. Generally speaking, a GP's treatment of an ACVS patient would be considerably hampered by limited access to timely imaging tests that are so important in determining the direction of a patient's time sensitive care plan. The documentation of this GP-based care would be directed by the record-keeping system used in the physician's office that may or may not include decision support for stroke-related care.

The percentage of general practitioners who use an electronic system in their individual offices would vary over the years covered by this study data. While the use of such a system would have been considerably lower in the earlier years (e.g. 2007-2010), the use of both electronic records and clinical decision support tools in GP offices has become more widespread. The National Physician survey of 2007 suggested that 34.5% of general practitioners in British Columbia were either using a fully electronic record keeping system or a combination system (electronic and paper-based) to enter and retrieve clinical patient notes. This survey was repeated in 2010 and 2013 and found that this percentage had increased to 52.2% in 2010 and 72.4% in 2013. These surveys do not include any information regarding the levels of system integration or the provision of clinical decision support but it is unlikely that these systems would be linked to hospital records and would include clinical decision support modules to guide clinicians specifically through a neurological assessment.

The participants in the no-show group were carefully selected using their individual reasons for missing their appointment with the stroke clinic; these reasons are captured and recorded in broad categories by the clinic staff (Appendix B). Referrals that were considered inappropriate for the rapid assessment clinic environment were excluded from the sample alongside those individuals who were referred to another neurologist's office.

The former group represents patients who were identified as having experienced a health issue unrelated to transient neurological events (TNEs) and the latter group could not be considered *untreated* as they were likely to have been followed by a clinician in a specialist's office.

The dataset extracted from the Stroke Guidance System (SGS) database was de-identified (coded) and completely stripped of any patient identifiers such as names, birthdates, PHNs and MRNs. Individual participants were only identified by a unique ID known as a GUID (global unique identifier). The study link files containing information that could link study participants to the unique identifier (and subsequent clinical information) were not shared with the researchers and were only accessible to the approved database manager responsibe for extracting, de-identifying and encrypting the requested dataset.

Ethics

The proposed research project was approved by the Research Ethics Department at Island Health. The file was reviewed by the Joint University of Victoria (UVic)- Island Health (VIHA) research ethics sub-committee that is responsible for granting ethical approval to university faculty, staff or students who wish to conduct research within the health authority. Consistent with the definitions provided in the TriCouncil Policy Statement 2 (TCPS2), the secondary use of deidentified (coded) data from the Stroke Guidance System was considered a minimal risk study; the extracted dataset did not include any information that could be linked to specific patients. Approval for data extraction was granted by the research ethics department in January 2015 (Appendix C).

Measurement & Analysis

Data Measures

The dataset extracted from the Stroke Guidance System included data fields associated with the initial transient neurological events (TNEs) of those referred to the SRAU. Table 2 provides a brief description of the data fields that functioned as the primary components of the analysis plan. A full list of data elements extracted from the Stroke Guidance System (SGS) (including those which will be used to select the cohorts of SRAU patients) has been enclosed in Appendix B.

Table 2: Primary Data Felds for Proposed Research Plan

DATA FIELD	TYPE/ FORMAT	DESCRIPTION
AGE	Continuous	Age (years)= The difference between the StartDate (initial chart creation date) and the birthdate in years. If AGE is negative or 0, it is assigned the missing value 999
GENDER	Categorical	Assigned as male (M), female (F) or not reported (U).
ABCD Score (see Appendix D)	Categorical	Stroke severity score (called ABCD score) of the patient recorded from the referral form. This score is coded as a value between 1 and 6. Missing ABCD scores are coded as 'U'.
90 DAY OUTCOME (Y/N) (i) Hospital admissions- stroke (ii) Hospital admission- cardio (iii) Hospital admission- other	Categorical	The 90-day outcome variables (three columns in total) will be included in the dataset as dichotomous variables. These fields will indicate whether or not the patient experienced 90day outcome under each of the outcome categories.
90 DAY OUTCOME DATE (i) Hospital admissions- stroke (ii) Hospital admission- cardio (iii) Hospital admission- other	Date	The 90-day outcome date will indicate the date (dd/mm/yy) on which any of the outcomes occurred. This will be included in order to allow for the inclusion of survival analysis curves for the no-shows and shows.
1 YEAR OUTCOME (Y/N) (i) Hospital admissions- stroke (ii) Hospital admission- cardio (iii) Hospital admission- other (iv) Death- stroke (v) Death- cardiovascular (vi) Death- other	Categorical	The 1-year outcome variables (six columns in total) will be included in the dataset as dichotomous variables. These fields will indicate whether or not the patient experienced 1 year outcome under each of the outcome categories.
1 YEAR OUTCOME DATE (i) Hospital admissions- stroke (ii) Hospital admission- cardio (iii) Hospital admission- other (iv) Death- stroke (v) Death- cardiovascular (vi) Death- other	Date	The 1 year outcome date will indicate the date (dd/mm/yy) on which any of the outcomes occurred. This will be included in order to allow for the inclusion of survival analysis curves for the no-shows and shows.

Analysis

The Stroke Guidance System dataset was generated as an SPSS® .sav file and included data for both the treatment group (the shows) and the comparison group (the no-shows). Each row of the dataset represented one individual patient identified by a 32-digit ID code. As described in the inclusion criteria above, cases referred to and seen in the stroke clinic between January 2007 and December 2013 were selected. Patients with multiple events/episodes were included in the dataset using only their first episodes. The following 9 outcome fields existed in dataset as dichotomous variables (yes/no):

i. Stroke Outcomes:
   - 90-day hospital admissions
   - 1-year hospital admissions
   - 1-year deaths.

ii. Cardiovascular Outcomes:
   - 90-day hospital admissions
   - 1-year hospital admissions
   - 1-year deaths

iii. Other Outcomes:
   - 90-day hospital admissions
   - 1-year hospital admissions
   - 1-year deaths

All statistical analyses were conducted using SPSS® version 22 and looking at the following three probability values: $p < 0.05$, $p < 0.01$ and $p < 0.001$.

In comparing the outcomes of the two groups (shows versus no-shows), it was important to consider possible confounders in the statistical model including age, sex and severity score. The distribution of gender in the show (N= 8309) and no-show groups (N= 871) was compared using the chi-square test for variance in order to indicate whether the proportions of males and females were the same for both groups. Age and severity score were treated as continuous variables and were analyzed using independent t-tests. If the probability values (p-value) for any of these calculations were found to be less than 0.05, it was concluded the proportions of gender/age/severity were different amongst the treatment and comparison groups and the variables were entered as covariates into the logistic regression model for the 90-day and 1-year patient outcomes.

The primary analysis of patient outcomes involved multiple logistics regressions of the 9 dichotomous outcomes variables listed above. Using the intervention field as the independent variable in the model (e.g. stroke clinic visit or no stroke clinic visit), the outcome variables of both hospitalizations and deaths served as the dependent variables of the nine regression analyses. Cases with missing outcome variables, or those that were missing more than one of the confounding variables were excluded from the regression analyses. The resulting p-values and odd ratios (EXP(B)) were examined for significance using three probability values ($p < 0.05$, 0.01 and 0.001) and effect size. Reference values were selected to ensure the directionality of the regression results.

Due to waitlists and/or delays in assigned clinic appointments, it was identified that the no-shows cohort could represent patients who had negative events while waiting for their appointment date (a potential source of bias). In other words, the no-show patients

might have been unable to show up to their scheduled appointment simply because they had already experienced a hospital admission or death. However, since the intended appointment date for the no-shows is not tracked in the Stroke Guidance System, it is difficult to identify exactly which patients experienced outcomes while waiting for their appointment. Although the wait times for clinic appointments can vary widely amongst patients, the average wait time (5.4 days, 2007-2013) was used a proxy measure in order to exclude patients who most likely experienced an outcome while waiting for clinic appointments. A secondary set of multivariate logistic regressions was completed with the same dichotomous outcome variables in order to generate adjusted odds ratios/effect and assess the degree to which this bias might influence the overall study conclusions. As above, the p-values and odd ratios (EXP(B)) were examined for significance using three probability values ($p < 0.05$, 0.01 and 0.001).

Results

After selecting only the cases referred to and/or seen in the Stroke Rapid Assessment Unit (SRAU) between 2007 and 2013, the final study population was 9180. This population included 8309 participants in the treatment group (the shows) and 871 participants in the comparison group (the no-shows). Table 3 shows some of the baseline characteristics and referral information for the entire study population.

Table 3: Baseline characteristics of total population (N=9180)

	No. of Cases (% of total population)
AGE: Mean 68.42, Range: 18 to 102	
24 and under	61 (0.7%)
25 to 44	507 (5.5%)
45 to 64	2786 (30.3%)
65 to 84	4677 (50.9%)
85 and over	1149 (12.5%)
SEX	
Female	4651 (50.7%)
Male	4529 (49.3%)
YEAR OF REFERRAL	
2007	794 (8.6%)
2008	1021 (11.1%)
2009	1381 (15.0%)
2010	1514 (16.5%)
2011	1433 (15.6%)
2012	1452 (15.8%)
2013	1585 (17.3%)
SOURCE OF REFERRAL	
Emergency Department	4802 (52.3%)
General Practitioner	3576 (39.0%)
Other/Unknown	802 (8.7%)
GEOGRAPHIC ORIGIN	
South Island	5658 (61.6%)
Central Island	2717 (29.6%)
North Island	538 (5.9%)
Unknown	267 (2.9%)
FINAL DIAGNOSIS (Treatment group only, N=8309)	
Stroke/TIA	4348 (52.3%)
Mimic/Other	3686 (44.4%)
NYD (Not Yet Determined)	275 (3.3%)

In comparing the outcomes of the two groups (shows versus no-shows), it was important to consider possible confounders in the statistical model including age, sex and severity score. As a result, the first step of the analysis was to examine the degree to which the groups differed in regards to these potential confounders.

The participants' age, at the time of their stroke clinic referral, was provided in the dataset and used to compare the mean ages of the treatment and control groups. The average age of the shows/treatment group was 68.26 (N=8309) and 69.90 (N=871) for the no-shows (comparison group). As shown in Table 4, an independent sample t-test indicated the means were significantly different ($p < 0.01$); equal variances were not assumed as Levene's tests for equality of variances had a $p < 0.05$.

Table 4: Independent t-test comparison of mean age in the treatment and control groups of the Stroke Rapid Assessment Unit (SRAU), 2007-2013.

Variable	Group	Mean	Standard Deviation	N	P-value
Average Age	Shows (treatment group)	68.26	14.293	8309	p<0.01*
	No-shows (comparison group)	69.90	15.996	871	

*Two-tailed significance level. Value based on equal variances not assumed as Levene's equality of variance test was significant.

The distribution of sex in the two groups was compared using the cross tabulation and Chi-square; Table 5 shows the results of this comparison. The Fisher's Exact Test did not indicate a significant difference (p=0.831) between the two groups. Both groups were composed of slightly more females than males.

Table 5: Comparison of sex distribution in the treatment and control groups of the Stroke Rapid Assessment Unit (SRAU), 2007-2013

PATIENT GROUP	GENDER		TOTAL
	Female	Male	
Shows (treatment group)	4213 (50.7%)	4096 (49.3%)	8309 (100%)
No-shows (comparison group)	438 (50.3%)	433 (49.7%)	871 (100%)

Fisher's Exact Test: p = 0.831 (not significant)

The severity scores (ABCD scores) of the participants in each group were also examined. As shown in Figure 2, the scores in both groups ranged from 0 (least severe) to 6 (most severe) with most values falling in the middle values of this defined range. The t-test results were significant ($p < 0.01$) and indicated an average ABCD score of 3.64 (N=7634) for the treatment group and 3.50 (N=542) for the control/no-show group (Table 6). Equal variances were assumed since Levene's test was not significant ($p = 0.127$).

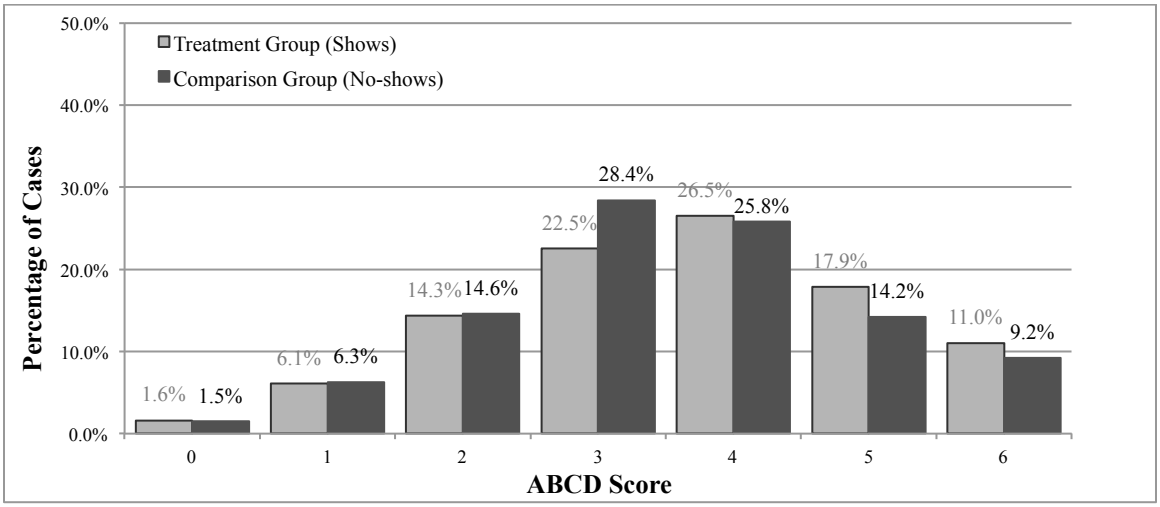

Figure 2: Distribution of ABCD scores (severity) in the treatment and control groups

Table 6: Independent t-test comparison of mean severity score (ABCD score) in the treatment and control groups.

Variable	Group	Mean	Standard Deviation	N	P-value
Average severity score (ABCD score)	Shows (treatment group)	3.64	1.447	7634	p<0.05*
	No-shows (comparison group)	3.50	1.391	542	

*Two-tailed significance level. Value based on equal variances assumed as Levene's equality of variance test was not significant.

The aforementioned findings do not indicate sex or severity score are important confounders for this study. Although the no-shows had significantly lower severity scores than the shows/treatment group, this finding only introduces a conservative bias. However, the no-show group was significantly older indicating that age is a confounder. Based on these results, it was decided that these three variables would be controlled for in the multivariate logistic regression.

Patient outcomes, measured in hospital admissions and deaths, were compared amongst the treatment and control groups (see Tables 7 through 24). As described above, both the hospital admissions and deaths were grouped into three primary categories: (i) outcome events due to stroke, (ii) outcome events due to cardiovascular issues and (iii) outcome events due to other health issues. Logistic regressions were carried out with the entire population and then repeated with the adjusted population. The adjusted population excluded cases that experienced any outcome within the first 5.4 days of their initial TNE (the average wait time of the stroke clinic); this was done to ensure that no-shows cohort did not simply represent those who had negative events while waiting for their appointment date (see Analysis section). Due to the fact that not all patients had been in the study for a full year, the total sample population was 8633 at 90-days and 7404 at 1-year due. The

sample sizes for the adjusted population at 90-days and 1-year were 8357 and 7134, respectively.

Age, severity score and gender were controlled for in all the logistic regression models. When the number of outcome events was sufficiently large (greater than 75 instances), the severity score was grouped into low, medium and high severity levels in order to assess the dose-response relationship and simplify the presentation of the logistic regression results. In these cases, the lowest severity score (ABCD = 0, 1 and 2) were grouped into the lowest severity category and used as the reference value. Scores of 3 and 4 were considered medium severity while scores 5 and 6 were categorized as high severity. These severity groupings are readily used by staff in the local clinic and have also appeared in the published stroke literature over the last several years (e.g. Tsivgoulis et al, 2007; Harrison et al., 2010; Kiyohara et al., 2014). When the number of outcome events was less than 1% of the population, the severity score was included as a continuous variable in order to ensure sufficient statistical power.

(i) Stroke-Related Outcomes

As shown in Table 7, the odds ratio (OR) for 90-day hospital admissions due to stroke for the treatment group (the shows) versus the comparison group (the no-show) was 0.071 ($p < 0.01$), indicating that the individuals in the treatment group (the shows) were significantly less likely to be hospitalized due to stroke within 90-days. Another way of describing this is that the odds of a stroke hospitalization within 90 days were 14.1 times greater ($1 \div 0.071$) for the no-show group. Although gender was not found to be significant in the regression model, both age (OR= 1.028, $p<0.01$) and severity score (OR= 2.180,

p<0.05; OR= 5.967, p<0.01) were significant. As expected, these odds ratios suggest that older patients with more severe symptoms are more likely to be hospitalized due to stroke within 90-days of their initial transient neurological event (TNE).

Table 7: 90-day Hospital Admissions due to Stroke-related Events (N=8633)

DEPENDENT VARIABLES	ODDS RATIO	P-VALUE
90-Day Hospital Admissions due to Stroke Events (N=178)		
Shows vs. No-shows (reference group = no-shows)	0.071	p<0.01
Demographics		
Gender (reference group = female)	1.232	n.s.
Age	1.028	p<0.01
Severity Score/ABCD Score (reference group: ABCD= 0, 1, 2)		
Medium severity (ABCD = 3 or 4)	2.180	p<0.05
Highest Severity (ABCD = 5 or 6)	5.967	p<0.01

Table 8 shows the same logistic regression model carried out on the adjusted population (N= 8357)- that is, the population excluding cases with outcomes in the first 5.4 days of their initial TNE. With this adjusted sample, the odds ratio for 90-day hospital admissions due to stroke in the shows versus the no-shows was 0.193 (p < 0.01). As above, this indicates that the individuals in the treatment group (the shows) were significantly less likely to be hospitalized due to stroke within 90-days; however, with this adjusted sample, the odds of a stroke hospitalization within 90days were 5.2 times greater (instead of 14.1 times) for the no-show group. Once again, both age (OR= 1.040, p<0.01) and severity score (OR= 5.538, p<0.01) were found to be significant in the regression model while gender was not found to be significant.

Table 8: Adjusted 90-day Hospital Admissions due to Stroke-related Events (N=8357)

DEPENDENT VARIABLES	ODDS RATIO	P-VALUE
90-Day Hospital Admissions due to Stroke Events (N=81)		
Shows vs. No-shows (reference group = no-shows)	0.193	p<0.01
Demographics		
Gender (reference group = female)	0.913	n.s.
Age	1.040	p<0.01
Severity Score/ABCD Score (reference group: ABCD= 0, 1, 2)		
Medium severity (ABCD = 3 or 4)	2.750	n.s.
Highest Severity (ABCD = 5 or 6)	5.538	p<0.01

At one year, the odds ratio for hospital admissions in the shows versus the no-shows was 0.091 (p<0.01); again this illustrates that participants in the treatment group were less likely to experience a stroke-related hospital admission within 1-year. As was the case at 90-days, both the age and severity score were found to be significant (see Table 9), once again suggesting that older patients with more severe symptoms are more likely to be hospitalized due to stroke events within 90-days. The odds ratio for gender was not significantly related to the 1-year outcome of stroke.

Table 9: 1-year Hospital Admissions due to Stroke-related Events (N=7404)

DEPENDENT VARIABLES	ODDS RATIO	P-VALUE
1-year Hospital Admissions due to Stroke Events (N=236)		
Shows vs. No-shows (reference group = no-shows)	0.091	p<0.01
Demographics		
Gender (reference group = female)	1.261	n.s.
Age	1.032	p<0.01
Severity Score/ABCD Score (reference group: ABCD= 0, 1, 2)		
Medium severity (ABCD = 3 or 4)	1.880	p<0.05
Highest Severity (ABCD = 5 or 6)	4.207	p<0.01

When repeated on the adjusted population, the odds ratio for hospital admissions in the shows versus the no-shows was still significant (OR = 0.258, p<0.01) but the effect size was considerably smaller (see Table 10). In other words, when controlling for age, gender and severity, the participants in the treatment group were still less likely to experience a

stroke-related hospital admission within 1-year, however, the odds of a 1-year stroke-related event were only 3.8 times higher (1÷ 0.258; Table 10) for the no-shows in the adjusted population compared to 10.9 times (1÷ 0.091; Table 9) for the no-shows in the total population. In the adjusted population, the odds ratio for age and severity were once again significantly related to the 1-year outcome of stroke while gender was not significantly related to the stroke outcome (see Table 10).

Table 10: Adjusted 1-year Hospital Admissions due to Stroke-related Events (N=7134)

DEPENDENT VARIABLES	ODDS RATIO	P-VALUE
1-year Hospital Admissions due to Stroke Events (N=135)		
Shows vs. No-shows (reference group = no-shows)	0.258	p<0.01
Demographics		
Gender (reference group = female)	1.090	n.s.
Age	1.041	p<0.01
Severity Score/ABCD Score (reference group: ABCD= 0, 1, 2)		
Medium severity (ABCD = 3 or 4)	1.850	n.s.
Highest Severity (ABCD = 5 or 6)	3.235	p<0.01

Table 11 indicates the regression results for stroke-related deaths within 1 year. The odds ratio for the show versus no-show groups was 0.167 (p<0.01), indicating that when controlling for age, gender and severity score, the patients in the treatment group were less likely to experience a stroke-related death within 1 year. With only 35 deaths due to stroke in the population, the sample size was too small to examine the dose response of ABCD score; in this model, the severity score was entered as a continuous variable.

Table 11: 1-year Deaths due to Stroke-related Events (N=7404)

DEPENDENT VARIABLES	ODDS RATIO	P-VALUE
1-year Deaths due to Stroke Events (N=35)		
Shows vs. No-shows (reference group = no-shows)	0.167	p<0.01
Demographics		
Gender (reference group = female)	1.556	n.s.
Age	1.102	p<0.01
Severity Score/ABCD Score (entered as continuous variable)	2.019	p<0.01

When evaluating the adjusted population and eliminating the cases that likely would have experienced their outcome before being seen in the clinic, the treatment group was still less likely to experience a death due to stroke within 1 year of their initial TNE (OR = 0.185, $p<0.05$; Table 12). Although gender was not found to be significant in the adjusted regression model for 1-year deaths, both age (OR= 1.100, $p<0.01$) and severity score (OR= 1.900, $p<0.05$) were significant. Once again, due to small sample sizes, the severity score was entered as a continuous variable in the logistic regression model.

Table 12: Adjusted 1-year Deaths due to Stroke-related Events (N=7134)

DEPENDENT VARIABLES	ODDS RATIO	P-VALUE
1-year Deaths due to Stroke Events (N=27)		
Shows vs. No-shows (reference group = no-shows)	0.185	$p<0.05$
Demographics		
Gender (reference group = female)	1.954	n.s.
Age	1.100	$p<0.01$
Severity Score/ABCD Score (entered as continuous variable)	1.900	$p<0.05$

(ii) Cardiovascular-Related Outcomes

Tables 13 and 14 show the regression results for 90-day and 1-year hospital admissions due to cardiovascular events. In both time periods, the odds ratios for the control group versus the treatment group were just below 1 (0.967 and 0.978, respectively) but neither appeared to be statistically significant in relation to the hospitalization outcome. At 90days, cardiovascular hospitalizations did appear to be associated with age (OR= 1.020, $p<0.05$), however did not appear to be impacted by severity score or gender. At 1-year there is again a small but statistically significant relationship between age and cardiovascular outcomes (OR= 1.032, $p<0.01$); however, different from the 90day hospitalizations, the 1-year results yielded an odds ratio of 1.588 ($p<0.05$) for the medium severity score.

Table 13: 90-day Hospital Admissions due to Cardiovascular-related Events (N=8633)

DEPENDENT VARIABLES	ODDS RATIO	P-VALUE
90-Day Hospital Admissions due to Cardiovasc. Events (N=86)		
Shows vs. No-shows (reference group = no-shows)	0.967	n.s.
Demographics		
Gender (reference group = female)	1.012	n.s.
Age	1.020	p<0.05
Severity Score/ABCD Score (reference group: ABCD= 0, 1, 2)		
Medium severity (ABCD = 3 or 4)	1.784	n.s.
Highest Severity (ABCD = 5 or 6)	1.604	n.s.

Table 14: 1-year Hospital Admissions due to Cardiovascular-related Events (N=7404)

DEPENDENT VARIABLES	ODDS RATIO	P-VALUE
1-year Hospital Admissions due to Cardiovasc. Events (N=227)		
Shows vs. No-shows (reference group = no-shows)	0.978	n.s.
Demographics		
Gender (reference group = female)	1.274	n.s.
Age	1.032	p<0.01
Severity Score/ABCD Score (reference group: ABCD= 0, 1, 2)		
Medium severity (ABCD = 3 or 4)	1.588	p<0.05
Highest Severity (ABCD = 5 or 6)	1.389	n.s.

Table 15 and 16 show the regression results for 90-day and 1-year hospital admissions due to cardiovascular events in the adjusted population. Once again, the odds ratios for the no-shows versus the shows (within both time periods) were not significantly related to the cardiovascular outcome. As found with the unadjusted population (see Table 13), the 90-day cardiovascular hospitalization outcome for the adjusted population was significantly related to age (OR= 1.023, $p < 0.05$) but not related to gender or severity (Table 15). Within 1-year for the adjusted population, there was not only a significant association between the cardiovascular outcome and age (OR= 1.033, $p < 0.01$) but also between the cardiovascular outcome and the medium severity score (OR= 1.609, $p < 0.05$).

Table 15: Adjusted 90-day Hospital Admissions due to Cardiovascular-related Events (N=8357)

DEPENDENT VARIABLES	ODDS RATIO	P-VALUE
90-Day Hospital Admissions due to Cardiovasc. Events (N=82)		
Shows vs. No-shows (reference group = no-shows)	0.811	n.s.
Demographics		
Gender (reference group = female)	1.000	n.s.
Age	1.023	p<0.05
Severity Score/ABCD Score (reference group: ABCD= 0, 1, 2)		
Medium severity (ABCD = 3 or 4)	1.740	n.s.
Highest Severity (ABCD = 5 or 6)	1.488	n.s.

Table 16: Adjusted 1-year Hospital Admissions due to Cardiovascular-related Events (N=7134)

DEPENDENT VARIABLES	ODDS RATIO	P-VALUE
1-year Hospital Admissions due to Cardiovasc. Events (N=212)		
Shows vs. No-shows (reference group = no-shows)	0.924	n.s.
Demographics		
Gender (reference group = female)	1.281	n.s.
Age	1.033	p<0.01
Severity Score/ABCD Score (reference group: ABCD= 0, 1, 2)		
Medium severity (ABCD = 3 or 4)	1.609	p<0.05
Highest Severity (ABCD = 5 or 6)	1.412	n.s.

Although not statistically different between the show and no-show groups, the 1-year cardiovascular deaths in both the unadjusted and adjusted populations appeared to be impacted by age (Tables 17 and 18). The odds ratio in both analyses indicated a weak but statistically significant relationship between age and cardiovascular death (OR=1.076, $p<0.01$; adjusted OR=1.092, $p< 0.01$). The odds ratio of 2.459 for gender ($p<0.05$) in the unadjusted population suggests males are more likely to experience cardiovascular fatalities within 90-days of their initial transient neurological event (TNE); although a similar odds ratio was seen in the adjusted population, the association was not found to be statistically significant when excluding cases that experienced outcomes in the first 5.4 days of their initial TNE (Table 18).

Table 17: 1-year Deaths due to Cardiovascular-related Events (N=7404)

DEPENDENT VARIABLES	ODDS RATIO	P-VALUE
1-year Deaths due to Cardiovascular Events (N=33)		
Shows vs. No-shows (reference group = no-shows)	0.391	n.s.
Demographics		
Gender (reference group = female)	2.459	p<0.05
Age	1.076	p<0.01
Severity Score/ABCD Score (entered as continuous variable)	1.000	n.s.

Table 18: Adjusted 1-year Deaths due to Cardiovascular-related Events (N=7134)

DEPENDENT VARIABLES	ODDS RATIO	P-VALUE
1-year Deaths due to Cardiovascular Events (N=25)		
Shows vs. No-shows (reference group = no-shows)	0.581	n.s.
Demographics		
Gender (reference group = female)	2.258	n.s.
Age	1.092	p<0.01
Severity Score/ABCD Score (entered as continuous variable)	1.033	n.s.

(iii) Other Outcomes

Hospital admissions at 90-days and 1-year include over 1000 reported outcomes. In general, the odds ratios produced in these logistic regressions indicated a small/weak relationship (effect size < 3) between other hospital admissions and the dependent variables included in the model. Tables 19 and 20 indicate that, when controlling for age, severity and gender, the treated participants were less likely to experience other hospitalizations with 90-days (OR= 0.525, p<0.01) and with 1-year (OR= 0.579, p<0.01) compared to the treatment group. Similar findings were noted in the logistic regression results for the adjusted population (Tables 21 and 22); although the association was slightly weaker (i.e. the odds ratios were larger and effect sizes smaller), the treatment group in the adjusted population was still less likely to experience other hospitalization within 90-days (OR= 0.600, p<0.01) and within 1-year (OR= 0.651, p<0.01).

In the unadjusted population, gender was significant for the 90-day outcomes (OR= 1.238, $p<0.05$), however, this relationship was no longer evident when looking at the 1-year statistics. Both age and severity scores remained significantly related to the hospitalizations within each of the time periods (see Tables 19 and 20), suggesting that older and more severe patients were more likely to experience other hospitalizations within 90days and 1-year of their initial TNE.

Table 19: 90-day Hospital Admissions due to Other Events (N=8633)

DEPENDENT VARIABLES	ODDS RATIO	P-VALUE
90-Day Hospital Admissions due to Other Events (N=488)		
Shows vs. No-shows (reference group = no-shows)	0.525	p<0.01
Demographics		
Gender (reference group = female)	1.238	p<0.05
Age	1.016	p<0.01
Severity Score/ABCD Score (reference group: ABCD= 0, 1, 2)		
Medium severity (ABCD = 3 or 4)	1.473	p<0.05
Highest Severity (ABCD = 5 or 6)	1.820	p<0.01

Table 20: 1-year Hospital Admissions due to Other Events (N=7404)

DEPENDENT VARIABLES	ODDS RATIO	P-VALUE
1-year Hospital Admissions due to Other Events (N=1078)		
Shows vs. No-shows (reference group = no-shows)	0.579	p<0.01
Demographics		
Gender (reference group = female)	1.111	n.s.
Age	1.025	p<0.01
Severity Score/ABCD Score (reference group: ABCD= 0, 1, 2)		
Medium severity (ABCD = 3 or 4)	1.263	p<0.05
Highest Severity (ABCD = 5 or 6)	1.249	p<0.05

When excluding those with very early outcomes (i.e. outcomes within 5.4 days of the initial TNE), the results indicate that neither gender nor medium severity scores were significantly related to these other hospitalizations (Table 21 and 22). In the adjusted population, both age (OR= 1.020, $p<0.01$) and highest severity (OR= 1.821, $p<0.01$) score were significantly related to the occurrence of non-cardiac, non-stroke outcomes within 90-

days (Table 21); similar results were found for the other hospitalizations within 1-year (Table 22). As with the unadjusted population, the odds ratios suggest that older and more severe patients were more likely to experience other hospitalizations within 90days and 1-year of their initial TNE.

Table 21: Adjusted 90-day Hospital Admissions due to Other Events (N=8357)

DEPENDENT VARIABLES	ODDS RATIO	P-VALUE
90-Day Hospital Admissions due to Other Events (N=413)		
Shows vs. No-shows (reference group = no-shows)	0.600	p<0.01
Demographics		
Gender (reference group = female)	1.215	n.s.
Age	1.020	p<0.01
Severity Score/ABCD Score (reference group: ABCD= 0, 1, 2)		
Medium severity (ABCD = 3 or 4)	1.358	n.s
Highest Severity (ABCD = 5 or 6)	1.821	p<0.01

Table 22: Adjusted 1-year Hospital Admissions due to Other Events (N=7134)

DEPENDENT VARIABLES	ODDS RATIO	P-VALUE
1-year Hospital Admissions due to Other Events (N=977)		
Shows vs. No-shows (reference group = no-shows)	0.651	p<0.01
Demographics		
Gender (reference group = female)	1.072	n.s.
Age	1.027	p<0.01
Severity Score/ABCD Score (reference group: ABCD= 0, 1, 2)		
Medium severity (ABCD = 3 or 4)	1.206	n.s.
Highest Severity (ABCD = 5 or 6)	1.259	p<0.05

At 1-year, the deaths due to other causes were less likely to occur in the treatment group (the shows) than the untreated no-shows (OR = 0.299, p<0.01); the effect size for this relationship was moderate (Table 23). Age (OR=1.050, p<0.01), gender (OR= 1.570, p<0.05) and severity score (OR= 2.467, p<0.05; OR= 3.437, p<0.05) were found to be significant in the regression model. These odds ratios indicate that older male patients with more severe symptoms are more likely to experience other fatalities within 1-year of their initial transient neurological event (TNE). The dose response of the severity score (see

Table 23) indicates that the likelihood of death due to other health-related events increases alongside the severity score of the initial stroke-related event.

Table 23: 1-year Deaths due to Other Events (N=7404)

DEPENDENT VARIABLES	ODDS RATIO	P-VALUE
1-year Deaths due to Other Events (N=138)		
Shows vs. No-shows (reference group = no-shows)	0.299	p<0.01
Demographics		
Gender (reference group = female)	1.570	p<0.05
Age	1.050	p<0.01
Severity Score/ABCD Score (reference group: ABCD= 0, 1, 2)		
Medium severity (ABCD = 3 or 4)	2.467	p<0.05
Highest Severity (ABCD = 5 or 6)	3.437	p<0.05

When the regression for 1-year deaths due to other causes was repeated on the adjusted population, the resulting odds ratios and significance values were similar to those of the unadjusted population. As shown in Table 24, the odds ratio for deaths in the shows versus the no-shows was significant (OR = 0.298, p<0.01) when controlling for age, gender and severity. All three of the aforementioned confounders were significant in the regression model (Table 24), once again suggesting that older males with higher severity score are more likely to experience 1-year deaths due to other causes.

Table 24: Adjusted 1-year Deaths due to Other Events (N=7134)

DEPENDENT VARIABLES	ODDS RATIO	P-VALUE
1-year Deaths due to Other Events (N=127)		
Shows vs. No-shows (reference group = no-shows)	0.298	p<0.01
Demographics		
Gender (reference group = female)	1.585	p<0.05
Age	1.050	p<0.01
Severity Score/ABCD Score (reference group: ABCD= 0, 1, 2)		
Medium severity (ABCD = 3 or 4)	2.398	p<0.05
Highest Severity (ABCD = 5 or 6)	3.388	p<0.05

Discussion

Driven by the need to keep detailed records, comply with health regulations and improve patient care, the healthcare industry has historically generated large amounts of data in hard-copy charts; despite many barriers and low adoption rates, the more recent push toward digital or electronic chart formats have made some of this data more readily available (Raghupathi & Raghupathi, 2014; Terry et al., 2009). In fact, some argue that use of electronic health records (EHRs) is now an essential component to reforming and improving healthcare services in Canada (Lai, 2009). Data held in these sorts of clinical databases have the potential to support programs or research on disease surveillance, population health management, clinical decision support and chronic disease management (Raghupathi & Raghupathi, 2014).

The use of the Stroke Guidance System (SGS) in the SRAU has resulted in the development of a rich clinical data repository. Although it was originally developed as an electronic health record system designed to collect data for clinical purposes and provide clinical staff with some decision support through a structured clinical assessment, its potential uses extend far beyond this initial role. With over 15,000 patient records now contained in the database, the SGS has the potential to answer many questions around current stroke prevention practices and reveal aspects of the current care that could benefit from quality improvement efforts. Research analyses like this study, would not be possible without the prospective collection of this clinical data in the rapid assessment unit. This highlights the importance of establishing electronic health records (and the corresponding databases) that not only improve access to large datasets for research studies but also have

the potential to improve the provision of healthcare services and patient care at a broader system level.

In addition to its significant sample size and tracking of clinic patients, the dataset from the SGS also includes information regarding nearly 1000 untreated patients who never made it to the clinic for their neurological work-up/assessment. In most ambulatory environments, these "unseen" patients would be excluded from record-keeping systems; if their basic information happened to remain in the clinic database, they would not be followed as rigorously (if at all) over the outcome periods. The research and clinical staff in the Victoria-based clinic, however, capture the outcomes of all referrals through electronic chart reviews regardless of whether a patient is seen or not. Requiring additional time and resources, this detailed outcome tracking is facilitated by the fact that the clinic population comes from a defined geographic area (single health authority) with one electronic medical record system (Penn et al, 2012). The tracking of the no-shows is a unique feature that supports evaluative research questions involving both treated and untreated populations, as opposed to comparisons of patients diagnosed with TIA versus stroke (a more common topic in the published stroke literature).

Potential Confounders

Confounders are defined as variables that are both causally related to the outcome and also associated with the intervention; in a statistical model, confounders can lead to over/under estimations of association and statistical significance (Gordis, 2009). As a result, a comparison of outcomes between the no-shows and shows in this study was preceded by an examination into possible confounders including age, sex and severity

score; these three variables were identified in the literature as being important factors related to stroke progression and outcome measures (Fonarow et al., 2012). The results indicate that the average age of the shows (68.26) was significantly lower than that of the no-shows (69.90, see Table 4). Given this statistically significant difference, it is possible that the younger age of the treatment group (the shows) could contribute to better outcomes overall while the older age of the no-shows could contribute to poorer outcomes. Since the average age was lower in the treatment group, it was considered a confounder and was controlled for in the study.

In considering the issue of age relative to hospitalization-based outcomes, it is necessary to acknowledge that there are many different factors that can influence a clinician's decision whether or not to admit a patient. Both internal and external factors play an important role in assessing patient risk and vulnerability (Culo, 2011). Questions regarding physical and mental health, cognitive capacity and functional impairment (internal factors) highlight the medical, ethical, legal and social complexities of making care-plans that are best suited to individual patients (Culo, 2011; Pavlou & Lachs, 2007). At the same time, clinicians are obliged to consider some of the more external factors such as living arrangements, social supports and financial status. All of these factors become progressively more important as patients age (Culo, 2011; Pavlou & Lachs, 2007) and, as a result, could potentially increase the number of hospital admissions seen in the older population (the no-shows). Furthermore, these older patients may exhibit a decreased likelihood adhere to clinic appointments due to the additional efforts required to physically get to a medical appointment with or without assistance. In an effort to reduce the impacts

of these age-related complexities, the age variable was identified as a confounder and controlled for in all of the outcome regressions.

In contrast, neither the sex nor the severity score were found to be important confounders. The gender distribution in the two groups was similar (not statistically different); both groups were composed of slightly more female than males, which could be explained by the fact that women are more likely to seek medical attention (Bertakis et al., 2000; Cameron et al., 2010). Contrary to what was expected, the mean severity of the shows (mean = 3.64) was higher than that of the no-shows (mean= 3.50) and was not considered an important confounder for this study. If anything, the lower severity score for the no-shows would only introduce a conservative bias to the outcome rates for this group. Despite these findings and in an effort to take a conservative and careful approach with the outcomes analyses, each of these potential cofounders was controlled for in the subsequent logistic regressions.

Patient Outcomes

The outcomes examined in this study were grouped into three broad categories: events related to stroke, cardiovascular and other health issues. As evidenced by the literature, the most important outcome measures were considered those related to stroke events following a patient's initial TNE. The interrelatedness of cardiovascular issues with stroke outcomes, however, deemed these cardiovascular events also important to examine. The remaining hospitalizations or deaths were grouped into a third category called "Other". It was initially thought that the outcome measures for this study could include 90-day

deaths for each of the three outcome categories, however, the sample size for these variables was not large enough to yield reliable results.

Stroke-related Outcomes

Controlling for age, gender and severity score, the hospitalizations due to stroke at 90-days and 1-year were both significantly related to whether or not a participant received treatment in the Stroke Rapid Assessment Unit (SRAU). The odds ratio of 0.071 at 90-days ($p<0.01$) suggested that patients who received treatment (the shows) were significantly less likely to experience a stroke related hospital admission within 90-days of their initial transient neurological event. The same finding was true when looking at the 1-year hospital admission variable (OR= 0.091, $p<0.01$).

Interestingly, the odds ratio at 1-year was slightly higher (OR= 0.091, $p<0.01$) than at 90-days. This finding may highlight the fact that the progression of TNE to stroke is considered to be front-loaded; that is, the highest risk of stroke for patients with an initial TNE occurs in the first week (Rothwell et al., 2007; Johnston et al., 2000). In some of the published literature, researchers included short-term outcome measures to address and track this timing issue. For example, Gladstone et al. (2004) included outcomes measures within 2 days, 7 days, 30 days and 90 days of their patient's initial event. In his study, however, the researchers were not comparing individuals in two cohorts (treated versus untreated); instead, they were looking at the overall stroke event rate following an emergency department visit for a TNE. When examining the success of a treatment process (like a rapid access clinic), these shorter time windows can be difficult to capture since there is often a delay between the patient's initial event and their treatment appointment. During this time, both the no-shows and shows populations remain untreated. Alternatively, this

higher odds ratio at 1-year could reflect the fact that no-show patients, who experience hospitalizations due to stroke within 90days, are subsequently treated and are less likely to have poorer outcomes in the time period between 90 days and 1 year (see Limitation section below).

Although the odds ratios for gender (1.232, 1.261 and 1.556) suggest that males were more likely to experience stroke-related hospitalizations and deaths within 90-days and 1-year, these associations were not statistically significant (p-values > 0.05). On the other hand, these hospital admissions and deaths due to stroke-related events were significantly and strongly related to age. This finding is in keeping with the stroke literature that suggests that the risk of stroke and stroke fatalities increases with patient age (Rothwell et al., 2004). On first glance, the odd ratios for the age variables appear modest, however, in considering that age is entered as a continuous variable and ranges from 18 to 100 in the given dataset, these odds ratios have to be applied to each unit of age (that is over 80 separate age intervals). In doing so, it is clear that the association of age with the stroke related hospitalizations and deaths is actually quite strong and was appropriately controlled for when attempting to compare the hospitalization and deaths between the no-shows and the shows.

Not surprisingly, the severity score (ABCD score), which was developed to predict the risk of stroke following a transient ischemic attack, was also correlated with the 90-day and 1-year hospital admissions and deaths due to stroke. Using the lowest ABCD score as a reference (that is 0 through 2), it was possible to see that patients with highest severity scores were considerably more likely to experience a stroke-related hospital admission. The odds ratio for those with the highest severity score (5 and 6) was nearly double the odds

ratio for those with a moderate severity score (3 and 4). Due to limited event rates, the logistic regression model for stroke-related fatalities within 1-year required the use of a continuous severity score variable that was found to be statistically significant ($p < 0.01$) in the same direction.

More recently, the ABCD score has been revised to include a value for diabetes as well as value for the occurrence of dual/multiple TIAs, important risk factors that were not included in the original calculation. These revised severity scores (known as $ABCD^2$ and $ABCD^3$) are becoming more common in the literature and are currently being evaluated for their ability to predict stroke risk following TIA (Kiyohara et al., 2014; Johansson et al., 2014). Change management processes have been initiated in the Victoria-based clinic in order to ensure that the data collection methods are capturing the additional fields required to compute these new score so that they can be included in future research studies.

In this dataset, there was some concern that the no-show population might be disproportionately composed of patients who have poor outcomes early on. In an attempt to address this potential source of bias, the logistic regression was repeated on an adjusted population which excluded those who experienced an outcome within 5.4 days of their initial transient neurological events (the average wait time for a clinic appointment). Clinically speaking, the exclusion of these cases is not ideal since the progression of TIA to stroke is known to be front-loaded. However, given the real-world wait times of the ambulatory clinic, it was necessary to compare the outcomes of the groups in this adjusted population. Even with this revised population, the odds ratio still suggested that patients who received treatment (the shows) were significantly less likely to experience a stroke

related hospital admissions or death following their initial transient neurological event (Tables 8, 10 and 12). The protective effect of the treatment lessened with the exclusion of these early outcome cases, supporting the notion that the risk of stroke progression is high within the first week.

Treatment in the stroke clinic typically involves neurological work-ups, specialized imaging and evidence-based therapies (i.e. prescriptions for aspirin, warfarin or the new oral anticoagulants) that focus on risk factor management and stroke prevention. These outcome measures related to stroke hospitalizations and deaths suggest that the clinic-based intervention has some positive impact on the health trajectory of the patients who are seen in the ambulatory clinic. The lowered protective effect of the treatment in the adjusted population not only suggests that some patients are experiencing outcomes soon after their initial TNE but also highlights the importance of seeing patients as quickly as possible.

Cardiovascular-related Outcomes

The 90-day and 1-year hospital admissions and deaths (1-year only) due to cardiovascular issues were not significantly different amongst the no-shows and shows when controlling for the three primary confounders of age, gender and severity score. This could reflect that the fact that, although cardiovascular and neurological issues are related, the treatment regime received in the clinic is not specifically targeted to prevent cardiovascular issues.

Interestingly, the 1-year deaths due to cardiovascular issues were found to be statistically related to gender; the odds ratio of 2.459 ($p < 0.05$) suggest that with 95% confidence, the odds of a male patient experiencing a 1-year death due to cardiovascular

issues is over two times that of the women. Research by Weidner (2000) compared the rates of heart disease in males and females and found that the gender differences in psychosocial and behavioral coronary risk factors, including excessive alcohol consumption and smoking favored women. Weidner also suggested that the ability of men to cope with stressful events may be less adaptive physiologically, behaviorally, and emotionally, contributing to their increased risk for heart disease.

Some researchers like Leening et al. (2014), however, argue that the occurrence of heart disease is similar amongst the different genders but that the first manifestation of cardiovascular issues are seen in men at a younger age than women. It is possible that the population from the Stroke Guidance system includes more younger men and fewer older women, contributing to this finding of increased cardiovascular deaths in the male cohort (regardless of whether or not they were treated at the stroke clinic or not).

Generally speaking, the severity score (ABCD score) was not found to be associated with the cardiovascular outcomes; because the score itself is designed to predict stroke outcomes (not cardiovascular events), this finding was expected. Although there appeared to be a statistically significant relationship between the moderate severity score and the 1-year hospital admissions for cardiovascular reasons (OR= 1.588, $p<0.05$), the dose response visualized in the stroke outcomes was not evident. As shown in Appendix D, the ABCD score includes the variable age; those who are over sixty gain an additional point so generally speaking, younger patients will have lower scores. If cardiovascular events are more likely to occur in younger patients as the research suggests, it is possible that we might see a weaker association between the high ABCD scores and the cardiovascular

outcomes.

Similar to the stroke-related outcomes, age alone was statistically related to all three of the cardiovascular outcomes. Although the effect sizes for the cardiovascular events were slightly smaller than those for the stroke-related outcomes, the results have the same trend. That is, older patients are more likely to experience cardiovascular–related outcomes than younger patients. This trend is seen in the analysis of all outcome categories and may simply reflect that the likelihood of patient mortality increases with age regardless of the cause.

As with the stroke outcomes, a secondary analysis of the cardiovascular outcomes was carried out on the population excluding cases with outcomes within 5.4 days (adjusted population). With this adjusted population, the directionality of the findings remained the same; none of the three cardiovascular outcomes were found to be statistically different between the shows and no-shows (Tables 15, 16 and 18). Although the odds ratios suggested that the protective effect of the treatment was slightly more protective for the hospital admission outcomes and less protective for the deaths, all of the reported p-values were insignificant.

Other Outcomes

With respect to other hospitalizations and deaths, the confounders of age, gender and severity were all found to be statistically correlated with the outcome measures. For the most part, the effect sizes of these correlations were small (OR between 0.5 and 1) suggesting that although significant, the strength of the relationships were not very strong. The odd ratio for severity scores with respect to 1-year deaths were the highest at 2.467 for

moderate severity ($p < 0.05$) and 3.427 for high severity ($p < 0.05$). This could reflect the fact that those with higher stroke severity scores represent more acute and more complicated cases where the occurrence of comorbid conditions can complicate decisions regarding cause of death; of course many causes of death, even if they are secondary to the initial stroke or heart attack, would be classified as other.

When controlling for age, gender and severity score, however, the hospitalizations and deaths due to events categorized as "other" were significantly less likely to occur in those who were referred to and assessed in the Stroke Rapid Assessment Unit ($p < 0.01$, see Tables 13-15). The odds ratio for the 90-day and 1-year hospitalizations were 0.525 and 0.579, respectively, but the strongest association was seen in the 1-year deaths (OR = 0.229, $p<0.01$). With over 1700 reported outcomes in the dataset (that is nearly, 19% of the entire sample), this outcome category could identify associations/correlations supported by rigorous statistics; however, the fact that the category includes such a wide variety of events (e.g. broken bones, infections, trauma, mental health, etc.) makes it difficult to draw conclusions regarding causal relationships.

As was seen with the cardiovascular outcomes, there was little change in the results when the analysis was rerun on the adjusted sample (excluding cases with early outcomes in order to avoid inflated outcome rates in the no-show group). When controlling for age, gender and severity score, the deaths and hospitalizations due for other reasons remained less likely to occur in the treatment group (the shows) and remained statistically related to both age and severity (see Tables 21, 22 and 24). This revised analysis resulted in small changes to the degree of protection offered by the treatment but did not indicate a need for

concern regarding the interpretation of the unadjusted odds ratios and significance values reported above.

In fact, although the results suggest that those who were seen in the clinic had better outcomes for these non-stroke and non-cardiovascular events, the difference in events rates between the no-shows and shows could potentially have little to do with the assessment and treatment in the stroke clinic. It could be argued that the lower hospitalizations and deaths in the treatment group simply reflect the fact that patients who adhere to their appointment times in the stroke clinic may represent those who are more proactive or engaged in their individual healthcare matters and therefore less likely to experience health issues that result in hospitalizations. That being said, the treatment in the clinic does address risk factor management including smoking, alcohol consumption, diabetes, hypertension and high cholesterol which, when controlled, could contribute to improved overall health.

Study Limitations

Design Limitations

Without the requirement of individual or site randomization, quasi-experimental studies like the post-test only design provide an opportunity to conduct research in fields that cannot ethically or logistically accommodate random assignment. In addition to being recognized as easier to carry out, quasi experiments are often touted as having higher external validity and being more representative of the real-world scenarios (Gordis, 2009; Calder et al., 1982).

However, without randomization, it can be difficult to control for confounding variables

and make strong inferences about the causal relationships; these difficulties are most commonly described as *threats to internal validity* (Okolo, 1990; Cook et al., 1976). In fact, a large majority of methodological literature on quasi experimentation includes discussions around the different threats to internal validity and the suitability of the design to various different research fields. In 2002, Shadish et al. summarized nine different categories of internal validity threats:

- Selection: Systematic differences in respondent characteristics that could also cause the observed effect.
- History: Events occurring concurrently with intervention could cause the observed effect.
- Maturation: Naturally occurring changes over time could be confused with a treatment effect.
- Attrition: Loss of respondents can produce artifactual effects if correlated with intervention.
- Interactive effects: The impact of an intervention may depend on the level of another intervention.
- Instrumentation: The nature of a measurement may change over time or conditions.
- Testing: Exposure to a test can affect scores on subsequent exposures to that test (practice effect).
- Regression: When units are selected for their extreme scores, their subsequent scores will often be less extreme; this can be confused with an intervention effect.
- Ambiguous temporal precedence: Lack of clarity about whether intervention occurred before outcome.

In 2006, Harris et al. completed a systematic review of quasi experiments in medical informatics journals and used these nine threats to emphasize that different types of quasi-experimental designs are associated with varying levels of quality. In this work, Harris et

al. (2006) developed a relative hierarchy of these designs with respect to their ability to establish causal associations between an intervention and an outcome (see Table 25 below).

Table 25: Relative Hierarchy of Quasi Experimental Design (taken from Harris et al., 2006)

QUASI EXPERIMENTAL STUDY DESIGNS	Design Notation
A. Quasi-Experimental designs without control groups	
1. One-group posttest only design	X O_1
2. One-group pretest-posttest design	O_1 X O_2
3. One-group pretest-posttest design using double pre-test	O_1 O_2 X O_3
4. One-group pretest-posttest design using a nonequiv. Depend. Variable	{O_{1a} O_{1b}} X {O_{2a} O_{2b}}
5. Removed Treatment Design	O_1 X O_2 O_3 remove X O_4
6. Repeated Treatment Design	O_1 X O_2 remove X O_3 O_4
B. Quasi-Experimental designs that use a control group but no pretest	
1. Posttest-only design with nonequivalent groups	Intervention Group: X O_1 Control Group: O_2
C. Quasi-Experimental designs that use control groups and pretests	
1. Untreated control group with dependent pretest and posttest samples	Intervention Group: O_{1a} X O_{2a} Control Group: O_{1b} O_{2b}
2. Untreated control group with dependent pretest and posttest samples using a double pretest	Intervention Group: O_{1a} O_{2a} X O_{3a} Control Group: O_{1b} O_{2b} O_{3b}
3. Untreated control group with dependent pretest and posttest samples using switching replications	Intervention Group: O_{1a} X O_{2a} O_{3a} Control Group: O_{1b} O_{2b} X O_{3b}
D. Interrupted time-series design	
1. Multiple pretest and posttest observations spaced at equal intervals of time.	$_1$ O_2 O_3 O_4 O_5 X O_6 O_7 O_8 O_9 O_{10}

Increasing Quality ↓

O = Observational Measurement; X= Intervention Under Study. Time moves from left to right.

According to Harris et al. (2006), the post-test only design proposed in this project falls in the middle of the quality ratings. Although there is a control/comparison group in this design, the absence of a pretest makes it difficult to know if a change occurred in the treatment/intervention group and whether any change is a result of the intervention itself or some other differences between the control and treatment groups. While it may not be feasible to completely eliminate the impact of all of the confounders highlighted in these validity threats, the use of a comparison group (the no-shows) and the steps taken to control for potential known confounders (age, gender and severity score) served to minimize the impact of threats such as selection, history and maturation.

It has also been argued that quasi-experimental studies are less suited toward longer studies because increased experimental timelines also increase the probability that other events will obscure the effects of the intervention (Robson et al., 2001). Although this particular limitation is not always discussed in the literature, it has implications for research studies that examine long-term outcomes of patients post intervention. As a result, this study was limited to the analysis of shorter-term patient outcomes (that is, 90-days and 1-year).

Dataset Limitations

In addition to the research design considerations, there are a few limitations of the Stroke Guidance System dataset that should be acknowledged when looking at the results of this study.

First, although the no-shows are intended to represent patients of the clinic who remain untreated with regards to their transient neurological event (TNE), there is a possibility that some of these individuals may have been referred to a local neurologist office after missing their initial clinic appointment. This could result in better outcomes for the no-show cohort (e.g. fewer hospitalizations and deaths) effectively narrowing the gap between the no-shows and shows (conservative bias) and reducing the odds ratios in the logistic regression for all of the outcome variables. In an effort to reduce this potential bias, the 346 no-show cases that were referred from the SRAU to another neurologist's office (and labeled as such) were excluded from the study population.

In addition, no-shows patients who are hospitalized due to stroke-related events at some point within the study period would have been given medical care during this hospitalization and therefore cannot be considered fully untreated over the remaining

outcome period. This could results in fewer subsequent outcomes for the no-shows (following an initial hospitalization) and again introduces a conservative bias when comparing this group with those treated at the outset (the shows). It would not be ethical to control this particular factor and withhold treatment for patients in this group; however, the fact that this issue introduces a conservative bias reduces the concern of its impact on the overall study conclusions.

Second, there was some concern that the no-show group may include patients by virtue of the fact that they have had an outcome while waiting for their appointment in the ambulatory clinic. For example, if a patient experiences a severe outcome event and remains hospitalized until his/her scheduled clinic appointment, he/she is will not be seen in the outpatient rapid assessment clinic and will be labeled as a no-show; this could inflate the number of poor outcomes in the no-shows and introduce a bias to these results. In other words, it is possible that the individuals in the treatment group will have better outcomes simply due to the fact that they make it to their appointment date without a hospital admission.

In order to address this concern, the decision was made to exclude cases with very early outcomes and rerun the logistic regressions for all outcomes variables. However, because the appointment date for the no-shows (the missed one) is not recorded in the database, it was difficult to know which of the no-shows had outcomes while waiting for their appointment. In this adjusted analysis, the mean wait time of the clinic (5.4 days) was used a proxy for estimating a reasonable appointment date for the no-shows so that those patients who experienced outcomes within the first 5.4 days of their initial TNE could be excluded. In reality, the wait times in the stroke clinic can vary widely by patient. The goal

of seeing patients as quickly as possible means that many are seen earlier than five days; however, many are also seen later than five days (due to various scheduling issues or delays in referral process).

The decision to use the mean wait time for the adjusted logistic regressions could introduce some bias to the results; the use of the mean wait time could unnecessarily exclude patients who were seen quickly and fail to exclude the patients who, in reality, were seen later than 5.4 days. Future data collection in the clinic could be expanded to include details regarding when (date/time) a patient misses his/her appointment at the clinic, a variable not currently recorded in the Stroke Guidance System. This date/time could then be used to specifically exclude patients who experienced outcomes while waiting for their appointment. With this new variable in place, it would also be possible to do a survival analysis starting from the time of a patient's appointment regardless of whether or not the appointment was kept (shows) or missed (no-shows).

Third, it should also be acknowledged that the electronic medical record itself could impact the outcomes of patients seen in the clinic. The existing links to guidelines, publications and stroke best practices are out of date and have not been substantially updated since the initial development of the system in the 1990s. Updating the decision support aspect of the SGS could improve outcomes of patients by ensuring that clinicians have access to current guidelines that can inform their clinical practice and encourage awareness of stroke-related literature and research.

Lastly, the deaths recorded in the Stroke Guidance System database represent only those found through a chart review of the island-wide hospital information management system. As a result, it is possible that participant deaths occurring in the community

(without an encounter with the local hospital) or outside the health authority may not have been captured in the dataset. This would introduce a conservative bias with regards to the number of deaths occurring in the study population; however, since this bias is considered relevant to both the no-shows and the show groups, it may be less likely to impact the comparison between these two groups. Future research could be improved by linking the SGS data to other provincial datasets that more accurately track patient mortality. This could include data from the British Columbia Vital Statistics Agency that is responsible for registering all deaths that occur in the province.

Conclusions

The initial analysis involved in this study revealed a significant difference between the no-shows and shows in regards to both age and severity score (but not sex). The directionality of the severity score was unexpected with the no-shows having lower severity scores than the shows (non-confounding effect). In considering these results, it was decided that the most conservative approach for the subsequent logistic regressions would be to control for all three variables in the regression models.

When controlling for age, sex and severity score, patients referred to and seen in the Stroke Rapid Assessment Unit (SRAU) were significantly less likely to experience hospital admissions and deaths due to stroke when compared to those who were referred but not seen in the clinic (the no-shows). Interestingly, the no-shows and shows, however, were not found to be significantly different in terms of hospitalizations and deaths due to cardiovascular issues. For all other causes of admissions and deaths, the regression results indicated that the patients in the treatment group (the shows) were again less likely to experience these other outcomes following their initial transient neurological event.

Generally speaking, the exclusion of those patients who likely experienced an outcome while waiting for a clinic appointment, lowered the protective effect of the treatment however did not change the study conclusions with regards to the stroke, cardiovascular and other outcomes at 90-days and 1-year. In fact, in the case of the stroke-related outcomes, the revised analysis reiterated the importance of seeing patients as soon as possible in order to address the front-loaded risk of stroke after an initial TNE.

With the possible confounders included in the model, the strongest associations (smallest odds ratios) were seen with the stroke-related outcomes (90-day & 1-year hospital admissions and 1-year deaths). While it could be argued that there are many other possible confounders to consider (e.g. lifestyle risk factors, presence or absence of co-morbid medical conditions), these results suggests that, at a high level, the treatment offered in the Stroke Rapid Assessment Unit is having a positive impact on patient outcomes related to stroke. Following some changes to data entry into the stroke clinic information system, future research could explore the distribution of such lifestyle risk factors and comorbid medical conditions within the no-show and show populations in order to assess their impact on patient outcomes. In addition, future research could focus on the outcomes of the treatment group (broken down by diagnosis) in order to more fully understand which patients, despite being treated, are experiencing poor outcomes. This research could inform quality improvement efforts in the clinic with regards to current treatment practices.

In a health care system that is often considered financially unsustainable, improvements in patient outcomes and reduced stroke-related hospitalizations will be a welcome message. Making initial investments in acute treatment of transient neurological events (TNEs) can reduce future healthcare costs by reducing subsequent stroke risk and the possibility of post-stroke disability (Luengo-Fernandez et al., 2009; Rothwell et al., 2007). Future research that explores factors influencing appointment adherence and patient attitudes towards acute treatment of TNEs might reveal strategies that could help to reduce the number of patients who remain untreated and at a higher risk for poor outcomes.

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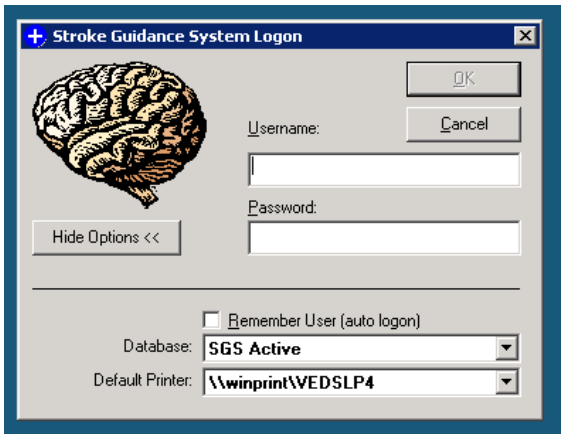
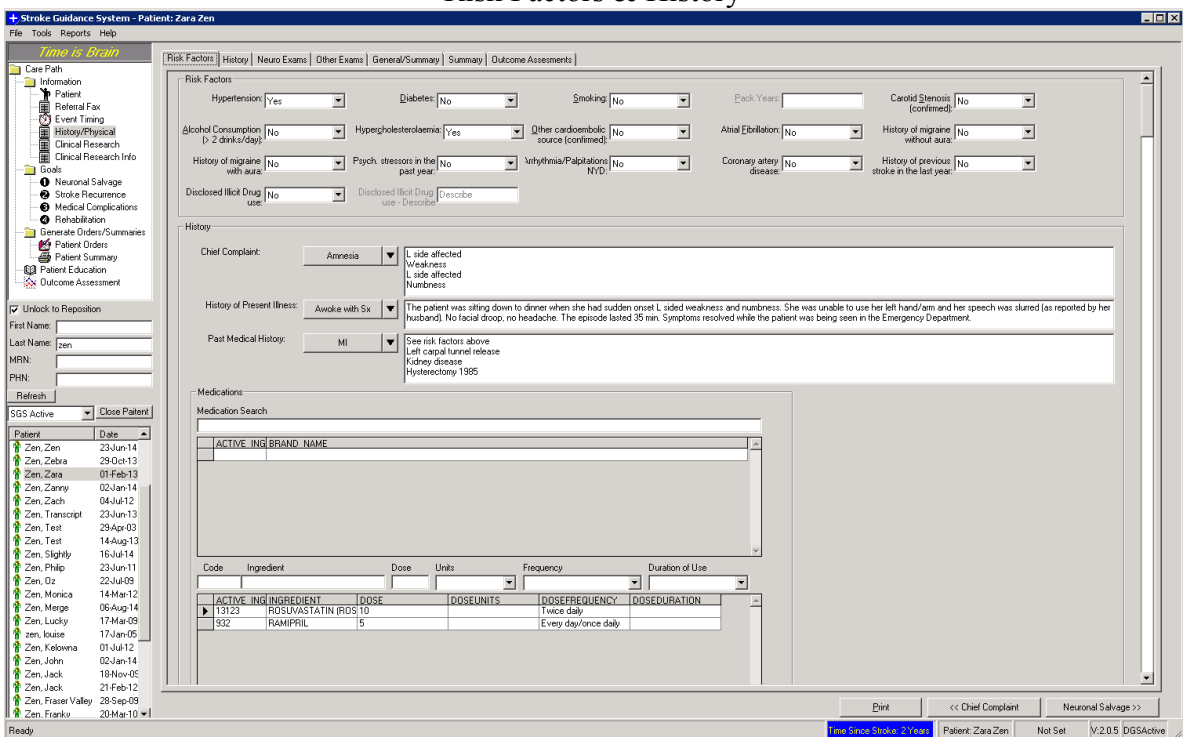
Appendix A. Structured Assessment of the SGS: User Interface Screen shots

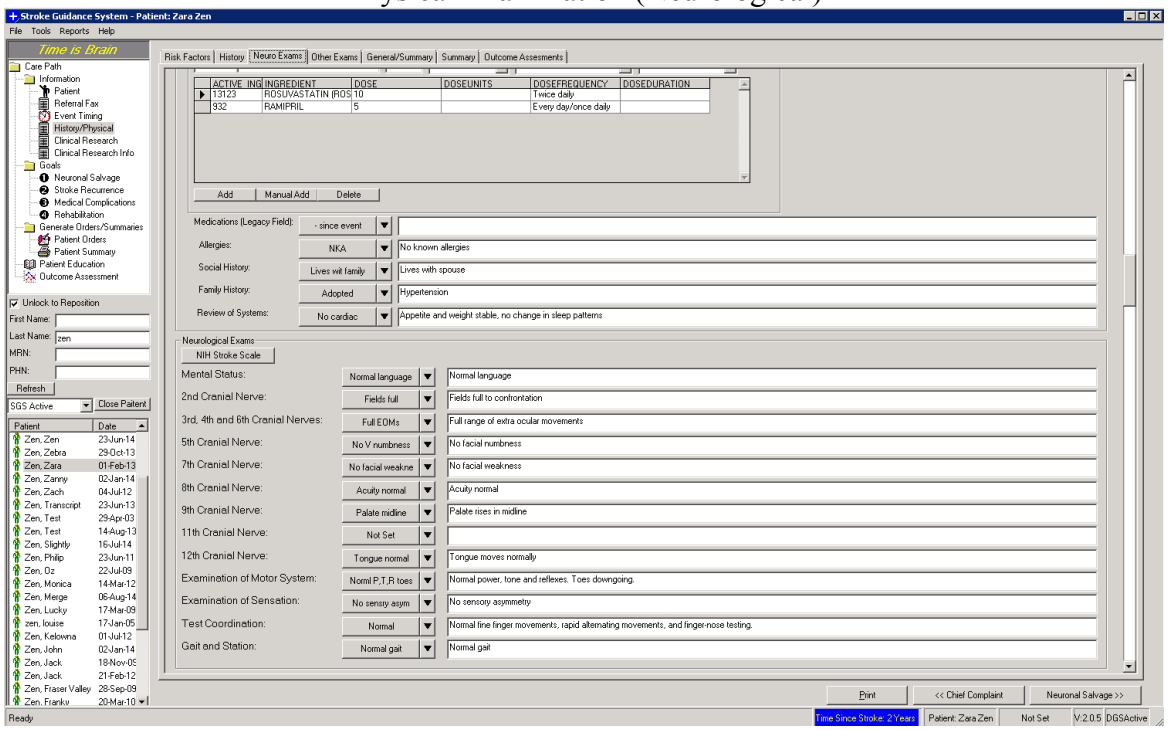


Note: all the data shown in the subsequent images is fictitious and has been fabricated for the purposes of these screen captures. Patients with a last name "Zen" are the test cases used in the Stroke Guidance System application and database.

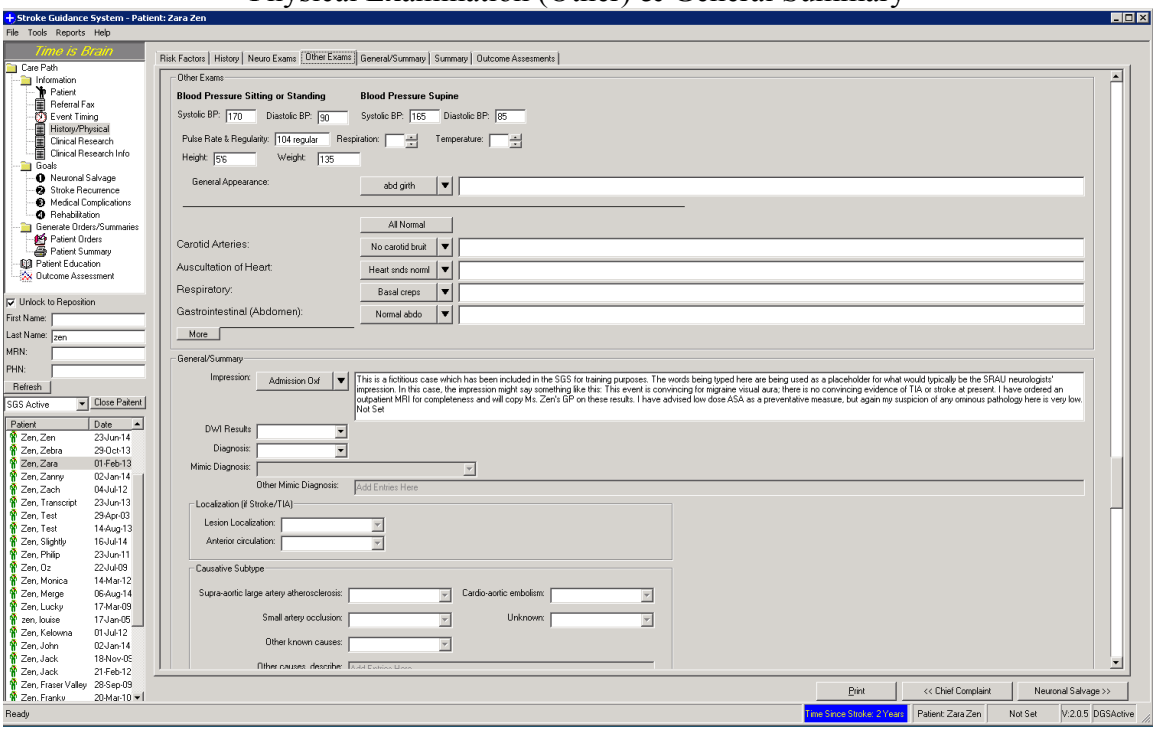
Risk Factors & History



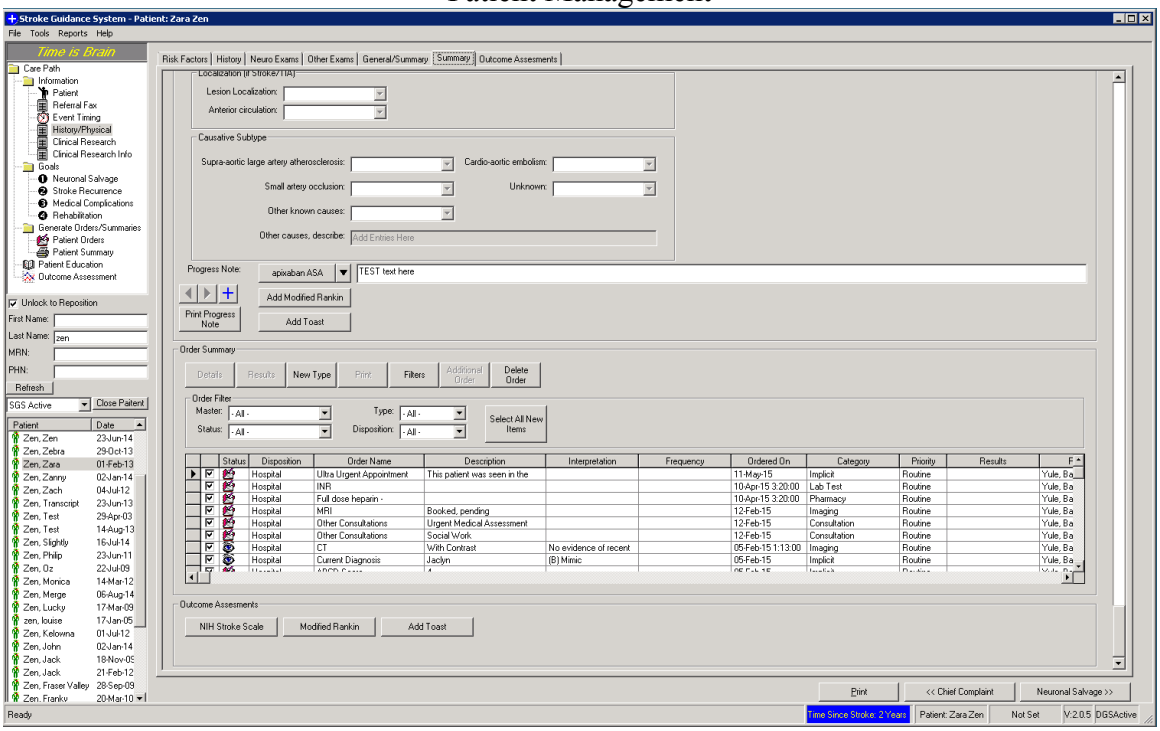
Physical Examination (Neurological)



Physical Examination (Other) & General Summary



Patient Management



Appendix B. Data Elements in the SGS Database

Data Field Name	Data Type	Statistical Scale	Data Description
Global Unique Identifier (GUID)	int(10) unsigned	Integer (random)	Unique numerical identifier that links individual database records (clinical and demographic information) to an individual patient. ***NOTE: This field will removed by the Database Manager during the data extraction process and only remain in the restricted-access keyfile.**
Case ID	int(3)	Integer (random)	Numerical ID number that will be assigned by Database Manager and included in the project keyfile. This will ensure that the cases in the dataset cannot be linked back to any identifiable information.
GenderCode	Varchar (16)	Categorical (M,F,U)	Assigned as male (M), female (F) or unknown/not reported (U).
Age	Double	Integer	Age (years)= (StartDate - BirthDateTime)/365.25 The difference between the StartDate and the BirthDateTime in years. If Age is negative or 0, it is assigned the missing value 999.
Currdiag	longtext	Categorical	Indicates the final patient diagnosis as assessed by attending neurologist. Diagnosis is defined as one of the following: Stroke, Stroke Probable, Stroke Possible, TIA, TIA Probable, TIA Possible, Mimic, Other. *Note: If 'Mimic' or 'Other' is chosen, there are 30+ subcategories of diagnoses that are placed in the diagnosis details field (below).*
Diagdet	longtext	Categorical	Diagnosis details (subcategories) for the patient's considered 'Mimic' and 'Other'(see above).
Dx_assigned	longtext	Categorical	Indicates whether or not the final diagnosis was entered by a neurologist, nurse or research staff member.
MonthFinal	double		Indicates the month of the patient's encounter extracted from the patient's time of arrival. This is a numeric month value between 1 (Jan) and 12 (Dec). *Note: If no time of arrival exists, this field will report the referral month. If no referral date exists, this variable will report the stroke month. If no time of stroke exists, this field will report the month of the Start date (always exists). No missing values necessary.*
geographic_origin3	varchar(30)		Uses the patient's postal code to classify him/her into one of three Vancouver Island regions: South, Central, North island. Unknown or unrecognized postal codes are given a geographic origin of U.
geographic_origin2	varchar(30)		Uses the patient's postal code to classify him/her into one of two Vancouver Island regions: Victoria and Non-Victoria. Unknown or unrecognized postal codes are given a geographic origin of U.
geographic_origin4	varchar(30)		Uses the patient's postal code to classify him/her into one of four Vancouver Island regions (as described by

Data Field Name	Data Type	Statistical Scale	Data Description
			the recent *regionalization* project): Region 1, Region 2, Region 3, Region 4. Unknown or unrecognized postal codes are given a geographic origin of U.
Post_Code_Location	varchar(30)		This field essentially functions as a Forward Sortation Area (FSA); it uses the first three characters of a patient's postal code to indicate the community in which he/she lives. With this field, patients from the Central Island would now be relabelled as Nanaimo South, Lake Cowichan and Ladysmith (for example). Unknown or unrecognized postal codes are given a geographic origin of U.
YearFinal	double		Indicates the year of the patient's encounter extracted from the patient's time of arrival. *Note: If no time of arrival exists, this field will report the referral year. If no referral date exists, this variable will report the stroke year. If no time of stroke exists, this field will report the year of the Start date (always exists). No missing values necessary.*
abcdScore	longtext	Integer (Interval)	Displays the ABCD score of the patient (recorded from the referral form). This score is coded as a value between 1 and 6. Missing ABCD scores are coded as 'U'.
timearr	datetime		Displays a patient's time of arrival at the SRAU. Date format used is *dd-mmm-yyyy hh:mm:ss* If no time of arrival is available, the field remains blank.
timestrk	datetime		Displays a patient's time of stroke. Date format used is *dd-mmm-yyyy hh:mm:ss* If no time of arrival is available, the field remains blank.
refdate	datetime		Displays the date the patient was referred to the SRAU. Date format: *dd-mmm-yyyy hh:mm:ss* If no referral date is available, the field remains blank.
refsource	longtext	Categorical	Displays the source of the patient referral within three main categories: Emergency Department, General Practitioner and Other. *Note: this field allows for free text so there are variations in the data entry practices.*
StartDate	datetime		Displays the date/time when the SGS chart was created. If there are cases where all other dates (timearr, timestrk, refdate) are missing, the year component of the start date can be used as a proxy value.
institut	longtext		Indicates the institution/site at which the patient was seen. Results are recorded with three-letter acronyms for differing locations (e.g. VGH- Victoria General Hospital, RJH- Royal Jubilee Hospital, SRU- Stroke Rapid Assessment Unit, LMH- Lady Minto Hospital, TSV- Telestroke Victoria etc.). Unknown institutions are coded as 'UNK' and missing values are coded as 'U'.
Outcome and Outcome_summary	longtext	Categorical	Displays any relevant outcomes (e.g. Hospital admissions, deaths, unknown) that have been noted

Data Field Name	Data Type	Statistical Scale	Data Description
			through the outcome review process via PowerChart. Sourced from free text or from an available drop down menu within the SGS. Several entries/complaints permitted. If there are no outcomes recorded the field will display a 'U'. The summary field provides the total outcomes (within each outcome category) for any given SRAU patient.
Outcomerev	datetime		Indicates the date on which the patient's outcomes were last checked/reviewed/logged (date format *dd-mmm-yyyy hh:mm:ss)*. If the patient's file has not been reviewed for relevant outcomes, the field will remain blank.
Date of Outcome (Outcome_opd)	datetime		Displays the date of any relevant outcomes (e.g. Hospital admissions, deaths, unknown) that have been noted through the outcome review process.
Noshowy/noshow_y	longtext		Indicates whether or not the patient was designated as a no-show (e.g. did not show up in the SRAU). Coded as 'YES' or 'U' (no).
Noshowr/noshow_r	longtext		Displays the reason why the patient did not show up in the SRAU. These include inappropriate referrals, referred to specialist, worsening symptoms, refused and death. Sourced from free text or from an available drop down menu within the SGS.
Risk_Factors	Varchar (16)	Categorical	Indicates the presence/absence (1 and 0) of several risk factors including diabetes, smoking, hypercholesteremia, hypertension, alcohol consumption, carotid stenosis and atrial fibrillation. Sourced from an available drop down menu within the SGS.
Clinical_Features	Varchar (16)	Categorical	Indicates the presence/absence (1 and 0) of several clinical features for any SRAU patient. This includes communication/cognition issues, vestibular symptoms, weakness, numbness and visual disturbances. This data is text mined from the chief complaint field in the SGS using pre-established database coding.
Exam_y & Exam_d	longtext	Categorical	Indicates the examinations received by the patient during their visit to the SRAU (CT, MRI, Holter etc.). It does not include any text-based results of these tests but simply indicates whether or not they received the tests in the unit. The exam_d field provides the date that these tests occurred.

Appendix C. Calculating the ABCD Score for Stroke Severity

The ABCD score generates a score (out of a maximum of 6 points) based on four core components:

(**A**) Age
(**B**) Blood Pressure
(**C**) Clinical Features
(**D**) Duration

The points scored in each of the four core categories are totaled to compose the final ABCD score. That is:

ABCD Score = Age Points + Blood Pressure Points + Clinical Points + Duration Points

Points are allotted according to the table summarized below:

	A	B	C	D
POINTS	**AGE**	**BLOOD PRESSURE**	**CLINICAL FEATURES**	**DURATION**
0	<60 years	Other	Other	<10 min
1	≥ 60 years	>140 systolic and/or ≥ 90 diastolic	Speech issues, no weakness	10-59 min
2	--	--	Weakness present	>60 min

The dataset from the Stroke Guidance System (SGS) includes the patient age, patient blood pressure, clinical features (from chief complaint variable) as well as the ABCD score.