A comparison of a standard neurological assessment tool to a stroke scale for detecting symptomatic cerebral vasospasm

By

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Abstract

One of the primary causes of disability and death in individuals who have experienced a subarachnoid hemorrhage due to an aneurysm rupture is cerebral vasospasm. Vasospasm can cause a general decrease in the level of consciousness or the onset of focal deficit such as hemiplegia or aphasia. Early detection of vasospasm is critical in allowing prompt intervention and treatment to prevent further ischemia or infarction. The nurses role in observing and detecting changes in these critically ill patients was guided by the Nursing Model of Hospitalization Events (Smith, 1998).

The research study consisted of comparing two assessment tools for quantitative data analysis of early detection of symptomatic vasospasm. The standard neurological record that is currently used was compared to the stroke scale developed by the National Institute of Neurological Disorders, and Stroke, and the National Institute of Health. The methodology was also comprised of a qualitative component using content analysis of the nurses' notes to enhance information regarding the patients' neurological status.

There was no statistical significance demonstrated between the vasospasm and non-vasopasm groups, however several clinically relevant findings were shown. In particular the assessment of focal symptoms, such as motor power will be discussed. Observations by the nurses regarding generalized changes in neurological status revealed findings such as restlessness, impulsiveness, and unusual behaviors are highlighted and provide evidence for future investigation. All findings and their relevance to the nurse's role in detecting symptomatic vasospasm will be discussed.

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List of Abbreviations

CT	computerized tomography
GCS	Glasgow Coma Scale
NIH-NINDS	National Institute of Health- National Institute of Neurological Disorders and Stroke
SAH	subarachnoid hemorrhage
WFNS	World Federation of Neurologic Surgeons

Statement of the Problem and Conceptual Framework

Introduction

Subarachnoid hemorrhage (SAH) resulting from aneurysmal rupture occurs in approximately 30,000 persons per year in North America (Ullman & Bederson, 1996). Of those who suffer from a SAH, 30% will experience vasospasm (Hickey, 1997). These patients are cared for in the acute care setting. Combined medical and nursing care is required to optimize the patient's outcome. The nurse's role in these complicated patients is multi-factorial. However, the aspect of assessment is essential to observe and detect changes in the patient's neurological status (Warnell, 1996). The importance of the nurse's role in assessing the patient for potential symptomatic vasospasm will be discussed in detail.

Statement of the Problem

Vasospasm reduces cerebral perfusion and leads to ischemia and possible infarction. Vasospasm can cause a general decrease in level of consciousness or the onset of a focal deficit (Ullman & Bederson, 1996). Patients with a subarachnoid hemorrhage require hospitalization and intensive care from health care professionals. The patient requires frequent observation by the nurse and in particular, observation of his/her neurological status. A standard neurological assessment that consists primarily of the Glasgow Coma Scale (GCS) is normally performed by the nurse. The GCS with the standard neurological record (Appendix A) was developed to reduce subjectivity when assessing the level of consciousness of patients with a traumatic brain injury. The GCS is used to detect a general change in the level of consciousness, which may not be adequate for patients experiencing symptomatic vasospasm. When a patient exhibits focal symptoms the

standard neurological assessment tool may not cue the nurse to pick up on the subtle deficit (Bell & Kongable, 1996). Anecdotal information from the nurse's progress notes indicates that nurses may detect a subtle change in the patient's condition, that may not be detected by using the standard neurological assessment tool. In this situation the observation may or may not be documented in the patient's chart. It may represent the earliest signs of vasospasm and therefore must be documented to assist as a trigger for intervention. A key role for nurses is to observe the patient, detect changes, and notify the neurosurgeon of the significant changes in patient status (Warnell, 1996).

The National Institute of Health (NIH) National Institute of Neurological Disorders and Stroke (NINDS) developed a stroke scale (Appendix B) to detect focal changes resulting from stroke. The NINDS is a component of the NIH and the two government agencies collaborated to develop the scale referred to as the stroke scale. The symptoms of vasospasm are a result of lack of blood flow to the cerebral tissue; hence this scale may provide a tool for nurses to detect the subtle changes that can occur with the patient.

One of the key components to all nursing is the assessment of the patient's status. Early detection of vasospasm is critical to ensure prompt intervention and treatment, with the hope of preventing further ischemia or infarction (Armstrong, 1994). The patient is medically diagnosed with vasospasm when symptoms occur during the classic time frame and results of a CT scan rule out any other cause for neurological worsening. The diagnosis may be confirmed by transcranial doppler or an angiogram. Given the fact that the diagnostic tests are not always available or ordered by the neurosurgeon, the assessment of neurological status performed by the nurse is crucial to the initiation of treatment. Nurses carry out a baseline assessment when the patient enters the hospital,

and continue hourly assessment to detect changes in neurological status (Armstrong). With the nurse's efforts in assessment, it is crucial to know which assessment tool is the most appropriate in detecting changes in the patient's status.

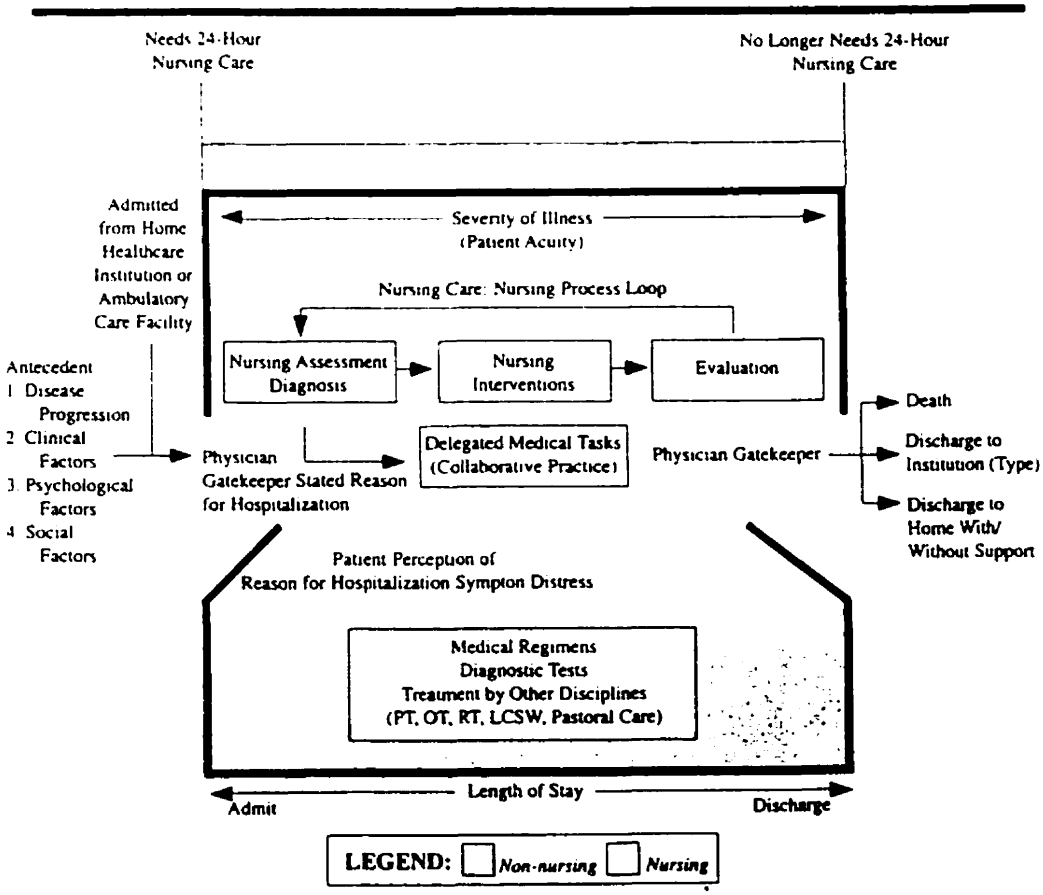
Purpose of the Study

The purpose of this study was to critically analyze the current method of nursing assessment for patients who may experience symptomatic vasospasm. The standard neurological assessment scale and the stroke scale were compared to determine if one scale is more effective than the other in detecting symptoms of vasospasm. A quantitative study, with a small qualitative component was used to investigate the issue of the nursing assessment performed to detect symptoms of vasospasm.

Conceptual Framework

The Nursing Model of Hospitalization Events (Smith, 1998) is the conceptual framework that guided the research. The model shows a concise view of a hospital admission that includes the importance of 24-hour nursing care needed by patients along a health-illness continuum. Patients who suffer from a subarachnoid hemorrhage typically experience a sudden event that leads to hospitalization, and acute, or intense nursing and medical care around the clock. As seen in Diagram 1, the gatekeeper to the patient's admission and discharge is the physician. The model clearly depicts, however, the collaborative process between nurses and physicians.

Diagram A



Smith, A. R. 1998, p. 71

The model indicates that the patient's perception for admission may differ from that of the nurses. One of the strengths of the nursing discipline is the ability to treat patients as individuals, and part of this is relevant to understand what the event of being hospitalized means to the patient, and how the patient perceives their illness (Mitchell & Gallucci, 1991). The patient's severity of illness can vary, with it the intensity of nursing care required for the patient. For patients diagnosed with a subarachnoid hemorrhage the intensity of nursing care is defined by several treatments and observations, with a key aspect being the frequency of neurological observations. Intensity of nursing care is also defined by the medical and nursing treatments required. For example the patient in vasospasm may require therapy to hemodilute, increase systemic blood pressure, and increase volume expansion (Ullman & Bederson, 1996). This involves not only carrying out the treatments necessary, but also an array of assessing neurological status, respiratory and cardiac status. Effects of the treatment also necessitate assessment of the skin integrity, and fluid and electrolyte balance of the patient. Smith (1998) states that this is dependent on the amount of care, as well as the skill level required to perform the care. The model does not strictly define relationship between severity of illness and patient acuity. The context of this model provides a framework, however, for further nursing research could be developed to demonstrate the relationship between severity of illness and patient acuity. The model also identifies that hospitalized patients require intensive diagnostic and technical treatment. This is evidenced in the patients who are admitted with a subarachnoid hemorrhage.

As previously mentioned Smith (1998) clearly depicts in the diagram the role of nurse, physicians, and other members of the health care team. Smith believes the nursing role to

be independent and collaborative. It is known that the nursing process includes that of assessing and diagnosing the patient, carrying out interventions to treat the patients, evaluating the effectiveness of the interventions and beginning the loop again. Nursing has an independent role of diagnosing and treating the patient's actual or potential response to an illness (Mitchell & Gallucci, 1991). When caring for patients with SAH, the nurse monitors the patient's neurological status closely, to detect symptoms of the common complications; rebleed, vasospasm and hydrocephalus. This aspect of nursing intervention is collaborative and is initiated by a physician. It is essential for the nurse to continue with the repetition of evaluating and continually assessing and diagnosing the patient's response to treatments, and or the illness. Assessment and observation of the patient is an independent nursing role that is depicted in the nursing process loop of the model. This detection of signs and symptoms of vasospasm, and appropriate notification of such to other nurses and the physician leads to the collaborative component of nursing care, which includes both the medical and nursing component. The importance of early detection of symptomatic vasospasm by the nurse and prompt communication with the physician allows for decisions to treat and prevent neurological deficits for the patient (Powsner, O'Tuama, Jabre, & Melham, 1998). The physician relies on the nurse to monitor the patient, and detect signs and symptoms of problems, and inform the physician so further decisions can be made about the medical treatment the patient may require (Counsel, Gilbert, Snively, 1995). It is important to note that the nurse's independent role is to observe changes in neurological status, understand the significance of these changes and to report their observation to the neurosurgeon. It cannot be assumed that medical care will be altered based on the nurse's findings, and it is not the

intent here to address this issue. Nurses care for patients in collaboration with physicians, however, medical treatments once initiated by the physician require the nurse to implement the treatment plan and continue to evaluate the patient's status.

This provides the primary focus of the topic being investigated in this study. Nurses need to assess patients after a subarachnoid hemorrhage for signs and symptoms of vasospasm (Flynn, 1989). Because the patient's status may change suddenly or symptoms can fluctuate, it is common for the nurse to assess the patient's neurological status frequently over several days (Hickey, 1997). During the patient's hospitalization the need for nursing care and assessment, particularly the neurological status, is constant throughout the 24-hour day. The assessment performed by the nurse is relevant clinically, hence deserves the opportunity to be researched and analyzed for its effectiveness. This study, based on this framework compared two assessment tools that may assist the nurses with the neurological assessment of patients with potential vasospasm.

This model considers discharge home or to another facility as an outcome. Patients with SAH can suffer from severe disability and often require care in an extended facility or they may be discharged with supports in place at home. Today much investigation is based on the length of stay of diagnostic related groups (Hickey, 1997), and this study provides a framework for designing research based on patients with SAH. The outcomes of death, discharge to another institution, discharge home with or without support could be monitored. Discharge outcomes will not be assessed in this study, however, it may be considered for future research. The ability to measure the care the patient receives and its relationship to the discharge outcome of the patient could provide valuable information for future management of the patient. Many aspects of this illness can be within given the

framework of this model. This conceptual framework provides the structure to research the outcomes of hospitalized individuals in general and for the purpose of this study, outcomes related to individuals diagnosed with subarachnoid hemorrhage. As noted earlier, the nursing assessment is an independent function that can lead to early detection or prompt intervention within this group of patients.

The Research Question

When patients experience symptomatic vasospasm will the stroke assessment tool detect changes in neurological status earlier than the standard neurological assessment?

The hypothesis is that patients experiencing symptomatic vasospasm will have changes in neurological status detected earlier when nurses use a stroke assessment tool compared to the standard neurological assessment protocol.

Assumptions/Limitations

One limitation is that the nurses varying levels of expertise may impact on the assessments conducted and documented.

A major assumption in this study is that earlier detection in symptomatic vasospasm will lead to earlier management of the illness. This is consistently identified in the literature (Armstrong, 1994, Barker & Heros, 1990, Hickey, 1997, Powsner, O'Tuama, Jabre, & Melham, 1998, & Rusy, 1996,).

Significance of the Study

For years nurses have utilized a neurological assessment tool, that consists primarily of the GCS to assess patients for potential vasospasm. Little research has been conducted to determine the effectiveness of this tool in assessing patients with this neurological problem. The GCS is a standardized assessment tool that promotes excellent

communication across varied health disciplines, however, it may not detect a change in neurological status of the patient (Robinson, 1992). Anecdotal information received from nurses and family members indicated that observations of a decline in neurological status are observed that are not included on the standard neurological assessment form. However, this has not been well documented in a systematic manner.

The importance of early detection of vasospasm symptomats to institute prompt medical management to prevent permanent ischemia has been cited in the literature (Barker & Heros, 1990, Powsner, O'Tuama, Jabre, & Melham, 1998). Several authors indicate it is the ongoing assessments provided by the nurse that is critical in detecting symptomatic vasospasm (Armstrong, 1994, Hickey, 1997, Rusy, 1996). Little is mentioned as to what the neurologic assessment should include.

The stroke scale, while utilized in the research setting, has yet to be applied in the clinical practice of nursing. Based on the pathophysiological mechanisms associated with vasospasm, the stroke scale and the theory behind its development suggest it may be a more appropriate form of assessment for vasospasm based on the pathophysiological mechanism that occurs.

A comparison of the current neurological assessment tool, to the stroke scale in terms of effectiveness for monitoring the symptoms of vasospasm and detection of symptoms early in the illness was conducted. In order to enrich the data collected with the assessment tools, a qualitative component further investigated those aspects of assessments carried out by nurses and recorded in the nurse's notes.

Definition of Terms

Subarachnoid hemorrhage

- Bleeding into the subarachnoid space resulting from a rupture aneurysm (Hickey, p. 568).

Vasospasm

- Narrowing of a cerebral blood vessel (Hickey, p.579)

Ischemia

- A state of reversible alteration in cell function due to a decreased oxygen supply (Davis, p.947)

Infarction

- An area of tissue that undergoes necrosis following cessation of blood supply (Davis, p. 907)

Aneurysm

- A saccular outpouching of a cerebral artery (Hickey, p. 569)

Hydrocephalus

- Interference of reabsorption of cerebrospinal fluid resulting from the blood in the subarachnoid space (Hickey, p. 580)

Cerebral perfusion pressure

- Blood pressure gradient across the brain (Hickey, p. 299)

Step Down Unit

- An intermediate care unit, where patients receive intensive nursing care, and observation.

Consciousness

- State of general awareness of oneself and the environment and includes the ability to orient toward new stimuli (Hickey, p. 134). Subjective awareness of the external world and self, including awareness of the inner private world of one's own mind, of perceptions, thoughts (Sherwood, 1997, p.143)

Family

- Adults who are related to the patient, or friends who are identified as being "significant other" to the patient (Leith, p. 6)

Summary of Chapter

Patients who experience a subarachnoid hemorrhage can develop cerebral vasospasm that may lead to permanent disability or death. Vasospasm is associated with an array of symptoms that require astute nursing observation to be detected. The tools that nurses' have available to him or her, is an important part of the assessment. It is proposed that determining the effectiveness of one nursing assessment tool required further investigation. Therefore a comparison of the standard neurological assessment tool to the stroke tool was conducted to determine if one tool enabled detection of symptoms earlier in the patient's illness. The research design was quasi-experimental utilizing a time series of multiple treatment interventions. Smith (1998) provided the conceptual framework for this research conducted in the acute hospital setting. This framework addressed aspects of nursing care required, including the vulnerable population experiencing SAH.

Literature Review

Introduction

A detailed review of vasospasm literature will be discussed in this section of the paper. The standard neurological assessment tool, primarily the GCS and the stroke scale will be discussed in terms of its relevance to vasospasm.

Literature Review

Vasospasm occurs following the rupture of an intracranial aneurysm. This rupture causes blood to enter the subarachnoid space. Following SAH, rebleeding and vasospasm are the two main complications which can occur (Rusy, 1996). Ullman and Bederson (1996) did a retrospective analysis of patients with subarachnoid hemorrhage and found that 45% of the people died, and approximately 48% were left with a moderate to severe disability 30 days following the subarachnoid hemorrhage. Haley, Kassell, and Torner (1993) studied the effects of medication in treating vasospasm and found that 3 months later the vasospasm was the primary cause of disability and death for 75% of the population studied. Up to one third of the people who survive a SAH may experience significant problems with vasospasm (Eskridge, Newell & Winn, 1994). Symptomatic cerebral vasospasm is defined as neurological worsening after subarachnoid hemorrhage that cannot be explained by the two other common complications, rebleeding, and hydrocephalus (Powsner, O'Tuama, Jabre, Melham, 1998). Symptomatic vasospasm is also referred to as a delayed ischemic neurological deficit (DIND) or also as delayed ischemic deficit (DID), (Warnell, 1996). It is defined as a general decrease in level of consciousness, or the onset of a focal deficit that corresponds to an arterial territory

(Ullman & Bederson, 1996). Vasospasm may be either radiographic or clinical. Radiographic vasospasm is defined as the narrowing of cerebral arteries that are evidenced by a cerebral angiogram (Hickey, 1997). Various definitions for symptomatic vasospasm can be found in the literature. Haley, et al (1997) define vasospasm by the patient meeting the criteria of having the symptoms during the classic time frame, having a CT scan which rules out other causes for neurological decline, and having no other identifiable reason for deterioration in condition. They comment that vasospasm may or may not be confirmed by the use of angiography or transcranial doppler. Oropello, Weiner, and Benjamin (1996), comment that cerebral vasospasm is diagnosed by the exclusion process, and is rarely made with complete certainty. This is an important definition for the purpose of this study, because at the Health Sciences Centre, in clinical practice, the patient may or may not have an angiogram to confirm vasospasm. The angiogram is an invasive test that cannot be performed for serial monitoring. Transcranial doppler is a noninvasive measurement of the blood flow velocity in the cerebral arteries, which will indicate vasospasm with increased flow (Mizuno et al, 1994). The transcranial doppler has a ultrasonic signal that reflects the movement of red blood cells, and identifies a value in terms of its velocity and turbulence through the vessel (Bell, LaGrange, Maier, Steinberg, 1992). The technique of the technician is important, for example if the angle of the doppler is incorrectly placed, this can affect the reading (Bell et al, 1992). Transcranial doppler is used to assist in the detection of vasospasm, and can precede clinical symptoms, however false negative results are known to occur with this diagnostic test (Mizuno, et al, 1994). Bell et al, comment on the importance of utilizing daily transcranial doppler results along with the complete nursing assessments to

potentially predict vasospasm. This diagnostic test does require an experienced technician to avoid errors (Bell, et al, 1992), and is not currently utilized at the Health Sciences Centre. For these reasons Haley's, et al (1997) definition of vasospasm that has been stated previously, is essential for this study. The onset of vasospasm occurs between day 3 - 14 post-bleed (Powsner, O'Tuama, Jabre, & Melham, 1998, Bell & Kongable, 1996). It rarely occurs before 48 hours, and after 2 weeks (Armstrong, 1994). There had been no correlation made between the rate of occurrence with age, gender, size of the aneurysm, hypertension, atherosclerosis, or diabetes (Flynn, 1989). Becker (1998), however, found with those who had familial aneurysms there was a modifiable high risk with smoking, excessive alcohol use and hypertension in relation to developing an aneurysm.. Becker has also found for those with familial aneurysm that the incidence is higher in women than in men. Several theories exist regarding the pathophysiology of vasospasm, however the exact mechanism remains unknown (Rusy, 1996). One hypothesis is that vasospasm occurs secondary to structural changes in the arterial wall (Warnell). Vasospasm is also thought to be an anti-inflammatory reaction after subarachnoid hemorrhage (Flynn, 1989). A more accepted theory is that spasmogenic substances released from the blood clot caused prolonged temporarily irreversible vasoconstriction (Armstrong, & Warnell). This theory suggests that a single compound, or several, is released from the clot that interacts in some way with the vessels wall (Flynn). In fact several spasmogenic substances are found in the cerebrospinal fluid after SAH (Warnell). Oxyhemoglobin is released during lysis of the clot, and causes further breakdown of products, and oxyhemoglobin has been supported in its role of inhibiting the endothelium that is dependent for relaxation of the arterial wall (Ullman & Bederson,

1996). Most scientists agree that the blood clot around the arteries at the base of the brain is responsible for vasospasm (Hickey, 1997, & Warnell, 1996).

What is generally supported is that delayed ischemic neurological deficits are related to the presence and amount of blood found within the subarachnoid space, and the blood must be in contact with the vessels (Hickey, 1997). Bell and Kongable (1996) comment that vasospasm will develop in vessels that are surrounded by thick clots. Warnell (1996) adds that calcium is present in large quantities during vasospasm, and structural changes do occur within the vessels subsequent to vasospasm.

What is known and is significant is that vasospasm can result in reducing blood flow to various parts of the brain, and the brain becomes less able to handle its metabolic demands (Oropello, Weiner, Benjamin, 1996). This ischemia of the cerebral tissues can lead to infarction and death (Armstrong). Fisher, Kistler, and Davis (1980) studied and developed a scale that states the amount of subarachnoid blood detected on the initial CT scan will correlate directly with the incidence of vasospasm. They studied 47 cases of ruptured cerebral aneurysm, and investigated the amount and distribution of subarachnoid blood on the initial CT scan, in relation to the development of cerebral vasospasm. Their research demonstrated a strong correlation between Fisher grade 3 on the early CT scan, and the development of radiographic vasospasm and delayed signs and symptoms of vasospasm. Broderick, Brott, Culdner, Tomsick, & Leach (1994) used this scale for the clinical grade of the patient on admission, when attempting to determine the mortality and morbidity after SAH. Table 1, demonstrates the categories of the scale Fisher, et al developed. There were 24 patients who had a focal clot of 1mm or greater and of those patients 23 developed spasm demonstrated on angiogram, as well as symptoms of

vasospasm.

Table 1 Fisher Scale

Group One	no blood detected
Group Two	diffuse deposition or thin with all vertical layers of blood < 1 mm thick
Group Three	Localized clots +/- vertical amount of blood 1 mm or > in thickness
Group Four	Diffuse or no subarachnoid blood, but with intracerebral or intraventricular clots

Fisher, Kistler, & Davis , 1980

Patients are also graded on a scale from one to five to categorize their clinical condition upon admission to a hospital (see Appendix C). This scale was developed by the World Federation of Neurological Surgeons (1988), and essentially categorizes patients in good neurological condition as grade one, and grade five being poor neurological condition. This scale is used in clinical practice, as well in research, to identify the patient's condition, and investigate responses to treatments and the patient's outcome.

Symptoms of vasospasm are variable with each patient, and can also vary from hour to hour or minute to minute (Oropello, et al, 1996). Generalized symptoms can include lethargy, disorientation, confusion, and decreased level of consciousness (Hickey, 1997, and Flynn, 1989). The focal changes that Flynn describes may include speech difficulties, motor weakness or paralysis; as well Hickey adds cranial nerve deficits to that list. Bell and Kongable (1996) describe subtle changes of vasospasm, which include headache, lethargy, intermittent disorientation and focal deficits, such as hemiparesis, and speech difficulties. It is relevant to note that the nursing literature discusses symptoms in most articles, and describes the importance of a neurological assessment, but no description is given as to what parameters the assessment should include.

The GCS was developed to decrease subjectivity in assessing the level of consciousness related to traumatic brain injury (Jennett & Teasdale, 1977). Since that time the tool has been widely and internationally used (Robinson, 1992). The GCS is applied to a graphic assessment sheet, and is utilized in many hospitals for a variety of neurological problems (Robinson). At the study site location the GCS is represented on a graphic sheet which includes vital signs, pupil assessment, and bilateral motor assessment (Appendix A). This tool represents the standard nursing neurological assessment for patients with traumatic brain injury (TBI), brain tumors, subarachnoid hemorrhage and post-operative assessment for any surgical procedure related to cerebral function.

Articles can be found describing the practical problems in using the GCS, particularly that it's strength is not in assessing focal symptoms, but detecting generalized level of consciousness changes (Robinson, 1992 & Knight, 1986). In 1977 Jennett and Teasdale studied the tool extensively with a sample of 700 patients with TBI. They found the tool helpful to describe coma by its behavioral responses. Jennett and Teasdale (1977) state the GCS should be used to assess the brain as a whole and not the particular parts that demonstrate focal symptoms. Teasdale, Knill-Jones, & VanDerSande (1978) studied the observer variability using the GCS in assessing TBI patients, and patients who have had intracranial surgery. They utilized nurses, neurosurgeons, and general physicians and found the reliability and precision of the tool adequate. Studies have been conducted over the years to research several aspects of the GCS.

Ingersoll and Leydon (1987) studied the accuracy of nurses in the intensive care unit in scoring patients with TBI by the GCS with twenty-five nurses that volunteered to participate in the study. After receiving educational sessions, nurses and experts

evaluated the patients and recorded their responses independently. The investigators found that patients who were very alert or very unconscious were scored more reliably using the GCS. Patient's whose responses were scored in the middle ranges of the tool, were found to be less reliable. The investigators did not address the experience level of the nurses. The small sample size and the potential for inconsistency in the educational sessions were limitations of the study.

Another study by Rowley and Fielding (1991) studied the accuracy and reliability of the GCS. They included patients who had traumatic brain injury, or any cranial surgical procedure completed. A convenience sample of patients on the neurosurgery ward was obtained. An expert accompanied four groups of nurses with different levels of neuroscience expertise when performing the assessment. The expert ratings were used as the correct scoring of the GCS. More discrepancies in general were found in the middle ranges scores of the GCS. The group with the most experience had a high level of accuracy, and all groups used the tool reliably. A small sample size was used for this study and the assumption that the expert's assessment was correct may be a limitation to the study. The investigators support the use of the GCS with experienced and properly trained nurses, but note further validation of the GCS is necessary.

Another study conducted by Ellis and Cavanagh (1992) tested the GCS to see if any patterns of error in judgment occurred. Twelve patients were chosen for their variable responses and videotapes were made with a nurse doing the assessment. A convenience sample of 22 student nurses, and 27 experienced nurses saw the video and scored the patient according to the GCS. A panel of experts was used to set the criterion and determine the correct response. A suggestion was made through statistical analysis that

registered nurses made more correct responses than student nurses. Again the GCS and its use is supported with appropriate training and education. A limitation of the study was that the panel viewed the assessments on videotape, which could be less reliable.

A study by Juarez and Lyons (1995) was conducted to determine the interrater reliability of the GCS. It is important to note that the patients included were not restricted to TBI. The patients were videotaped, and the 57 participant volunteers viewed the videotape and marked their score on the GCS. Participants were nurses and physicians, with one month to 22 years of experience, with varying degrees of neuroscience experience. An expert panel of nurses and doctors was used to view the videotape and set the criterion. Good disagreement ratings were found when comparing the categories and also with the summation scores. The Wilcoxon analysis was used to indicate the criterion validity. A regression analysis was used demonstrating no difference in experience and educational levels with the accuracy of using the GCS. A limitation of this study could be the use of the videotape, and the ability to observe the responses accurately. The panel of experts and the larger sample size were strengths in this study.

In 1989 Brott et al, in collaboration with the National Institute of Health (NIH), developed a scale to be used for patients with stroke. The scale was developed to provide a valid assessment tool that could be done quickly at the bedside. The content was designed by ensuring that the tool represented the cerebral function provided by vascularization of every major blood vessel of the brain. It was field tested with 65 patients, for interrater reliability, and test-retest reliability. For reliability, four clinicians, a neurologist, neurology house officer, neurology nurse clinician, and emergency nurse clinician were utilized to perform assessments. Within one week of the stroke and twice

in a 24 hour period assessments were completed. The first exam occurred within 48 hours of admission to the hospital. To reduce patient fatigue, one clinician would perform the assessment, while the others recorded their findings independently. This method was used to decrease patient fatigue. To measure the validity of the scale a correlation with the volume of infarct on the CT scan was determined. Test-retest reliability was good with the correlation between the first and second exam =0.98 with a $p<0.0001$. Inter rater agreement was proven to be statistically significant. Items that had a high statistical agreement were pupil assessment, best motor arm and best motor leg assessment, and best gaze. The item with the lowest agreement was the qualitative assessment of level of consciousness. The exam took an average of 6.6 minutes to complete. The admission score and the score at seven days both correlated with the CT exam and were statistically significant. The investigators suggest that if a scale is abbreviated to improve reliability, the validity may then be lost and the scale may not be able to test various clinical ischemic syndromes. The investigators also analyzed the categories to see if changes in a category occurred with an overall change in the patient's neurological status. Overall the tool was determined to be reliable and valid. A weakness of the study is that the clinicians that participated also helped develop the tool.

Goldstein, Bertels, and Davis (1989) studied the interrater reliability of the NIH stroke scale. A sample size of 20 patients was used from one hospital. Four clinical stroke fellows went in pairs and individually assessed patients, with a randomized order among the pairs. To decrease the potential of fluctuating neurological status affecting the assessments, one assessment was completed immediately after the initial one. Inter observer agreement was determined by using the k statistic for each item. The value for

facial paralysis, and limb ataxia was not statistically significant. The items that were most often untestable were neglect and dysarthria, and that is likely because the patient was aphasic from the stroke. The investigators found that the NIH scale had moderate interrater reliability, and was an efficient tool for use in the clinical setting.

The stroke scale is often used in research settings (Heinemann et al, 1997). A medication study was conducted in the clinical setting to determine the effects of tirilizad mesylate in aneurysmal subarachnoid hemorrhage (Haley et al, 1997). Of interest in that study was that neurological worsening was defined as a decrease of two points or more on the GCS or an increase of two points or more on the NIH stroke scale that lasted for at least eight hours. The NIH stroke scale was used to detect neurological changes and allow the investigators to identify the cause or causes of deterioration in the patient condition.

Another study was done to investigate the NIH stroke scale and its application to patients in the medical rehabilitation setting (Heinemannn et, al, 1997). They found that 13 of the fifteen items were valuable for the medical rehabilitation setting. They also found that limb ataxia had a poor fit, and decided it should be eliminated. They also deleted pupil assessment due to its misfit, and altered aphasia by joining the middle two sections. Overall the stroke scale provided a tool that defines how severely the patient is impaired by the stroke, during their medical rehabilitation phase.

Table 2 highlights several of the studies and lists their purpose, the scale being tested and the methodology used. One common thread to all of the investigations was the consideration of patient fatigue during the assessments. The different methods used to test both scales will be considered when developing the methodology for this study.

The GCS tool was developed to assess patients with TBI who have the potential to develop a generalized decrease in level of consciousness. Some of the research that studies the GCS includes pupil assessment, which is not a component of the GCS. Clearly in practice, as at the site location, components of pupil assessment and bilateral motor assessment must be added to move the scope of assessment beyond TBI. Reports indicate various levels of reliability and accuracy of the GCS. Research studies indicating its use with diagnoses other than TBI does not specify if patients with a ruptured aneurysm were included, yet clinically this is the standard tool in daily practice.

Patients in vasospasm have an underlying ischemic event. The stroke scale may detect focal or subtle changes in neurological status in the patient. This valid and reliable scale has been used extensively in research related to stroke. It has been used also in pharmacological studies for monitoring patients with potential for vasospasm. The tool, however, has yet to be utilized in the clinical setting.

The stroke scale should be considered for assessing patients with the potential of symptomatic vasospasm. The existing gap between research and the extensive use of this tool, and the lack of its use in the clinical setting, may be narrowed with the introduction of this study.

Table 2

Table Summarizing Purpose, Tool, and Methodology of Studies

Author/Year	Tool tested/ purpose	Method/ education provided if applicable
Rowley & Fielding, 1991	GCS/ reliability & accuracy	-4 groups with varying levels of experience -read written instructions prior to assessment -assessed patient and recorded as a group
Ingersoll & Leydon, 1987	GCS/ test accuracy with TBI.	-Inservice provided -2 nurses assess patient at same time but record independently
Ellis & Cavanagh, 1992	GCS/investigate patterns of errors in assessing neurosurgical patients	-videotape made of patients -panel of experts viewed videotapes and set criterion -given written explanation of terms prior to assessments -nurses with different levels of experienced watched videotapes and recorded findings
Juarez & Lyons, 1995	GCS/test interrater reliability of GCS for neurological impaired patient	-Nurses/physicians watched videotapes of patient and recorded findings -able to watch videotape again, but no discussion allowed -expert panel viewed videotapes and set criterion
Teasdale, Knill-Jones, VanDerSande, 1978	GCS/observer variability	-observers assessed patient within 3 ours of each other -observers record findings independently -given standard definitions prior to assessment
Brott et al, 1989	NIH stroke scale/interrater and test-retest reliability	-four assessors, one assessed while the other three watched -observers combination of physicians, and nurses -all recorded findings independently
Goldstein, Bertels, & Davis, 1989	NIH stroke scale/interrater reliability	-four clinical stroke fellows, in pairs -one assessed and the second person assessed immediately afterwards

Summary of Chapter

The standard neurological record and the stroke scale are reliable tools that are currently used. The neurological record comprised mainly of the GCS is used clinically and for research purposes, while the stroke scale is used mainly for research purposes. The stroke scale seems to be a more appropriate tool to assess changes in the person who may be experiencing vasospasm, however the GCS is the major component of the nursing neurological assessment tool currently used. Detecting neurological change is a key component in nursing care of patients with suspected vasospasm. Since patient outcome is connected to astute nursing assessment it is essential to determine the effectiveness of each tool in detecting early neurological deviation in this vulnerable population.

Methodology

Introduction

To test the hypothesis patients' experiencing symptomatic vasospasm changes in neurological status will be detected earlier when nurses use a stroke assessment tool compared to standard neurological assessment protocol, a quasi-experimental research design was utilized. The methodology primarily consisted of a quantitative approach with a small qualitative component. Data were coded and the statistical analysis system (SAS) program was used.

The standard neurological assessment was compared to the stroke scale assessment by using t-tests and chi-square analysis. The qualitative component consisted of a review of the nurses' notes regarding the participant's neurological status. Textual data were coded and abstracted into categories.

Research Design

Polit and Hungler (1995) state that quasi-experimental design allows the researcher to "introduce some control over extraneous variables when full experimental control is lacking". (p. 276). In order to observe and measure the patient's level of neurological status throughout the health/illness continuum, the two assessments were repeatedly performed and documented. Data on the patients neurological status was measured by the nurses' observation with the guidance of the neurological assessment tool and the stroke scale assessment tool. One of the reasons for using biophysiologic measure in research (Polit & Hungler, 1995) is to determine the ways nursing care or medical treatment affects the outcome of the patient. For years, the GCS has been used to predict outcome of the traumatic brain injured person (Jennett & Teasdale, 1977). The research question

was, "When comparing the standard neurological assessment to the stroke scale assessment will one tool detect early symptoms of vasospasm prior to the other?" This research study attempted to evaluate the effectiveness of the measurement tools and documented nurses' recorded observations of patients who are at risk for experiencing vasospasm. This was accomplished through a time series of multiple treatment interventions that conform to a quasi-experimental design (Polit & Hungler, 1995). This can be visualized in Figure 1.

Figure 1

O1 X 02 X 03 X 04 X 05 X 06

The 0's represent the observed data that has been collected and the X's represent the treatment or the stroke scale assessment compared to the standard neurological record (Polit & Hungler). Patients were assessed using the standard neurological assessment form, with the stroke assessment tool as the additional assessment. The assessments were performed sequentially by the same nurse. Standard protocol and clinical judgement of the nurses and physicians determine the frequency of the assessments. The ability to detect the symptoms early in the illness necessitates the comparison of the two scales on a regular basis. Each individual becomes the control as the two scales are compared to that person.

The variable that was randomized was the order in which the scales were administered and documented. This was done to minimize the extraneous variable of patient fatigue that may be a factor during the initial or later stages of the patients' assessment. The options were to perform the standard neurological assessment immediately followed by

the stroke scale assessment, or vice versa. The order for the assessment to be performed on the subjects was then randomly assigned to the sample.

A qualitative component of the research design was included to enhance the data available regarding the patient's status and to lend in-depth information on the topic (Polit & Hungler, 1995). Content analysis is the process of analyzing data by coding it into categories and determining trends from the detailed information (Burnard, 1991). This method was used to analyze the nurses' progress notes. Nurses use the neurological tool to guide and document patients' neurological status, although they also write notations in the nurses progress notes about the patients' condition and progress. Anecdotally it has been noted that nurses will write comments in the chart regarding the patients neurological status that may or may not be reflected on the neurological assessment tool.

All nurses' notes regarding the patients' neurological condition was documented by the researcher, indicating the date and time of each documentation. The notes were read and the researcher identified general themes. The internal thesis committee member validated the process of defining categories. The notes were reviewed again and then categories were developed. The nurses documentation was read again to ensure the data fit into the categories. The data was then rewritten under each of the categories. The original documentation was preserved to allow for the ability to review the information in relation to time and the occurrence of the documentation of each patient. Once data were written under each of the categories, and no further collapsing of the categories was required, the researcher then began writing up the findings. These steps of analyzing data were founded on the work of Burnard (1991).

Combined Research Strategy

Combining the two research strategies provided complementary data. The quantitative data was represented by the measurement of the patients' neurological status for both assessment tools, and was represented in numerical form. These numbers provided the quantitative data for statistical analysis. The qualitative component offers detailed information about the patient as described in the nurses' progress notes, particularly when the nurses document observations that are not contained in either the standard neurological record or the stroke scale. This data provided an in-depth analysis to the problem (Polit & Hungler, 1995). Combining research methods is a form of triangulation increasing the ability to identify various rational for results obtained (Polit & Hungler). Adding the qualitative component to this study provided the opportunity to understand the data that is found through statistical analysis by analyzing the detailed nurses' notes regarding the patients neurological status (Polit & Hungler). Therefore, the statistical analysis that occurred from the data obtained via the two assessment tools was enhanced by the qualitative data obtained from the nurses' notes.

The Setting

The study was conducted on the neuroscience unit at a tertiary care teaching hospital in Winnipeg, Manitoba. The majority of patients with subarachnoid hemorrhage (SAH) are cared for on the thirty-two-bed neuroscience unit. There are SAH patients who require care in the surgical intensive care unit (SICU). For example if they are initially admitted to the SICU it is generally due to poor neurological condition. In addition if vasospasm occurs patients on the neuroscience unit may require intensive care monitoring and will be transferred to the SICU after the diagnoses of vasospasm is made.

The early detection of symptomatic vasospasm would most likely occur on the neuroscience unit. The neuroscience unit was the only unit appropriate to conduct the study. The tertiary care hospital is a consolidated neurosurgery program that provides service to Manitoba and Northeastern Ontario. The population at the site for the investigation can be generalized to represent people in Manitoba and part of Ontario who have suffered a subarachnoid hemorrhage.

Data indicated that there are approximately 45 people who experience a subarachnoid hemorrhage per year in Manitoba, (A. Gousseau, Neuroscience Research Assistant, personal communication, June 11,1999). Oroplleo, et al (1996) state that a range of 30 – 70 percent of the population with aneurysmal subarachnoid hemorrhage will demonstrate vasospasm on angiographic exam during day 4 –12 post rupture. Bell and Kongable (1996) note that 40 % of the population who survive a ruptured aneurysm will develop vasospasm. Bell and Kongable do not indicate whether they are referring to radiographic or symptomatic vasospasm. Eskidge, Newell and Winn (1994) state that one third of patients will experience significant clinical vasospasm after a subarachnoid hemorrhage. The incidence of vasospasm obviously varied among these studies. The comparison of two assessment scales allowed for three primary outcomes in the study. 1) The patient may go through testing and not experience vasospasm, indicated by no changes documented on either scale. 2) Symptomatic vasospasm may occur with clinical signs documented on one scale first. 3) Clinical signs of vasospasm may be documented on both of the assessment tools simultaneously. After consultation with the statistician from the Biostatisitcs Unit in the Department of Health Sciences a non-probability, convenience, purposive sample size required was determined to be thirty. This was based

primarily on the expected availability of patients per year, combined with the purposive sample, and the expected length of time that the researcher had to complete the study.

Inclusion and Termination Criteria

The inclusion criteria and guidelines for terminating the study were developed in order to maximize the assessment of symptomatic vasospasm. It is also important to point out that the method of diagnosing vasospasm is often done by exclusion (Oropello, Weiner, and Benjamin, 1996). Therefore how the diagnosis was determined was left to each individual physician and not standardized for the study. Therefore, only the diagnoses of vasospasm or no vasospasm was related to the outcome of the patients. The nurses approached any patient who met the inclusion criteria on the unit about participating in the study. It should be mentioned that the unit is an adult neuroscience unit, and this led to an adult population to be part of the convenience sampling which is appropriate given the incidence of the disease (Hickey, 1997).

INCLUSION CRITERIA:

- Diagnosed with subarachnoid hemorrhage due to rupture aneurysm.
- Clinical grade I-IV (World Federation of Neurologic Surgeons, 1988), (Appendix C).
- Patient is before or in the classic timeframe for vasospasm (day 3-14 post-rupture).
- Absence of diagnosis of vasospasm.
- Speaks English.
- 18 years of age and older

Once the patient agreed to participate in the study (see recruitment), the assessments were performed until termination criteria were met.

TERMINATION CRITERIA

- A decrease in neurological status is detected by either of the scales, and is attributable to vasospasm.
- A change in neurological condition occurs, not attributable to vasospasm, and is deemed irreversible by the neurosurgeon.
- When no symptoms of vasospasm are detected and the patient is past the time frame (day 3-14 post-rupture) for vasospasm or has been discharged from the hospital.

Recruitment of Participants

Permission to conduct the research project at the particular hospital was obtained (Appendix D) and the Ethical Review Committee of the Faculty of Nursing (Appendix E) granted ethical approval prior to beginning the study.

A meeting with the unit manager and a presentation to nurses at a regular staff meeting was arranged to discuss the research project. Nurses willing to participate were requested to notify the researcher by entering their name into a sealed box that remained on the unit. Nurses on the unit had not previously administered the stroke scale and were provided with educational sessions to learn how to perform and document the assessment. The nurses use the standard neurological record in their daily practice, and therefore no additional education was provided regarding this assessment tool. It was assumed that the varying levels of the nurses' expertise might impact on all of the

assessments and how they were conducted and documented. During the inservice the researcher discussed each component of the stroke scale, explained how to assess the patient, and how to document the varying patient responses on the form. Once the nurses attended the inservice they received a disclaimer regarding participation (Appendix F). Videotape developed by personnel at the Henry ford Hospital provided explanations for each category of the stroke scale assessment and demonstrated the assessment on a patient. Viewing the tape was optional, and it was left on the unit for the nurses to view at a convenient time. A poster was developed to highlight the stroke scale assessment and was placed on the unit. Pocket-sized laminated cards were left on the unit allowing the nurses to take it to the patient's bedside and use as a reference. These cards contained a brief description of the stroke scale assessment, and definitions of the range of findings. A small poster was developed to highlight the inclusion criteria and termination criteria as a quick reference for the nurses. A package was left on the unit at all times with information about the description of the project and detailed descriptions on how to perform the stroke scale assessment and grade the findings. The package contained the following information along with the appropriate appendices:

- Purpose and objective of the project
- Design
- Population, sample and inclusion criteria
- Sample recruitment procedure
- Data collection protocol
- Project location
- Documentation

- Data analysis plan
- Explanation of ethical considerations: informed consent, voluntary participation, access to gathered data, confidentiality of data, storage of data, recording of data, dissemination of results, new information, potential benefits, and burdens/risks.
- Copies of the standard neurological record, and the stroke scale
- Reference list
- Instructions for assessment, and definitions for each category (Appendix G)

On admission to the unit the nurses ascertained if the patient or authorized third party was interested in learning more about the study from the research assistant. A research assistant was involved to obtain consent in order to remove the researcher from this process. The nurse decided if the patient was too drowsy or confused to make decisions regarding participation, and approached the authorized third party if appropriate. The nurses on the unit regularly assess patients' for drowsiness and confusion and recognized the need to speak to an authorized third party.

The research assistant ensured the patient met the inclusion criteria and verbally explained the study and obtained consent (Appendix J). The research assistant is a nurse who conducts research studies for the department of Neurosurgery in Winnipeg. Once consent had been obtained each participant was randomly assigned to Group A or Group B. Given the small sample size (Polit & Hungler, 1995) putting the two different assessment tools into a box was an appropriate method of randomization. The two assessments were entered into the box, each 15 times. The type of assessment that was drawn indicated the assessment that would be performed first in the sequence, which essentially formed two groups.

Group A: Standard neurological assessment was performed first, followed by the stroke scale assessment.

Group B: Stroke scale assessment was performed first, followed by the standard neurological assessment.

The research assistant was given a list of the sample size of 30 patients, with the randomly assigned groups included. This allowed the research nurse to obtain consent and then inform the unit nurses of which scale was to be performed first.

Ethical Considerations

The process of obtaining consent had to be carefully thought out by the researcher. Today, with the continual changes in health care, programs that represent a specific population are subject to relocation among institutions within a city. The location of the neurosurgical program has varied over the years including the provision of care changing from a two-site to a one-site program. Several aspects of setting up a research study need to be considered in such a labile climate. During consolidation of the Neurosurgery program a nursing position was created into which the researcher was hired. The researcher's career position was considered when developing the process of obtaining consent, hence the researcher had no involvement during this stage of the process. It was deemed a critical point, ethically, to have an assistant obtain consents to avoid potential exploitation of the subjects (Polit & Hungler, 1995).

In some situations the patients entered in the study were confused or too drowsy to understand and receive an informed consent. According to the Tricouncil Policy Statement on Ethical Conduct for research Involving Humans (1998) if the patient was unable to provide consent, an authorized third party was sought, ensuring that the

participant maintained the right to participate, and the patient's best interest was protected. The authorized third party was a family member, or a significant other and the third party would ensure free and informed consent. Had the participant became competent at a later stage in the study, the research assistant, as a condition of continuing participation (Appendix K) would seek consent from the participant.

The patients and nurses who participated were guaranteed anonymity and were informed they could withdraw from the study at any time. For the patients who agreed to participate these issues were reflected in the consent form, and for the nurse participants these issues were reflected in the disclaimer form. The patients who were approached regarding participation were assured that they would receive the standard nursing care regardless of participation in the study. Prior to beginning the study a letter was sent to the neurosurgeons to secure medical approval for patient participation and to request permission to access charts and retrieve demographic information notation of WFNS grade (Appendix C), and Fisher score (Table 1) for all patients in accordance with the Personal Health Information Act (1998).

The researcher and her Thesis Chair would have access to the gathered data, and this was verbally explained to patients and indicated in the consent form. The members of the researcher's thesis committee would have access to the processed data only. Confidentiality was maintained through a coding system. The participants' names did not appear on any of the data collection records. The master list recording participants' names and hospital numbers were kept in a separate locked file, apart from the written data. The nurses' names did not appear on any of the data collected. The data would be stored in a locked file for a minimum of seven years then shredded and destroyed.

Risks and Benefits

There is a potential that participants may have symptoms of vasospasm detected earlier with the use of the stroke scale. This observation by the nurse would be reported to the neurosurgeon, which may potentially lead to a change in treatment. It was stressed to the patients, that if they chose not to participate, or withdraw from the study, they would continue to receive the standard nursing care.

There were no costs or risks to the subjects of this study.

Data Collection

The data collected came from a variety of sources. Demographic data was collected from the admission history to describe the sample. This included information regarding the participant's age, gender, history of the patient's illness, previous medical history, medications being taken at home, allergies, and location of the aneurysm. Data was also collected regarding the patient's World Federation of Neurologic Surgeons (WFNS) clinical grade at the time of admission and when entering the study (if different), and the Fisher grade that classifies the presence of blood on the CT scan in order to predict vasospasm. All quantitative data from the two assessment tools were recorded on blank sheets. The method of diagnosing vasospasm, specifically by the use of diagnostic tests the CT scan or angiogram was included in the raw data.

The qualitative component consisted of reviewing the participant's chart and retrieving any nursing documentation that described the neurological status of the participant.

The data were collected from July 1999 to June 2000.

Pilot Testing

Initially the researcher assessed inter-rater reliability with two staff nurses, with different levels of experience. The decision was to have two nurses assess one patient, with the researcher observing as the expert. In this situation the nurses performed the assessments without any update about the assessment from the researcher. The assessments were extremely inconsistent and there were five categories that were incorrectly evaluated. The inter-rater reliability was not determinable and therefore not reported. The researcher quickly realized that the time lag between the inservice and performance of the assessments resulted in inconsistencies. Following that process the researcher decided to provide the staff nurses updates on how to perform the assessments. These were offered to the nurses during their regular hours of work.

The researcher then conducted another pilot to determine inter-rater reliability. A patient from the unit was assessed by one nurse, while two other nurses and the researcher observed and documented their findings. The two staff nurses had variable level of experience on a neuroscience unit, and the nurse educator is the nurse responsible for the education of the nurses on the neuroscience unit. The assessment results of the findings can be seen in Table 3.

Table 3

Inter-rate reliability for the stroke scale				
Assessment	**Staff nurse-Assessor**	**Staff nurse**	**Researcher**	**Nurse educator**
Level of consciousness	0	0	0	0
LOC questions	0	0	0	0
LOC commands	0	0	0	0
Gaze	0	0	0	0
Visual	0	0	0	0
Facial Palsy	0	0	0	0
Motor arm (R & L)	R=0 L=0	R=0 L=0	R=0 L=0	R=0 L=0
Motor Leg (R & L)	R=0 L=0	R=0 L=0	R=0 L=0	R=0 L=0
Limb ataxia arm (R & L)	R=0 L=0	R=0 L=1	R=0 L=0	R=0 L=0
Limb ataxia leg (R & L)	R=0 L=0	R=0 L=1	R=0 L=0	R=0 L=0
Sensory	0	0	0	0
Neglect	0	0	0	0
Dysarthria	0	1	0	0
Language	1	1	1	1
Distal motor function	0	0	0	0

The data collected from this pilot provided a descriptive analysis of the assessment and evaluations by the various nurses. The assessment was consistent with the method taught, and one discrepancy was noted in the category of limb ataxia. The decision was to proceed with the study.

Limitations

A significant limitation of this study was the number of nurses required to perform the assessments for each of the participants'. Although inter-rater reliability was demonstrated to be adequate, the nurses' abilities and clinical experience may have affected the findings. Every attempt was made by the researcher to fully prepare the

nurses for consistency in assessing and documenting findings. The researcher recognizes the value of having one or two assistants to provide consistency, however this was not feasible for this particular study.

Another limitation of the study is the participants potential for varying level of consciousness related to general fatigue. An attempt to address this occurred by randomizing the order of the assessments, however, it should be recognized that participants are human and can be unpredictable by nature.

Although there are limitations present, this exploratory study provides data and findings that are significant to the core of nursing in terms of assessment of patients in a critical period of illness.

Summary of Chapter

This research study consisted of comparing two assessment tools for quantitative data analysis of early detection of symptomatic vasospasm. It is also comprised a qualitative component using content analysis of the nurses' notes to enhance information regarding the participants' neurological status. An extensive plan was carried out to educate the nurses on the stroke assessment scale and inter-rater reliability was measured. Ethical issues and institutional access guidelines were followed to protect the rights and confidentiality of the participants. Data was gathered by the researcher and analyzed to determine if either of the stroke assessment tool or the standard neurological assessment tool detected symptomatic vasospasm prior to the other. Data was analyzed also to determine the extensiveness of information gathered by the two assessment tools.

Findings

Introduction

Patients who experience a subarachnoid hemorrhage require hospitalization for this sudden illness. Nurses play a key role in caring for the patient during this phase of illness. The nursing role is independent as well as collaborative with the physicians and outlined in the Nursing Model of Hospitalization Event (Smith, 1998). Patients who have been admitted with a subarachnoid hemorrhage require intensive nursing care, of which assessment is a main priority for the nurses. As evidenced in Smith's Model, the patient with a severe illness requires complete care by the nurse 24 hours a day. This is clearly the case with patients who have had a subarachnoid and are at risk for vasospasm. Nurses provide continuous care, and ongoing assessments that will drive the care needs for the patient. In order to provide the optimum care the assessments completed by the nurse must be accurate, and detect symptoms of vasospasm. The focus of this study was to ensure that the assessments conducted by the nurses are enabling the nurse to detect symptoms of vasospasm, so this may be communicated to the surgeon and allow for prompt treatment.

A quasi-experimental design was utilized to compare the current standard neurological assessment conducted by the nurses, to the stroke scale. These two scales were compared to determine if one scale detects symptoms of vasopasm earlier than the other. A qualitative component of the research design was conducted to enhance the data available regarding the patients' status and to lend in-depth information on the topic (Polit & Hungler, 1995).

Recruitment

In total 30 patients were entered into the study in total. One patient was entered, and subsequently removed from the data. This particular patient had a decrease in neurological status, and was determined to have vasospasm, however at the time of neurological decline the nursing assessments for the stroke scale had not been conducted and therefore protocol for data collection was incomplete. One additional patient was recruited to bring the sample size to 30. The study was conducted from July 1999 to June 2000.

Inclusion Criteria

Patients were entered into the study if:

1) Diagnosed with subarachnoid hemorrhage due to a ruptured aneurysm
2) Had a clinical grade on the WFNS between 1-4 (Appendix C)
3) Patient is before or within the classic timeframe for vasospasm, which is day 3-14, post-rupture.
4) Absence of diagnoses of vasospasm
5) Speaks English
6) 18 years of age and older

Termination Criteria

There was termination criteria established and they were:

1) A decrease in neurological status detected by either of the scales, and attributable to vasospasm.
2) A change in neurological condition occurs, not attributable to vasospasm, and was

deemed irreversible by the neurosurgeon.

3) No symptoms of vasospasm are detected and the patient is past the time frame (day 3-14 post-rupture) for vasospasm or has been discharged from the hospital.

Demographics

Demographic information gathered on the patients included age, gender, and location of aneurysm, and past medical history. Information was also obtained regarding the patients' neurological status by using the World Federation of Neurologic Surgeons (1988). This scale provides a snapshot picture of the patients' clinical status. Finally information was gathered regarding the amount and distribution of blood on the initial CT scan, and graded according to the Fisher scale (Fisher, Kistler, & Davis, 1980), which has been evidenced to predict vasospasm.

The patients ranged in age between 18 and 69 years of age. Categories and number of patients in each are shown in Table 4.

Table 4

Age of patients within ranges in ascending order of age	
Ages Ranges in ascending order	**Frequency of patients within range**
18-20	1
21-25	1
26-30	1
31-35	2
36-40	3
41-45	5
46-50	3
51-55	4
56-60	4
61-65	4
66-70	2

There were 20 females and 10 males in the study. Becker (1998) describes smoking,

excessive alcohol use, and hypertension as modifiable high risk factors for non-traumatic subarchnoid hemorrhage. The patients' medical history as shown in Table 5 demonstrates the frequency of patients with past medical histories and those with a family history of aneurysm. Research now indicates a significant prevalence of familial aneurysms (Leblanc, 1997)

Table 5

Frequency of past medical problems in the total sample size in descending order of occurrence	
Past Medical History Related Family Illness	**Frequency**
Smokes	9
Hypertension	9
Migraines (persistent headaches)	6
Cardiac History	3
Parent/Sibling with Aneurysm	3
Sleep Apnea	1

The location of the aneurysms was collected and a summary is provided in Table 6. Of the thirty patients entered into the study there were four who had two aneurysms located on the angiogram.

Table 6

Summary of location of aneurysms	**Frequency**
Middle cerebral artery	8
Anterior communicating artery	10
Posterior communicating artery	7
Internal carotid artery	5
Posterior inferior cerebellar artery	1
Pericallosal artery	1
Basilar tip artery	1
Not recorded	1
Sum	34

Data regarding the patients' clinical status is reflected by their Grade according to the World Federation of Neurologic Surgeons scale (see Appendix C). The grade was recorded on admission to the hospital, and at the time the patient was entered into the study. This information was important to obtain, as one of the exclusion criteria was a poor clinical grade of 5 in this scale, which likely meant the patient would be difficult to assess at that current time. There were four patients who scored a poor clinical grade when admitted to the hospital. These four patients did, however, improve and fit the inclusion criteria so they were entered into the study. Table 7 shows the number of patients with their correlating clinical grade when entered into the study.

Table 7

Clinical grade of patients when entered into the study by decreasing levels of functioning	
***WFNS Clinical Grade**	**Frequency**
1	18
2	5
3	4
4	3
5	Patient excluded as per inclusion criteria

* World Federation of Neurologic Surgeons (see Appendix C)

The Fisher scale represents the amount of blood demonstrated on the patients' CT scan upon admission (refer to Table 1) and can be correlated to the presence of vasospasm. Table 8 demonstrates a summary of the patients and their Fisher score on admission to the hospital.

Table 8

Fisher scores	Frequency	
	Vasospasm	Non-vasospasm
Group one	0	2
Group two	5	2
Group three	6	5
Group four	4	6
Sum	15	15

Quantitative Data Analysis

The researcher recorded the quantitative data from both the standard neurological record and stroke scales onto separate data sheets. The patients were coded numerically in the order entered into the study to maintain confidentiality. The raw data were entered into Microsoft excel spreadsheet and analyzed using Statistical Analysis System Version 7.0. The researcher developed the codes for data entry purposes, which can be found in Table 9. Data analysis was conducted using descriptive statistics. Chi-square analysis was utilized for data that consisted of large volumes, while fisher exact test was used for 2X2 contingency tables with a small sample size, and exact test was used for the variety of other contingency tables that existed in the data.

Table 9

List of categories and codes for the standard neurological record and the stroke scales			
Standard neurological record		**Stroke scale**	
Eye opening	Eye	Level of consciousness	LOC
Best verbal response	Verbal	Level of Consciousness Questions	LOC Q
Best motor response	Motor	Level of consciousness commands	LOC C
Right arm movement	R. arm	Gaze	Gaze
Left arm movement	L. arm	Visual	Visual
Right leg movement	R. leg	Facial Palsy	Facial
Left leg movement	L. leg	Motor arm right	MAR
		Motor arm left	MAL
		Motor leg right	MLR
		Motor leg left	MLL
		Arm ataxia right	AAR
		Arm ataxia left	AAL
		Leg ataxia right	ALR
		Leg ataxia left	ALL
		Sensory	Sensory
		Neglect	Neglect
		Dysarthria	Dysarthria
		Language	Language
		Distal motor function right	DMR
		Distal motor function left	DML

Prospective Analysis

The research question was to determine if the stroke assessment tool would detect symptoms of clinical vasospasm earlier than the standard neurological record. A prospective comparison of the individual categories of each assessment tools were analyzed in relation to the absence or presence of vasospasm. The first area analyzed was the maximum score in each category. This represents the maximum score the patient was observed and documented to have had at some point in the observation period. The

standard neurological record is designed as such that the highest score represents the patients' best neurological status. Table 10 provides the maximum scores for each category of the standard neurological tool based on the outcome of presence or absence of vasospasm. There was no significant difference of the neurological record scores between the non-vasospasm and the vasospasm group.

Table 10

Maximum scores on neurological record for each category according to presence or absence of vasospasm

Categories and potential scores	Actual scores	Non-Vasospasm		Vasospasm	
		n	%	n	%
Eye opening (eye) score 1-4	4	15	100	15	100.0
Best verbal response (verbal) score 1-5	4 5	0 15	0 100	1 14	6.7 93.3
Best motor response (motor) score 1-6	6	15	100	15	100.0
Right arm strength (R. arm) score 1-7	7	15	100	15	100.0
Left arm strength (L. arm) score 1-7	5 7	0 15	0 100	1 14	6.7 93.3
Right leg strength (R. leg) score 1-6	6	15	100	15	100.0
Left leg strength (L. leg) score 1-6	4 6	0 15	0 100	1 14	6.7 93.3

* p values non significant between non-vasospasm and vasospasm group

The data for the stroke scale was also compared in the non-vasopasm and vasospasm groups in relation to the maximum score the patients' had during the observation period. The maximum score for the stroke scale represents the lowest level of neurological status for the patient. Table 10 represents the summary of the highest score for each category based on the outcome of presence or absence of vasospasm. There was no significant difference of the stroke scale scores between the non-vasospasm and the vasospasm

groups.

The scoring of facial symmetry whereby was 1 or a mild facial weakness has been determined by the researcher to be an invalid assessment. Throughout the study researcher observed that several nurses were allocating a score of 1 for patients' who were unable to raise an eyebrow. This deficit occurred post-operatively with the patients and the reason for the inability to move the eyebrow was a result from surgery. With a ptereonal craniotomy approach the nerve can be affected which limits the movement of the eyebrow (Greenberg, 1997). It is relevant to note the definition for a grade 1 paralysis does not address the movement of the eyebrow, however it was consistently assessed that way by the nurses.

Table 11

Maximum scores on stroke scale for each category according to absence or presence of vasospasm

Categories and potential scores	Actual scores	Non-Vasospasm		Vasospasm	
		n = sum	percentage	n = sum	percentage
Level of consciousness (LOC) 0-3	0	1	6.7	2	13.3
	1	12	80.0	10	66.7
	2	2	13.3	3	20.0
Level of consciousness questions (LOC Q) 0-2	0	6	40.0	4	26.7
	1	6	40.0	7	46.7
	2	3	20.0	4	26.7
Level of consciousness commands LOC C 0-2	0	10	66.7	7	46.7
	1	4	26.7	7	46.7
	2	1	6.7	1	6.7
Gaze 0-2	0	9	60.0	9	60.0
	1	4	26.7	6	40.0
	2	2	13.3	0	0.0
Visual 0-3	0	8	53.3	8	53.3
	1	7	46.7	5	33.3
	2	0	0.0	2	13.3
Facial 0-3	0	4	26.7	1	6.7
	1	8	53.3	13	86.7
	2	3	20.0	1	6.7
Motor arm right (MAR) 0-4	0	9	60.0	8	53.3
	1	3	20.0	5	33.3
	2	3	20.0	0	0.0
	3	0	0.0	2	13.3
Motor arm left (MAL) 0-4	0	9	60.0	10	66.7
	1	3	20.0	3	20.0
	2	2	13.3	1	6.7
	4	1	6.7	1	6.7
Motor leg right (MLR) 0-4	0	13	86.7	11	73.3
	1	1	6.7	3	20.0
	4	1	6.7	1	6.7
Motor leg left (MLL) 0-4	0	10	66.7	9	60.0
	1	1	6.7	3	20.0
	2	1	6.7	1	6.7
	3	0	0.0	1	6.7
	4	3	20.0	1	6.7
Ataxia arm right (AAR) 0-2	0	8	53.3	8	53.3
	1	7	46.7	7	46.7
Ataxia arm left (AAL) 0-2	0	7	46.7	9	60.0
	1	8	53.3	6	40.0
Ataxia leg right (ALR) 0-2	0	10	66.7	9	60.0
	1	5	33.3	5	33.3
	2	0	0.0	1	6.7
Ataxia leg left (ALL) 0-2	0	9	60.0	9	60.0
	1	6	40.0	6	40.0
Sensory 0-2	0	11	73.3	10	66.7
	1	2	13.3	3	20.0
	2	2	13.3	2	13.3
Neglect 0-2	0	10	66.7	11	73.3
	1	4	26.7	3	20.0
	2	1	6.7	1	6.7
Dysarthria 0-2	0	9	60.0	9	60.0
	1	4	26.7	5	33.3
	2	2	13.3	1	6.7
Language 0-3	0	8	53.3	9	60.0
	1	4	26.7	4	26.7
	2	2	13.3	2	13.3
	3	1	6.7	0	0.0
Distal motor strength right (DMR) 0-2	0	13	86.7	15	100.0
	1	2	13.3	0	0.0
Distal motor strength left (DML) 0-2	0	12	80.0	12	80.0
	1	2	13.3	2	13.3
	2	1	6.7	1	6.7

* see legend Table 10

The data was analyzed by comparing the vasospasm and non-vasospasm groups and the minimum score for each category of the tools. The minimum score for the standard neurological record provides information about the patients' lowest level of consciousness. The data for the minimum score for each category of the neurological record according to the absence or presence of vasospasm is provided in Table12. There was no significant difference of the neurological record scores between the non-vasospasm and the vasospasm groups.

Table 12

Minimum scores on neurological record for each category according to absence or presence of vasospasm					
Categories and potential scores	**Actual scores**	**Non-Vasospasm**		**Vasospasm**	
		N = sum	**percentage**	**N= sum**	**percentage**
Eye opening (eye) score 1-4	1	4	26.7	2	13.3
	3	10	66.7	13	86.7
	4	1	6.7	0	0.0
Best verbal response (verbal) score 1-5	1	1	6.7	3	20.0
	3	2	13.3	1	6.7
	4	4	26.7	7	46.7
	5	8	53.3	4	26.7
Best motor response (motor) score 1-6	5	0	0.0	3	20.0
	6	15	100.0	12	80.0
Right arm strength (R. arm) score 1-7	1	0	0.0	1	6.7
	4	1	6.7	0	0.0
	5	0	0.0	2	13.3
	6	4	26.7	6	40.0
	7	10	66.7	6	40.0
Left arm strength (L. arm) score 1-7	1	1	6.7	2	13.3
	5	4	26.7	3	20.0
	6	1	6.7	4	26.7
	7	9	60.0	6	40.0
Right leg strength (R. leg) score 1-6	1	0	0.0	1	6.7
	4	2	13.3	5	33.3
	5	3	20.0	4	26.7
	6	10	66.7	5	33.3
Left leg strength (L. leg) score 1-6	1	1	6.7	2	13.3
	4	3	20.0	5	33.3
	5	2	13.3	2	13.3
	6	9	60.0	6	40.0

* see legend Table 10

The minimum score the patient obtains in the stroke scale represents the highest level of neurological functioning for the patient. The data comparing the vasopsasm group to the non-vasospasm group for the minimum scores achieved by the patients' is provided in Table 13. There was no significant difference of stroke scale scores between the non-vasospasm and the vasospasm groups.

Table 13

Minimum scores on stroke scale for each category according to absence or presence of vasospasm					
Categories and potential scores	**Actual scores**	**Non-Vasospasm**		**Vasospasm**	
		n = sum	**percentage**	**n= sum**	**percentage**
Level of consciousness (LOC) 0-3	0	15	100.0	15	100.0
Level of consciousness questions (LOC Q) 0-2	0	15	100.0	14	93.3
	1	0	0.0	1	6.7
Level of consciousness commands (LOC C) 0-2	0	15	100.0	15	100.0
Gaze 0-2	0	14	93.3	15	100.0
	1	1	6.7	0	0.0
Visual 0-3	0	15	100.0	15	100.0
Facial 0-3	0	13	86.7	14	93.3
	1**	2**	13.3**	1**	6.7**
Motor arm right (MAR) 0-4	0	15	100.0	15	100.0
Motor arm left (MAL) 0-4	0	15	100.0	14	93.3
	3	0	0.0	1	6.7
Motor leg right (MLR) 0-4	0	15	100.0	15	100.0
Motor leg left (MLL) 0-4	0	15	100.0	14	93.3
	3	0	0.0	1	6.7
Ataxia arm right (AAR) 0-2	0	15	100.0	15	100.0
Ataxia arm left (AAL) 0-2	0	15	100.0	15	100.0
Ataxia leg right (ALR) 0-2	0	15	100.0	15	100.0
Ataxia leg left (ALL) 0-2	0	15	100.0	15	100.0
Sensory 0-2	0	15	100.0	15	100.0
Neglect 0-2	0	15	100.0	14	93.3
	1	0	0.0	1	6.7
Dysarthria 0-2	0	14	93.3	13	86.7
	1	0	0.0	2	13.3
	2	1	6.7	0	0.0
Language 0-3	0	14	93.3	14	93.3
	1	0	0.0	1	6.7
	2	1	6.7	0	0.0
Distal motor right (DMR) 0-2	0	15	100.0	15	100.0
Distal motor left (DML) 0-2	0	15	100.0	14	93.3
	1	0	0.0	1	6.7

* see legend Table 10

** invalid assessment

A further prospective review of the data included descriptive analysis of the patients' maximum positive change at any point during the observation period. A positive change in the standard neurological record demonstrated an improvement in the patient's level of neurological functioning. The data for the maximum positive change for the standard neurological record in relationship to absence or presence of vasospasm is provided in Table 14.There was no significant difference of the neurological record scores between the non-vasospasm and vasospasm groups.

Table 14

Maximum positive change in scores on neurological record for each category according to absence or presence of vasospasm

Categories and potential scores	Actual scores	Non-Vasospasm		Vasospasm	
		n = sum	percentage	n= sum	percentage
Eye opening (eye) Score 0-3	0	1	6.7	0	0.0
	1	11	73.3	14	93.3
	2	2	13.3	1	6.7
	3	1	6.7	0	0.0
Best verbal response (verbal) score 0-4	0	8	53.3	5	33.3
	1	6	40.0	8	53.3
	3	0	0.0	2	13.3
	4	1	6.7	0	0.0
Best motor response (motor) score 0-5	0	15	100.0	13	86.7
	1	0	0.0	2	13.3
Right arm strength (R. arm) score 0-6	0	10	66.6	7	46.7
	1	4	26.7	7	46.7
	3	1	6.7	0	0.0
	6	0	0.0	1	6.7
Left arm strength (L. arm) score 0-6	0	9	60.0	7	46.7
	1	2	13.3	6	40.0
	2	4	26.7	0	0.0
	4	0	0.0	2	13.3
Right leg strength (R. leg) score 0-5	0	10	66.7	5	33.3
	1	5	33.3	9	60.0
	4	0	0.0	1	6.7
Left leg strength (L. leg) score 0-5	0	8	53.3	6	40.0
	1	5	33.3	7	46.7
	2	1	6.7	0	0.0
	3	1	6.7	2	13.3

* see legend Table 10

The data for maximum positive change was analyzed for the stroke scale and is summarized in Table 15 in accordance to absence or presence of vasopasm. The maximum positive change in the stroke scale represents deterioration in the patients' level of neurological functioning. There was no significant difference of the stroke scales scores between the non-vasospasm and vasospasm group.

Table 15

Maximum positive change in scores on stroke scale for each category according to absence or presence of vasospasm					
Categories and potential scores	**Actual scores**	**Non-Vasospasm**		**Vasospasm**	
		n = sum	**percentage**	**n= sum**	**percentage**
Level of consciousness (LOC) 0-3	0	3	20.0	2	13.3
	1	12	80.0	13	86.7
Level of consciousness questions (LOC Q) 0-2	0	7	46.7	5	33.3
	1	6	40.0	7	46.7
	2	2	13.3	3	20.0
Level of consciousness commands LOC C 0-2	0	10	66.6	9	60.0
	1	4	26.7	5	33.3
	2	1	6.7	1	6.7
Gaze 0-2	0	10	66.6	9	60.0
	1	4	26.7	6	40.0
	2	1	6.7	0	0.0
Visual 0-3	0	8	53.3	10	66.7
	1	7	46.7	5	33.3
Facial 0-3	0	6	40.0	2	13.3
	1**	8**	53.3**	13**	86.7**
	2	1	6.7	0	0.0
Motor arm right (MAR) 0-4	0	12	80.0	9	60.0
	1	2	13.3	5	33.3
	2	1	6.7	0	0.0
	3	0	0.0	1	6.7
Motor arm left (MAL) 0-4	0	11	73.3	12	80.0
	1	3	20.0	3	20.0
	2	1	6.7	0	0.0
Motor leg right (MLR) 0-4	0	13	86.6	11	73.3
	1	1	6.7	4	26.7
	3	1	6.7	0	0.0
Motor leg left (MLL) 0-4	0	12	80.0	11	73.3
	1	1	6.7	3	20.0
	2	0	0.0	1	6.7
	3	2	13.3	0	0.0
Ataxia arm right (AAR) 0-2	0	8	53.3	9	60.0
	1	7	46.7	6	40.0
Ataxia arm left (AAL) 0-2	0	7	46.7	11	73.3
	1	8	53.3	4	26.7
Ataxia leg right (ALR) 0-2	0	10	66.7	9	60.0
	1	5	33.3	5	33.3
	2	0	0.0	1	6.7
Ataxia leg left (ALL) 0-2	0	10	66.7	10	66.7
	1	5	33.3	5	33.3
Sensory 0-2	0	12	80.0	11	73.3
	1	3	20.0	3	20.0
	2	0	0.0	1	6.7
Neglect 0-2	0	10	66.7	12	80.0
	1	5	33.3	2	13.3
	2	0	0.0	1	6.7
Dysarthria 0-2	0	10	66.6	11	73.3
	1	4	26.7	4	26.7
	2	1	6.7	0	0.0
Language 0-3	0	9	60.0	9	60.0
	1	6	40.0	5	33.3
	2	0	0.0	1	6.7
Distal motor right (DMR) 0-2	0	13	86.7	15	100.0
	1	2	33.3	0	0.0
Distal motor left (DML) 0-2	0	12	80.0	12	80.0
	1	3	20.0	3	20.0

* see legend Table 10

** demonstrates invalid assessment

A maximum negative change in each category for both tools was analyzed. The negative change can occur at any point throughout the study for an individual patient. A negative change in the standard neurological record demonstrates deterioration in the patients' level of neurological functioning. The data for the negative maximum change for the standard neurological record is provided in Table 16 in relationship to absence or presence of vasopasm. There was no significant difference of the neurological record scores between the non-vasospasm and vasospasm groups.

Table 16

Maximum negative change on scores in neurological record for each category according to absence or presence of vasospasm

Categories and potential scores	Actual scores	Non-Vasospasm		Vasospasm	
		n = sum	percentage	n= sum	percentage
Eye opening (eye) score -3 – 0	-3	1	6.7	0	0.0
	-2	3	20.0	2	13.3
	-1	9	60.0	13	86.7
	0	2	13.3	0	0.0
Best verbal response (verbal) score -4 -0	-4	1	6.7	2	13.3
	-3	0	0.0	1	6.7
	-2	0	0.0	1	6.7
	-1	6	40.0	5	33.3
	0	8	53.3	6	40.0
Best motor response (motor) score –5 - 0	-1	0	0.0	2	13.3
	0	15	100.0	13	86.7
Right arm strength (R. arm) score –6 - 0	-6	0	0.0	1	6.7
	-3	1	6.7	0	0.0
	-2	0	0.0	1	6.7
	-1	4	26.7	6	40.0
	0	10	66.6	7	46.6
Left arm strength (L. arm) score –6 - 0	-6	1	6.7	1	6.7
	-4	0	0.0	1	6.7
	-2	1	6.7	1	6.7
	-1	4	26.6	5	33.3
	0	9	60.0	7	46.6
Right leg strength (R. leg) score –5 - 0	-5	0	0.0	1	6.7
	-2	0	0.0	2	13.3
	-1	5	33.3	6	40.0
	0	10	66.7	6	40.0
Left leg strength (L. leg) score –5 - 0	-5	0	0.0	1	6.7
	-4	1	6.7	0	0.0
	-3	0	0.0	1	6.7
	-2	0	0.0	2	13.3
	-1	5	33.3	4	26.7
	0	9	60.0	7	46.6

* see legend Table 10

The data for the stroke scale indicating the maximum negative change by correlating the groups by vasospasm and non-vasospasm is provided in Table 17. A negative change demonstrated by the stroke scale reflects an improvement in the patients' neurological functioning. There was no significant difference of the stroke scale scores between the non-vasospasm and vasospasm groups.

Table 17

Maximum negative change in scores in stroke scale for each category according to absence or presence of vasospasm					
Categories and potential scores	**Actual scores**	**Non-Vasospasm**		**Vasospasm**	
		n = sum	**percentage**	**n= sum**	**percentage**
Level of consciousness (LOC) -3 - 0	-2	0	0.0	1	6.7
	1	13	86.7	12	80.0
	0	2	13.3	2	13.3
Level of consciousness questions (LOCQ) -2 - 0	2	3	20.0	2	13.3
	-1	6	40.0	8	53.3
	0	6	40.0	5	33.3
Level of consciousness commands (LOCC) -2 - 0	2	1	6.7	0	0.0
	1	3	20.0	6	40.0
	0	11	73.3	9	60.0
Gaze -2 - 0	2	1	6.7	0	0.0
	1	5	33.3	6	40.0
	0	9	60.0	9	60.0
Visual -3 - 0	1	7	46.7	3	20.0
	0	8	53.3	12	80.0
Facial -3 - 0	2	1	6.6	0	0.0
	1**	7**	46.7**	12**	80.0**
	0	7	46.7	3	20.0
Motor arm right (MAR) -4 - 0	-3	0	0.0	1	6.7
	-2	1	6.7	0	0.0
	-1	3	20.0	5	33.3
	0	11	73.3	9	60.0
Motor arm left (MAL) -4 - 0	-2	1	6.7	0	0.0
	-1	4	26.7	4	26.7
	0	10	66.6	11	73.3
Motor leg right (MLR) -4 - 0	-2	1	6.7	0	0.0
	-1	1	6.7	4	26.7
	0	13	66.6	11	73.3
Motor leg left (MLL) -4 - 0	-3	1	6.7	0	0.0
	-2	1	6.7	1	6.7
	-1	1	6.6	5	33.3
	0	12	80.0	9	60.0
Ataxia arm right (AAR) -2 - 0	-1	6	40.0	7	46.7
	0	9	60.0	8	53.3
Ataxia arm left (AAL) -2 - 0	-1	7	46.7	6	40.0
	0	8	53.3	9	60.0
Ataxia leg right (ALR) -2 - 0	-2	0	0.0	1	6.7
	-1	4	26.7	5	33.3
	0	11	73.3	9	60.0
Ataxia leg left (ALL) -2 - 0	-1	5	33.3	6	40.0
	0	10	66.7	9	60.0
Sensory -2 - 0	-2	1	6.7	2	13.3
	-1	2	13.3	3	2.0
	0	12	80.0	10	66.7
Neglect -2 - 0	-2	0	0.0	1	6.7
	-1	4	26.7	1	6.7
	0	11	73.3	13	86.6
Dysarthria -2 - 0	-1	3	20.0	3	20.0
	0	12	80.0	12	80.0
Language -3 - 0	-1	4	26.7	5	33.3
	0	11	73.3	10	66.7
Distal motor right (DMR) -2 - 0	-1	2	13.3	0	0.0
	0	13	86.7	15	100.0
Distal motor left (DML) -2 - 0	-1	2	13.3	3	20.0
	0	13	86.7	12	80.0

* see legend Table 10

** invalid assessment

The ranges of the scores in each category were analyzed prospectively for both tools.

The range for each category of the standard neurological record is provided in Table 18 in accordance to the absence or presence of vasopasm. There was no significant difference of the neurological record scores between the non-vasospasm and vasospasm groups.

Table 18

Range of scores on neurological record for each category according to absence or presence of vasospasm

Categories and potential scores	Actual scores	Non-Vasospasm n = sum	Non-Vasospasm percentage	Vasospasm n= sum	Vasospasm percentage
Eye opening (eye) score 0-3	0	1	6.7	0	0.0
	1	10	66.6	13	86.7
	3	4	26.7	2	13.3
Best verbal response (verbal) score 0-4	0	8	53.3	5	33.3
	1	4	26.7	6	40.0
	2	2	13.3	1	6.7
	4	1	6.7	3	20.0
Best motor response (motor) score 0-5	0	15	100.0	12	80.0
	1	0	0.0	3	20.0
Right arm strength (R. arm) score 0-6	0	10	66.6	6	40.0
	1	4	26.7	6	40.0
	2	0	0.0	2	13.3
	3	1	6.7	0	0.0
	6	0	0.0	1	6.7
Left arm strength (L. arm) score 1-7	0	9	60.0	6	40.0
	1	1	6.7	4	26.6
	2	4	26.6	3	20.0
	4	0	0.0	1	6.7
	6	1	6.7	1	6.7
Right leg strength (R. leg) score 0-5	0	10	66.7	5	33.3
	1	3	20.0	4	26.7
	2	2	13.3	5	33.3
	5	0	0.0	1	6.7
Left leg strength (L. leg) score 0-5	0	8	53.3	6	40.0
	1	3	20.0	2	13.3
	2	3	20.0	5	33.3
	3	0	0.0	1	6.7
	5	1	6.7	1	6.7

* see legend Table 10

The range of each category of the stroke scale by comparing the vasospasm to the non-vasospasm group is summarized in Table 19. There was no significant difference of the stroke scale scores between the non-vasospasm and vasospasm groups.

Table 19

Range of scores on stroke scale for each category according to absence or presence of vasospasm					
Categories and potential scores	Actual scores	Non-Vasospasm		Vasospasm	
		n = sum	percentage	N= sum	percentage
Level of consciousness (LOC) 0-3	0	1	6.7	2	13.3
	1	12	80.0	10	66.7
	2	2	13.3	3	20.0
Level of consciousness questions (LOC Q) 0-2	0	6	40.0	4	26.7
	1	6	40.0	8	53.3
	2	3	20.0	3	20.0
Level of consciousness commands (LOC C) 0-2	0	10	66.6	7	46.6
	1	4	26.7	7	46.6
	2	1	6.7	1	6.7
Gaze 0-2	0	9	60.0	9	60.0
	1	5	33.3	6	40.0
	2	1	6.7	0	0.0
Visual 0-3	0	8	53.3	8	53.3
	1	7	46.7	5	33.3
	2	0	0.0	2	13.3
Facial 0-3	0	5	33.3	1	6.7
	1**	8**	53.4**	14**	93.3*
	2	2	13.3	0	0.0
Motor arm right (MAR) 0-4	0	9	60.0	8	53.4
	1	3	20.0	5	33.3
	2	3	20.0	0	0.0
	3	0	0.0	2	13.3
Motor arm left (MAL) 0-4	0	9	60.0	10	66.6
	1	3	20.0	4	26.7
	2	2	13.3	1	6.7
	4	1	6.7	0	0.0
Motor leg right (MLR) 0-4	0	13	86.6	11	73.3
	1	1	6.7	3	20.0
	4	1	6.7	1	6.7
Motor leg left (MLL) 0-4	0	10	66.6	9	60.0
	1	1	6.7	4	26.6
	2	1	6.7	1	6.7
	3	0	0.0	1	6.7
	4	3	20.0	0	0.0
Ataxia arm right (AAR) 0-2	0	8	53.3	8	53.3
	1	7	46.7	7	46.7
Ataxia arm left (AAL) 0-2	0	7	46.7	9	60.0
	1	8	53.3	6	40.0
Ataxia leg right (ALR) 0-2	0	10	66.7	9	60.0
	1	5	33.3	5	33.3
	2	0	0.0	1	6.7
Ataxia leg left (ALL) 0-2	0	9	60.0	9	60.0
	1	6	40.0	6	40.0
Sensory 0-2	0	11	73.4	10	66.7
	1	2	13.3	3	20.0
	2	2	13.3	2	13.3
Neglect 0-2	0	10	66.6	12	80.0
	1	4	26.7	2	13.3
	2	1	6.7	1	6.7
Dysarthria 0-2	0	10	66.6	10	66.7
	1	4	26.7	5	33.3
	2	1	6.7	0	0.0
Language 0-3	0	8	53.4	9	60.0
	1	5	33.3	5	33.3
	2	2	13.3	1	6.7
Distal motor right (DMR) 0-2	0	13	86.7	15	100.0
	1	2	13.3	0	0.0
Distal motor left (DML) 0-2	0	13	86.7	15	100.0
	1	2	13.3	0	0.0

* see legend Table 10

** invalid assessment

For the prospective review of the data it was relevant to analyze the two scales in their entirety. Both the standard neurological scale and the stroke scale can be represented in its entirety by adding the scores in each category to provide a summation. Table 20 provides a summary for the complete standard neurological record of the prospective analysis in accordance to absence or presence of vasospasm.

Table 20

Summary of maximum, minimum, maximum positive change, maximum negative change, and range scores for the complete standard neurological record according to absence or presence of vasospasm			
Scale and potential score	**Total maximum score**	**Non-Vasospasm n (%)**	**Vasospasm n(%)**
Standard neurological scale			
Maximum score 7-41	36	0 (0)	1 (7)
	40	3 (20)	3 (20)
	41	12 (80)	11 (73)
Minimum score 7-41	26	0 (0)	1 (6)
	28	1 (7)	0 (0)
	29	0 (0)	2 (13)
	31	2 (13)	2 (13)
	32	0 (0)	1 (6)
	33	1 (7)	0 (0)
	34	0 (0)	1 (6)
	36	0 (0)	2 (13)
	37	3 (20)	0 (0)
	39	2 (13)	3 (20)
	40	6 (40)	3 (20)
Maximum positive change	1	6 (40)	5 (33)
0-34	2	2 (13)	2 (13)
	3	1 (6)	1 (6)
	4	3 (20)	3 (20)
	5	2 (13)	2 (13)
	6	1 (6)	1 (6)
	11	0 (0)	1 (6)
Maximum negative change	-10	0 (0)	1 (6)
-34 – 0	- 9	1 (6)	0 (0)
	- 8	0 (0)	2 (13)
	- 7	0 (0)	1 (6)
	- 5	1 (6)	2 (13)
	- 4	2 (13)	1 (6)
	- 3	2 (13)	0 (0)
	- 2	3 (20)	2 (13)
	- 1	5 (33)	6 (40)
	0	1 (6)	0 (0)
Range 0 – 34	1	6 (40)	3 (20)
	2	2 (13)	3 (20)
	4	3 (20)	0 (0)
	5	0 (0)	2 (13)
	7	1 (6)	2 (13)
	9	1 (6)	3 (20)
	10	1 (6)	0 (0)
	12	1 (6)	1 (6)
	14	0 (0)	1 (6)

* see legend Table 10

The prospective summary of the data for the entire stroke scales is summarized in Table 21 in relationship absence or presence of vasospasm. The higher the number in the stroke scale represents the lower level of neurological status for the individual patient. For two patients in the non-vasospasm group the nurses had indicated at some point the assessments were unable to be done, and the data is incomplete for these particular sections of the analysis.

Table 21

Summary of maximum, minimum, maximum positive change, maximum negative change, and range scores for the complete stroke scale according to absence or presence of vasospasm			
Scale and potential score	**Total maximum score**	**Non-Vasospasm n (%)**	**Vasospasm n(%)**
Stroke scale			
Maximum score 0-52	0	1 (6)	0 (0)
	1	3 (20)	0 (0)
	2	3 (20)	2 (13)
	3	1 (6)	2 (13)
	4	0 (0)	3 (20)
	5	3 (20)	1 (6)
	6	0 (0)	2 (13)
	7	0 (0)	1 (6)
	8	2 (13)	1 (6)
	10	0 (0)	1 (6)
	12	1 (6)	0 (0)
	13	0 (0)	1 (6)
	16	0 (0)	1 (6)
	17	1 (6)	0 (0)
Minimum score 0-52	0	10 (66)	10 (66)
	1	2 (13)	1 (6)
	2	1 (6)	1 (6)
	4	1 (6)	0 (0)
	5	0 (0)	1 (6)
	6	0 (0)	1 (6)
	8	1 (6)	0 (0)
	10	0 (0)	1 (6)
Maximum positive change	0	2 (15)	0 (0)
	1	5 (38)	2 (13)
	2	2 (15)	6 (40)
	3	1 (7)	2 (13)
	4	3 (23)	4 (26)
	5	0 (0)	1 (6)
	** unobtainable data	2 (13)	0 (0)
Maximum negative change	- 6	1 (6)	1 (6)
	- 5	1 (6)	1 (6)
	- 4	1 (6)	5 (33)
	- 3	1 (6)	1 (6)
	- 2	3 (20)	5 (33)

	- 1	3 (20)	2 (13)
	0	2 (13)	0 (0)
	1	1 (6)	0 (0)
	**unobtainable data	2 (13)	0 (0)
Range	0	2 (13)	0 (0)
	1	5 (33)	0 (0)
	2	2 (13)	2 (13)
	3	1 (6)	2 (13)
	4	0 (0)	5 (33)
	5	2 (13)	1 (6)
	6	1 (6)	2 (13)
	7	0 (0)	2 (13)
	8	0 (0)	1 (6)
	11	1 (6)	0 (0)
	17	1 (6)	0 (0)

* see legend Table 10

** observations indicated to be unobtainable

Nurses' indicated on both of the assessment tools when they were unable to assess the patient. The inability to assess the patient occurred in categories of the assessments or at times included the entire assessment. The researcher decided to enter the code numbers nine each time the observations indicated that the category was untestable. The frequency that this documentation occurred was analyzed by comparing the two assessment scales and is shown in Table 22.

Table 22

Total frequency for both scales when nurses' documented the category was untestable	
Scale	**Sum**
Standard neurological record	8
Stroke scale	1910

The frequency that patients' were unable to be assessed was compared to both assessment tools in relation to whether or not the patient experienced vasospasm. Table 23 provides a summary of patients who were at some point unable to be assessed for both scales. There was no significant difference of scores of both scales between the non-vasospasm and vasospasm groups.

Table 23

Comparison of the standard neurological record to the stroke scale regarding observations nurses unable to assess in accordance of absence or presence of vasospasm				
Assessment scale	**Non-Vasospasm**		**Vasospasm**	
Standard neurological record	n= sum	percentage	n=sum	percentage
Nine's absent in data	9	60	8	53
Nines present in data	6	40	7	47
Stroke scale				
Nines absent in data	2	13	0	0
Nines present in data	13	87	15	100

* see legend Table 10

Comparison of Specific Categories

Some of the categories within the standard neurological record and the stroke scale assess similar aspects of the patients' neurological status. The standard neurological record has categories such as: eye opening, best verbal response, best motor response that are similar to certain categories of the stroke scale such as level of consciousness, level of consciousness questions, level of consciousness commands, and language. The researcher thought it was important to analyze these categories to examine the consistency of both scales, and the also the consistency of the nurses' observations. Both scales have categories that analyze the strength or function of each limb of the patient. It was determined that these categories should also be analyzed and compared to determine the degree of consistency.

During the analysis there was evidence found where the nurses' did not document any

findings for particular assessments. In situations where the data were missing from the nurses' observations it was coded as non-recorded. There were also observations by the nurses that were indicated in the particular category as being untestable. This data was included in the analysis.

Table 24 demonstrates a comparison of observations between the patients' ability to open their eyes with the standard neurological scale and the patients' level of consciousness in the stroke scale. There was no significant difference of scores between the scales, however, it can be suggested that discrepancies exist amongst some of the assessment.

Table 24

A comparison of frequency of observations between eye opening (eye) of the standard neurological tool and level of consciousness (LOC) of the stroke scale						
	Level of consciousness					
Eye opening	**NR**	**0**	**1**	**2**	**9**	**total**
NR	0	4	10	0	0	14
1	1	2	9	5	0	17
2	6	2	11	2	0	21
3	27	75	252	5	7	366
4	35	256	146	0	11	448
9	0	0	1	0	0	1
Total	69	339	429	12	18	867

NR = data not recorded by nurses
9 = observations deemed untestable by the nurses
* p values non significant

Another component of the standard neurological record compared the patients' best verbal response with the patients' ability to answer level of consciousness questions of the stroke scales and is shown in Table 25. There was no significant difference between the scores of the two assessment scales, however, there was evidence that nursing observations are not consistent when compared by the two scales.

Table 25

A comparison of frequency of observations between best verbal response (verbal) of the standard neurological tool and level of consciousness questions (LOC Q) of the stroke scale						
	Level of consciousness questions					
Verbal	**NR**	**0**	**1**	**2**	**9**	**total**
NR	0	8	4	1	1	14
1	21	7	1	1	28	58
2	0	0	0	0	1	1
3	0	0	3	3	1	7
4	13	79	130	50	5	277
5	38	426	39	3	3	509
9	0	0	0	0	1	1
Total	72	520	177	58	40	867

* see legend Table 24

The patients' best motor response in the standard neurological record is similar to the patients' ability to obey level of consciousness commands of the stroke scale. These two categories were compared to determine the degree of consistency that existed. The data are summarized in Table 26, and there was no significant difference between the scores of the two scales. There is suggestion of discrepancy between the observations when compared by the two scales and will be discussed later.

Table 26

A comparison of frequency of observations between best motor response (motor) of the standard neurological tool and level of consciousness commands (LOC C) of the stroke scale						
	Level of consciousness commands					
Motor	**NR**	**0**	**1**	**2**	**9**	**total**
NR	1	13	0	0	1	15
5	0	2	1	1	0	4
6	73	671	49	13	40	846
9	0	0	0	0	2	2
Total	74	686	50	14	43	867

* see legend Table 24

The researcher decided it was important to compare the patients' ability to speak to the patients' best verbal response to determine if consistencies existed. Table 27 provides a summary of a comparison between the patients' best verbal response indicated in the standard neurological record to the patients' language abilities in the stroke scale. There was no significance of the scores between the two scales. There were discrepancies found to exist when these categories of observations were compared between the assessment scales.

Table 27

A comparison of frequency of observations between best verbal response (verbal) of the standard neurological tool and language (language) of the stroke scale							
	Language						
Verbal	**NR**	**0**	**1**	**2**	**3**	**9**	**total**
NR	0	12	0	0	0	2	14
1	21	2	0	3	1	31	58
2	0	0	0	0	0	1	1
3	0	4	2	0	0	1	7
4	13	198	35	11	0	20	277
5	37	430	14	5	18	5	509
9	0	0	0	0	0	1	1
Total	71	646	51	19	19	61	867

* see legend Table 24

Both scales include categories to document observations regarding the patients' motor power or strength in each of their limbs. A comparison of these observations for each limb was analyzed prospectively to determine consistency of the scales and the nurses' observations. The data collected included missing documentation as well as categories or items the nurses' deemed untestable. Table 28 contains a summary of the observations of right arm strength in the neurological record compared to right arm motor function of the stroke scale. There was no significant difference of scores between the two scales however there are inconsistencies demonstrated.

Table 28

A comparison of frequency of observations between right arm strength (R arm) of the standard neurological tool to right motor arm function (MAR) of the stroke scale							
	Motor arm right (MAR)						
Right arm	**NR**	**0**	**1**	**2**	**3**	**9**	**total**
NR	1	10	1	1	0	2	15
1	1	0	0	0	0	0	1
4	0	1	0	0	0	0	1
5	0	2	0	0	0	0	2
6	10	38	11	4	2	20	85
7	59	599	22	0	1	81	762
9	0	0	0	0	0	1	1
Total	71	650	34	5	3	104	867

* see legend Table 24

A comparison of observations of the patients' left arm strength using the standard neurological tool to the left motor arm function using the stroke scale was summarized and shown in Table 29. There was no significant difference in scores between the two scales. There are discrepancies between the two scales that become evident when compared to each other and will be discussed in detail.

Table 29

A comparison of frequency of observations between left arm strength (L arm) of the standard neurological tool to left motor arm function (MAL) of the stroke scale								
	Motor arm left (MAL)							
Left arm	**NR**	**0**	**1**	**2**	**3**	**4**	**9**	**total**
NR	1	11	1	0	0	0	2	15
1	3	0	0	0	0	3	0	6
3	2	0	0	0	0	1	0	3
5	4	7	0	0	16	5	9	41
6	10	55	19	6	0	0	52	142
7	51	544	20	3	0	0	41	659
9	0	0	0	0	0	0	1	1
Total	71	617	40	9	16	9	105	867

* see legend Table 24

The next category compared between the two scales was the right leg strength of the neurological record to right motor arm function of the stroke scales. There was no significant difference between the scores of the two scales. Once again there are inconsistencies noted between the observations of the two assessment scales. A summary of the results of the data is provided in Table 30.

Table 30

A comparison of frequency of observations between right leg strength (R leg) of the standard neurological tool to right motor leg function (MLR) of the stroke scale								
	Motor leg right							
Right leg	**NR**	**0**	**1**	**2**	**3**	**4**	**9**	**total**
NR	2	9	3	0	0	0	2	16
1	1	0	0	0	0	0	0	1
4	1	7	1	7	10	8	3	37
5	22	63	11	4	0	0	40	140
6	45	557	3	1	0	0	66	672
9	0	0	0	0	0	0	1	1
Total	71	636	18	12	10	8	112	867

* see legend Table 24

The final category analyzed was the comparison of the patients' left leg strength of the standard neurological record to the patients' left motor leg function in the stroke scale. The summary is found in Table 31. There was no significant difference in scores between the two scales however there was evidence of inconsistencies amongst these observations.

Table 31

A comparison of frequency of observations between left leg strength (L leg) of the standard neurological tool to left motor leg function (MLL) of the stroke scale								
	Motor leg left (MLL)							
Left leg	**NR**	**0**	**1**	**2**	**3**	**4**	**9**	**total**
NR	1	11	1	0	0	0	2	15
1	3	0	0	0	0	4	0	7
4	7	7	6	1	21	14	6	62
5	24	66	9	0	6	1	70	176
6	36	513	22	3	0	0	32	605
9	0	0	0	0	0	0	1	1
Total	71	597	38	4	27	19	111	867

* see legend Table 24

Time Lapse

A prospective data analysis was completed evaluating the categories of each tool in terms of the current observation documented followed by the next assessment documented. Each category was analyzed by the frequency of the observation or score that immediately followed it. This was done to analyze the component of time lapse in relation to the ranges of the scores indicated by both assessment tools. This analysis

provided no additional information and therefore the findings are not included.

Retrospective Analysis

The prospective analysis compared data between a group of patients' who experienced vasospasm and group of patients' who did not experience vasospasm. The prospective analysis did not, however, answer the question of which assessment tool would detect the earliest symptoms of clinical vasospasm. In order to answer this question a retrospective analysis was undertaken for all of the patients in relation to the absence or presence of vasospasm. The data were analyzed to clearly detect early major changes by comparing the standard neurological record to the stroke scale tool. The data were also analyzed to demonstrate the categories in either assessment scale that showed the early major changes. All aspects of the retrospective analysis will be reviewed.

Early Major Changes Detected by the Two Assessment Scales

There are two main sets of data that describe the patients' who had major changes and the scale that detected those changes first. The data also indicates patients who were never observed to have a major change. The data were analyzed with two different sets of information due to the lack of clarity of what constitutes a major change. Evidence in Tables 26-29 shows that inconsistencies may have occurred when scoring the patient's limb strength as being strong, moderate, or weak using the standard neurological record. What constitutes a major change is clinically a relevant point, and can vary amongst clinicians. The data were analyzed in two main groups with the groups defined as:

1) A major change in the standard neurological record constitutes a change of two points except for limb strength. A major change for each limb is defined as a one- point change within that category.

2) A major change in the standard neurological record is defined as a two-point change with no exceptions.

The stroke scale had a major change defined consistently as a two-point change in the scale with the exception of motor limb function. Each limb function was defined as a major change with a one- point change within the category. The qualitative data suggested that detecting a limb drift and dysphasia was clinically significant to the early detection of vasospasm, therefore the one-point change was deemed a major change for these categories for the retrospective analysis.

The analysis also had to consider the role of the observations when nurses' documented items as being untestable (refer to Tables 21 and 22). The reasons the nurses recorded observations as untestable are unknown. It can be suggested that when a patient was unable to complete the assessment required by either of the scales that the patient has experienced deterioration in neurological status. If this were the case the question remains whether this change should be considered a major change in neurological status or a minor change in neurological status. The researcher decided to analyze the data for groups one and two with the inclusion and exclusion of the untestable items appearing in the analysis. This was done to fully explore the role of potential major changes in neurological function in relation to vasospasm.

Group One

The data in Table 32 provides a summary of the earliest major changes comparing the two assessment scales. A major change in the standard neurological scale is defined as a two-point change, with the exception of limb strength. A major change in limb strength is defined as a one-point change. The summary in this table also includes the observations

that nurses documented as being untestable. Therefore these observations are considered a major change, or a two-point change in this table. There was no significant difference of major changes between the two scales for the vasospasm and non-vasospasm groups.

Table 32

Summary of the earliest detected major changes comparing the standard neurological tool to the stroke scale according to absence or presence of vasospasm including untestable items		
Definitions: Standard neurological tool major change is 2 points with the exception of limb strength. A major change in limb strength is a one-point change.		
First major changes	**Non-vasospasm**	**Vasospasm**
Standard neurological scale first	2	1
Stroke scale first	8	11
Both scales concurrent changes	2	3
No major changes	3	0
Sum	15	15

* p values non-significant between non-vasospasm and vasospasm groups

Table 33 provides a summary of the earliest detected major changes with the untestable items being excluded. This now considers untestable items as being a minor change or a one-point change for both scales. There is no significant difference between the two assessment scales in the non-vasospasm or vasospasm groups.

Table 33

Summary of the earliest detected major changes comparing the standard neurological tool to the stroke scale according to absence or presence of vasospasm excluding untestable items.		
Definitions: Standard neurological tool major change is 2 points with the exception of limb strength. A major change in limb strength is a one-point change.		
First major changes	**Non-vasospasm**	**Vasospasm**
Standard neurological scale first	3	2
Stroke scale first	5	7
Both scales concurrent changes	2	5
No major changes	5	1
Sum	15	15

* p values non-significant between non-vasospasm and vasospasm groups

For both of these tables the stroke scale often detected the first major changes regardless of the outcome for vasospasm. A change in the results occurred when the untestable data was considered a minor change instead of being a major change, as the frequency that the stroke scale detects major changes becomes less. Given the high frequency in number of untestable items of the stroke scale compared to the standard neurological record (refer to Table 21) and the results in the analysis of early major changes, the unknown reason for untestable items requires further discussion. Overall the ability for the stroke scale to detect major changes demonstrates an improvement compared to the standard neurological record.

Group Two

The next two sets of data provide information about the earliest changes with the different definition of a major change for the standard neurological record. A major change in the standard neurological record was defined for this group as a two-point change on the scale. A major change in the stroke scale remained the same, being two

points with the exception of limb function and language. Limb function and language required a one-point change to be defined as a major change. Table 34 provides a summary of the earliest detected changes comparing the two assessment scales in accordance of presence or absence of vasopasm. This table includes the untestable observations and considered them as a major or two-point change in either scale. There was no significant difference between the scales in relation to the absence or presence of vasopasm.

Table 34

Summary of the earliest detected major changes comparing the standard neurological tool to the stroke scale according to absence or presence of vasospasm including untestable items.

Definitions: Standard neurological tool major change is 2 point.

First major changes	Non-vasospasm	Vasospasm
Standard neurological scale first	2	0
Stroke scale first	10	13
Both scales concurrent changes	0	2
No major changes	3	0
Sum	15	15

- p values non-significant between non-vasospasm and vasospasm groups

Table 35 contains a summary of the earliest detected changes by comparing the two assessment tools in the absence or presence of vasospasm excluding the items deemed untestable. This now defines the untestable items as a minor change or a one-point change on either scale. There is no significant difference between either scale in relation to absence and presence of vasospasm.

Table 35

Summary of the earliest detected major changes comparing the standard neurological tool to the stroke scale according to absence or presence of vasospasm

Definitions: Standard neurological tool major change is 2 point.

First major changes	**Non-vasospasm**	**Vasospasm**
Standard neurological scale first	2	1
Stroke scale first	7	10
Both scales concurrent changes	1	3
No major changes	5	1
Sum	15	15

* p values non-significant between non-vasospasm and vasospasm groups

The results suggest that the stroke scale determined the earliest major changes prior to the standard neurological record regardless of the outcome of vasospasm. The untestable items when considered as a minor or one-point change alter the results of the tools and the earliest major detection. The unknown reason for the items being untestable, and the high frequency of these within the stroke scale requires further discussion. The standard neurological record in group A detected slightly more early major changes than in group B. It can be suggested that when a change in the motor strength of one point of the standard neurological record is clinically relevant and will be discussed in more depth.

Day Three Analysis

A retrospective analysis was completed for the data of all the patients prior to day three post-rupture of the aneurysm. This was done to enhance the information regarding the early detection of major change in neurological status. The third day was chosen as the cut off point for analyzing data because it is the third day that represents the beginning of the peak time frame for vasospasm to occur. The data provided no additional information and therefore was not included in the results.

Early Major Changes Detected by Categories

As mentioned previously, it was relevant to consider what categories in each of the assessment scales demonstrates a significant change. The issue of which category detected the earliest major changes for both assessment tools was analyzed using a retrospective analysis. A documented major change in both assessment scales required clear definition in order to compare the results of early detection in the categories. The data were organized into two groups and defined as follows:

1) A major change in the standard neurological record constitutes a change of two points except for limb strength. A major change for each limb is defined as a one-point change within that category.
2) A major change in the standard neurological record is defined as a two- point change with no exceptions.

The defining characteristics of the stroke scales remain the same as in the previous data. Therefore a two-point change in the stroke scale is a major change, except for each limb function and language that requires a one-point change to be considered a major change. Based on the previous findings in table 30-35 the researcher has compared the categories

of the two assessment tools excluding the data where nurses documented the inability to assess the patient. This meant that observations documented by the nurses' as untestable were considered to be minor changes and were not a factor in the earliest major change detected.

Group One

Table 36 summarizes the frequency of the specific categories that detected early changes for both scales based on the presence or absence of vasospasm. There was no significant difference with the categories for both tools in relationship to the absence or presence of vasospasm.

Table 36

Summary of each category that demonstrated the earliest detected major changes for both scales according to the absence or presence of vasospasm.		
Definitions: Standard neurological tool major change is 2 points with the exception of limb strength. A major change in limb strength is a one-point change.		
Scale and category with first major change	**Non-vasospasm**	**Vasospasm**
Standard neurological record		
Eye opening	1	0
Right arm strength	1	1
Left arm strength	1	1
Right leg strength	1	1
Left leg strength	0	2
Sum	4	5
Stroke scale		
Level of consciousness questions	2	0
Motor arm function right	2	1
Motor arm function left	2	1
Motor leg function right	0	1
Motor leg function left	0	2
Ataxia leg right	0	1
Sensory	0	1
Language	0	1
Sum	6	8

* p values non-significant between non-vasospasm and vasospasm groups

Group Two

Table 37 indicates the summary of the earliest major changes detected in the specific categories for both scales. There was no significant difference amongst the categories for both scales in relation to the absence or presence of vasospasm.

Table 37

Summary of each category that demonstrated the earliest detected major changes for both scales according to the absence or presence of vasospasm.		
Definitions: Standard neurological tool major change is 2 point.		
Scale and category with first major change	**Non-vasospasm**	**Vasospasm**
Standard neurological record		
Eye opening	1	0
Right arm strength	1	0
Left arm strength	1	0
Left leg strength	0	1
Sum	3	1
Stroke scale		
Level of consciousness questions	1	1
Motor arm function right	2	3
Motor arm function left	4	1
Motor leg function right	0	3
Motor leg function left	1	2
Ataxia leg right	0	1
Sensory	0	1
Language	1	2
Sum	9	14

- p values non significant between vasospasm and non-vasospasm groups

It is indicated that limb strength is a category that frequently demonstrates the earliest major detection for both scales. Analyzing the data with the two different definitions of a major change in limb strength of the standard neurological record has demonstrated a relevant change in the analysis. It can be suggested that major changes were detected more often in the neurological record compared to the stroke scale when the motor change of the neurological record is defined as one point. It can further be suggested that

defining a major change with the standard neurological record will require further discussion and analysis.

Summary of Quantitative Results

When the data were analyzed by comparing the groups of those who experienced vasospasm and those who did not, according to the measurement by two different scales, the standard neurological record and the stroke scale, the groups appeared relatively similar. The prospective quantitative analysis suggests that there are discrepancies amongst particular categories when the two assessment scales are compared. The data also indicates that patients frequently have minor neurological changes according to scores for both scales, and the qualitative analysis also indicates this general finding. The frequent observations recorded by nurses that they were unable to assess the patients, and the reasons for this require further investigation. The retrospective analysis suggests that the stroke scale tends to detect the earliest changes for vasospasm more frequently than the standard neurological tool. The retrospective analysis also suggests that the category of limb strength for both tools demonstrated a higher frequency of detecting major changes for vasospasm. Although the findings were not significantly different the issue of clinical relevance requires further investigation.

Qualitative Findings

Qualitative analysis was conducted to provide detailed information about the nurses' observations of patients during the time when detection of vasospasm is crucial. Nurses observe and monitor the patient 24 hours a day, and are in the key role to detect changes. The Nursing Model for Hospitalization Events clearly provides a framework that highlights the nursing process, and role while the patient requires continuous care during the acute phase of an illness such as a subarachnoid hemorrhage (Smith, 1998). At the hospital where all patients are admitted for treatment of this disease, the nurses conduct repeated assessments, as often as necessary, to observe the patients' neurological status. The nurses utilize the standard neurological record that primarily consists of the GCS for assessing patients' neurological status. This record has been compared to the stroke scale in the quantitative analysis.

The nurses also document observations about the patient in general and their neurological status, and write their observations in the progress notes. The nurses' chart in the progress notes using a format that includes subjective, objective, assessment, implementation, and evaluation data (SOAPIE). The nurse documents in areas of SOAPIE applicable to observations and care over the course of a given shift. Observations recorded by the nurse related to neurological function were analyzed using content analysis.

Several categories emerged from the analysis which were:

1) Close relationship to the standard neurological record
2) Close relationship to the stroke scale
3) Fluctuation versus stability

4) Non-specific changes in level of consciousness not included in either scale

The two assessment scales were also compared and analyzed through the qualitative data. Some of the sub-categories that arose from the category of close relationship to the standard neurological record were level of alertness, eye opening, verbal responses, and obeying, motor response, and pupil size and reaction. There were three sub-categories that emerged from the category of close relationship to the stroke scale and they were as follows: neglect, facial weakness, and visual deficit. The category of non-specific changes in level of consciousness contained observations that were not captured in either of the assessment tools. Three sub-categories were subsumed under this category were restlessness, impulsive, and unusual behavior. The findings of each category are discussed in detail.

Close Relationship to the Standard Neurological Record

Level of Alertness

Most of these nurses' observations are documented and fit into the main categories of the GCS. The nurses tend to chart frequently about the patients level of alertness. The observation about how alert or drowsy a patient is should be captured in the entire assessment of the GCS, however the nurses continue to chart on it frequently, so it became one of the categories requiring analysis.

There was in total 124 comments documented about the patients' level of alertness for the thirty patients entered in the study. The comments observed and documented by the nurses were organized into taxonomy to demonstrate some of the trends in reporting level of consciousness status as shown in Table 38.

Table 38

Observations of patients' level of consciousness in order of decreasing neurological status		
Nurses Documented	**Frequency**	**Percentage**
Alert	65	52%
Drowsy	9	7%
Drowsy but easily arousable	37	30%
Drowsy rouses spontaneously or to speech	2	2%
Description of deterioration in drowsiness	11	9%
Sum	124	100%

Data regarding the patients' level of alertness is normally obtainable by reviewing the patients' standard neurological record, and therefore documenting this general state of drowsiness is repetitive information. It is notable that the NIH scale has the first category as level of consciousness, and contains the descriptions in decreasing status as alert, drowsy, stuporous, coma. Given that the nurses have recorded this status for the study on the stroke scale, and have recorded the patient's status on the standard neurological tool, it becomes evident that documenting these observations in the progress notes is repetitive. It should also be noted that 52% of this documentation was observations that indicate the patient is alert, with no neurological decline. Of the thirty patients entered in the study, 24 of them were observed and documented as being drowsy at some point. Eleven of the 24 patients were determined to have vasospasm.

The documentation of four particular patients certainly provides a description of the patient who is worsening in their level of alertness.

> *Patient becoming increasingly drowsy throughout the day. Unable to maintain awake for crani check (neurological assessments).*

During checks patient seems harder to keep awake.

Patient appeared more drowsy, needed regular stimulation to keep awake.

Drowsy but rouses to repeated stimulation.

These descriptions provide information that is not captured in either the standard neurological record or the stroke scale. It is descriptions like this that give the clinician, either the nurse coming on for the next shift or the physician involved in the patient's care, valuable information about the patients' level of consciousness. It can be hypothesized that drowsiness plays a role in the diagnoses of symptomatic vasospasm.

Eye Opening

The next category is eye opening. This is the first main category in the GCS and indicates the ability of the patient to open his/her eyes spontaneously or to particular stimuli, and provides information about the patient's level of alertness. Overall, there was minimal documentation regarding this category as it occurred only 22 times throughout the study. Although (17/22) or 77% of the documentation noted abnormal findings, the same information was also noted in the neurological record and therefore is repetitive for the nurses to further document in the progress notes. The following provides examples of the nurses' observations that are documented in the patients' chart.

Eyes open spontaneously and to speech at times.

Eyes open spontaneously but at times pain is needed.

Nothing is added that is clinically relevant to the data gathered previously in the category of alertness using the standard neurological record.

Verbal Response

The patient's verbal response is the next category that is assessed when using the GCS as part of the neurological record. It provides description of the patient's verbal response with the best being oriented, and decreasing levels being confused, inappropriate, incomprehensible, and no verbal response at all. When nurses assess the patient for level of orientation they typically will ask the patient if they know their name, where they are and the current date. The documentation in the nurses progress notes tends to follow the format of the GCS.

The qualitative analysis revealed that nurses documented observations about the patients' verbal response 207 times. The NIH scale has a category called "level of consciousness questions" and requires the nurse ask the patient to state his/her age and the current month. There was no additional documentation related to the stroke scale in the progress notes by the nurses in this category. The data found in the nurses' progress notes is indicated in Table 39.

Table 39

Observations of patients' verbal responses in order of decreasing neurological status		
Documented Orientation	**Frequency**	**Percentage**
Fully oriented	98	47%
Oriented to three spheres except not to exact date	22	11%
Oriented to name and place at best, with detailed descriptions	46	22%
Confused	28	14%
Inappropriate	13	6%
Sum	207	100%

The section where the nurse has documented that the patient is oriented to name and place at best, is describing someone who is confused by the standard of the GCS. This category was added, however, because the nurses provide detailed descriptions about

what the patient is exactly oriented to and may not be captured in the GCS. The category that indicates the patient is confused contains the frequency of the times the nurse wrote 'confused' without any further description. The data demonstrates that 88% of the time the nurse documents observations in the progress notes, it is information already contained in the neurological record, the GCS and is repetitive. Trends in the patients' status was documented it in the following manner:

Oriented at times to one sphere, and to three spheres at others.

Intermittent confusion.

Inappropriate and confused during conversation at times. Oriented to two spheres last crani-check" (neurological assessment).

Oriented to three spheres, or to name, city, month, year. See crani-sheet (standard neurological record). General conversation with family inappropriate and confused at times.

Of the patients who remained fully oriented throughout the study, 5 out of those 6 patients did not experience vasospasm. The remaining 24 patients evidenced a fluctuation between being oriented and confused and/or inappropriate and 15 of these patients experienced vasospasm. It can be hypothesized that the patients' decrease in ability of remains fully oriented plays a role in the detection of symptomatic vasospasm.

Motor Response

The motor response is the next category that makes up the GCS. This category consists of the following components in the GCS: obeying, localizing, flexion withdrawal, flexion-abnormal, extension-abnormal. It should be noted that nurses tend to document most frequently the patients' ability to obey, the best level of motor response score on the GCS scale, and this indicates a normal response. Table 40 demonstrates the frequency that the nurses documented this observation in the nurses' notes.

Table 40

Observations of patients' ability to obey in order of decreasing neurological status		
Documentation	**Frequency**	**Percentage**
Obeys	66	89%
Does not obey fully	8	11%
Sum	74	100%

The data about the patients' ability to obey in the nurses' notes is clearly repetitive documentation. Some of the abnormal findings that were captured in the nurses' notes were as follows:

Obey most of the time but occasionally doesn't.

Obeys simple commands but not more detailed.

Obeys most of the time with continuous stimulation.

This documentation indicates abnormal responses that may fluctuate throughout the nurse's shift. It is relevant to remember the nurse is the one who assesses the patient on an ongoing basis, and trends in status are important for the nurse to observe in order to consider clinical significance. Of the 4 patients who were documented as being unable to obey commands 3 experienced clinical vasospasm. It can be hypothesized that the patient's inability to obey commands may play a role in the detection of symptomatic vasospasm.

The area of motor movement was analyzed by the participants' ability to obey, but the entire spectrum of motor strength must also be considered. The GCS essentially captures the best motor response, but does not assess the bilateral limb strength of the patient. This area has been added to the GCS and is part of the standard neurological record that is

used at this particular hospital. The frequency of the nurses' observation and documentation of the patients' strength is indicated in Table 41.

Table 41

Observations of motor strength documented in order of deteriorating level of function		
Motor Strength Documentation	**Frequency**	**Percentage**
Normal motor strength	235	77%
Abnormal motor strength	70	23%
Sum	305	100%

The nurses documented 77% of the time when the participant's response was normal.

Moves all limbs strong.

Moves all limbs strong & equal.

This documentation is contained within the standard neurological record and is repetitive for the nurses to be documenting in the progress notes. It is relevant to note trends in motor power function when assessing for clinical signs of vasospasm, which are indicated in these three examples in different patients.

Patient found with right side weakness and slight dysphasia which only lasts for a few minutes, patient presently has right drift.

Neurologically intact overnight except for left arm drift and right mild facial droop at 0400. At 0430 neuro check patient alert and oriented, moves all limbs well, strong and equal. No drift. No focal weakness.

Slight left arm drift noted at 0200 hrs.

These comments demonstrate evidence that the participant had a fluctuation in motor strength. These comments reflect patients who had a decrease in motor power by noting a limb drift. This assessment and documentation is not required within the standard neurological record. Of the 7 patients who demonstrated a fluctuation in motor strength 6

of them were diagnosed with clinical vasospasm. Of these six patients who experienced clinical vasospasm the nurses documented either a leg or arm drift in five of the patients. The sixth patient had a one-sided limb weakness, however a drift was not documented. It can be hypothesized that the observation of a limb drift in a patient plays a major role in the diagnoses of symptomatic vasospasm.

In the stroke scale the category that assesses the strength or motor power of the limbs requires that a drift be assessed and documented regarding its absence or presence. It is the nurses' usual practice, however, to document in the nurses progress notes following the format of the standard neurological record. It can be suggested that given the major role that a limb drift plays in the diagnoses of clinical vasospasm that this category of motor power assessment in the stroke scale be incorporated into the standard neurological record.

Pupil Size and Reaction

The next category that will be discussed is that of pupil size and reaction. The standard neurological record requires thorough assessment of the patient's pupil size and reaction to light. The nurses documented in the progress frequently about this assessment. The documentation follows the template of the standard neurological record.

Table 42 demonstrates the frequency of the findings of pupil size and reaction to light.

Table 42

Observed pupil size and reaction by order of decline in status		
Pupil Size and Reaction	**Frequency**	**Percentage**
Normal function	82	83%
Abnormal function	17	17%
Sum	99	100%

The nurses' documentation regarding normal pupil size and reaction was extremely high at 83%. One common example would be:

Pupils equal reacting to light, 3 mm and brisk.

This information is precisely the same as what is found in the standard neurological assessment tool. When nurses document this in the progress notes it is repetitive and not necessary. The documentation regarding deficits in this category indicated a stable deficit and did not indicate fluctuation. The documentation found regarding deficits was from two patients who experienced these deficits for a reason other than vasospasm. It can be hypothesized that pupil size and reaction does not play a role in the detection of symptomatic vasospasm.

Close Relationship to the Stroke Scale

Neglect

A subgroup of the participants entered the study with an existing motor weakness or deficit. Of these six patients, five of the patients did not experience vasospasm. One of the exclusion criteria for the study stipulated that the participant was not currently in clinical vasospasm, therefore the existing limb weakness was attributed to other causes such as a deficit from the initial subarchnoid bleed, or from an intra-operative complication such as stroke or rebleed. Of the 5 patients who had an initial deficit with limb motor power and no vasospasm, 4 also had a documented neglect.

Neglect is not part of the standard neurological record, however it is one category in the stroke scale and during the study the nurses were required to assess it. Neglect is observed in patients who ignore or do not pay attention to one side of their body when they receive stimulation that is visual, tactile, auditory. Neglect can also be observed

among patients' who completely ignore one half of their body, and behave as if it doesn't belong to them.

In the qualitative data the nurses documented six times about the presence of neglect demonstrated by the patient. Some examples of this documentation are as follows.

Right side stronger than left- query left side neglect.

Profound left side weakness/ neglect.

It is relevant to note that the nurses never documented in this category if the patient was normal, or had no deficits. This demonstrated that 100% of the time the observations were documented were that of abnormal findings. There were five patients who were observed as demonstrating neglect and none of those patients experienced vasospasm. It can be hypothesized that neglect does not contribute to the diagnoses of symptomatic vasospasm.

Facial Movement

The ability to move the face in a symmetrical fashion was also commented on in the qualitative data. Table 43 demonstrates the summary of facial weakness indicated through the qualitative analysis.

Table 43

Comparison of facial weakness observed at the onset of the patients entering the study to those who developed a weakness during the study			
Facial movement	**Total number of patients**	**Vasospasm**	**No Vasospasm**
Facial weakness exist at the onset	4	2	2
Facial weakness developed	2	1	1

The detection of a facial weakness is not part of the standard neurological record,

however it has been noted and documented by the nurses. The stroke scale does have a component to assess for a facial weakness. Nurses were found during the study to comment on a weakness of the eyebrow that was attributed to the ptereonal nerve being affected intra-operatively. Therefore any documentation that stated the patient had a weakness with the eyebrow or stated 'slight weakness' was not included in the analysis. The two patients who upon entering the study had intact facial movement and developed a deficit, had clear documentation from the nurse regarding weakness of the lower face.

...some facial palsy noted with L side ie. Showing teeth, slight weakness to mouth.

...mild R facial droop to r eye and cheek..

Given the limited qualitative data available it is not possible to hypothesize the role of facial weakness in detecting clinical vasospasm.

Extraocular Movements

The nurses observed deficits in extraocular movements and documented this in the progress notes 7 times. The nurses did not document normal findings about extraocular movements in the progress notes. Of the three patients who were found to have a deficit with extraocular movements 1 of these patients experienced clinical vasospasm. The assessment of extraocular movements is not part of the standard neurological record, however it is a category in the stroke scales requires assessment. With the data available in the qualitative analysis no hypothesis can be made regarding abnormal extraocular movements and the role in detecting clinical vasospasm.

Visual Deficit

The standard neurological record requires the assessment of pupil size and reaction to light, however there is no requirement for the assessment of the patient's ability to see in all visual fields. The stroke scale does require this assessment be conducted and documented by the nurse. In the nurses' progress notes the presence of a deficit was documented on two patients for a total frequency of 6 notations. There was no documentation in the progress notes that indicated the patients' findings as normal. For this category the documentation that occurred in the nurses notes was 100% related to abnormal observations. Two patients who were commented to have a deficit in this category both were found to experience vasospasm. It can be hypothesized that a visual deficit plays a role in the detection of symptomatic vasospasm.

Fluctuation versus Stability

One general category became evident through the content analysis, was the trend in neurological status and was noted as fluctuating or unchanged. The nurses' documented the patients' status as being unchanged or stable 91 times, and fluctuating 14 times. Patients could have documentation throughout the study of being stable at one point and fluctuating at another. It is important to understand the documentation by the nurse may be in the context of the one shift the nurse is working and assessing the patient. These comments do not provide a view of the patient outside the particular nurse's shift, and whether the patient is stable or fluctuating from the day before, or compared to prior assessments. Examples include:

Neurostatus fluctuating over day.

Neurostatus fluctuating over night.

The nurses who are at the bedside for observations 24 hours each day, hold the responsibility to detect these changes in the patient, to lead to appropriate diagnoses and treatment of the patients' problem. Of the 6 patients who had fluctuation documented in the nurses progress notes, 4 were diagnosed with clinical vasospasm. It is also possible that patients in this study had changes or fluctuation in status, without the nurses using the exact term to document this. There is evidence of fluctuation in the nurses' notes in the categories eye opening, best verbal response, best motor response, and motor strength. At times when the nurses document the stability of the patient their note may summarize the neurological assessment as evidenced in this comment.

Vital signs and neurological signs stable, see neurological record for details.

It can be hypothesized that a fluctuation in neurological status plays a role in the detection of symptomatic vasospasm. It is clinically relevant that the nurses observe and document changes in the patients and provide a picture of the patients' status that may not be evident in the standard neurological tool.

Comparison of the Two Scales

The researcher thought it would be relevant to compare the standard neurological record to the stroke scale. When the documentation regarding a comparison of the two scales was analyzed one trend detected was the difficulty patients had in completing the required tasks needed for the stroke scale. The following examples indicate the nurses' documentation for the five patients who experienced this problem.

Difficult to complete NIH assessment d/t poor participation.

More alert today, participating more today with stroke study.

Neurologically no change. ...Cooperative on occasion with NIH stroke study-see crani sheet (standard neurological record) for details.

Participating in stroke study with some reluctance.

Continues to refuse at times to participate in NIH study.

The documentation never reflected the observation that the patients were unable to participate with the standard neurological record. It should be noted that the investigator was never approached about a situation where the patient or family member no longer wished to participate in the study.

The second trend that occurred when analyzing the comparison of the two scales was the documentation noting neurological changes associated with the stroke scale, but not with the standard neurological record.

At night patient obeying commands during stroke scale assessment however quite drowsy, at 0200 assessment not following commands. GCS remained much the same.

...left arm drift and left side weakness...received 250 cc Pentaspan and improvement noted in left sided arm and leg weakness-no left arm drift and no let leg ataxia noted, motor strength left leg improved, ie. No drift for 5 seconds,only left facial droop noted at lips when asked to show teeth and smile. Left-sided neglect noted when asked to squeeze both hands at same time.

Drowsy earlier today however more awake and co-op this evening...inconsistencies noted with certain aspects of stroke scale assessment-please refer to sheet.

...fluctuated earlier in shift...earlier in am stroke scale showed deterioration compared to previous shift. See NIH stroke scale. Patient improved over course of the day.

...on NIH study unable to think of name for object 'Hammock" otherwise unchanged.

Of these 5 patients that had changes documented in the progress notes the stroke scale appears to detect clinical vasospasm prior to the standard neurological record. It is clinically relevant that with additional assessment using the stroke scale, three patients had symptoms detected earlier that would have been the case if only the standard

neurological record was used. Subsequently these three patients were diagnosed with clinical vasospasm. These results require further investigation and will be analyzed in the quantitative analysis.

On one occasion, documentation by the nurse indicated the neurological record showed changes, however no changes were reported for the stroke scales as indicated here:

NIH scale shows no deficits. GCS 13-15.

The scales for this particular patient were reviewed and the patient actually demonstrated changes in alertness in both scales at the same time according to the scales. In this instance information in the nurses' progress notes and that noted in the scales appeared to be contradictory.

Non-Specific Changes in Level of Consciousness Not Included in Either Scale

The final category that became evident during content analysis were comments in the nurses' progress notes that were not addressed in either the standard neurological record or the stroke scale. In Table 44 a summary is provided to demonstrate the thirteen patients who were observed to have non-specific changes that were not included in the neurological record or the stroke scale. The table summarizes the patients' behavior into three groups: restless, impulsive and unusual. These behaviors are be discussed in detail. The table indicates which patients experienced clinical vasospasm and what their GCS was for the shift leading up to the nurses' documentation. The nurses progress notes can be written as a shift summary, or can be written to document an event. Therefore it was determined necessary to review the GCS scores from the quantitative data to provide a picture of the GCS for the shift the nurse was caring for the patient.

Table 44

A summary of patients' observed to have non-specific changes not included in the standard neurological record or the stroke scale and in order of presentation in the study					
Patient Order	**Restless**	**Impulsive**	**Unusual**	**GCS score**	**Vasospasm (+ = yes, - = no)**
1		√		14-15	-
2	√	√		14	+
3		√		14-15	+
4	√			13	+
5	√			14	-
6	√			13	+
7	√			13	-
8			√	15	+
9	√			14	-
10			√	15	+
11	√		√	13	+
12	√		√	14	+
13			√	13-14	+
n= 13	n=8	n=3	n=5		+ n=9 - n=4

Thirteen patients out of thirty demonstrated non-specific observations that were not included in either the neurological record or the stroke scales. Of these thirteen patients nine experienced clinical vasospasm. Of these nine patients two demonstrated non-specific changes and continued to score 15 on the neurological record. The remaining patients showed non-specific changes in level of consciousness and a decrease in level of consciousness on the standard neurological record. According to the nurses notes the patients who demonstrated non-specific changes received a diagnoses of clinical vasospasm ranging from approximately five hours to five days after the initial onset of

these symptoms. It can be hypothesized that these non-specific changes are relevant to the diagnoses of clinical vasospasm.

Restless

One trend depicted in the data was of patients' restlessness. Quotes from the notes are as follows:

+++ *restless*

Restlessness ↑noted when pt. requiring bathroom.

Increasingly restless & lethargic.

Becoming increasingly restless at times.

Restless at times.

In some situations the nurses documented their observations regarding the patients' state in more detail.

Patient confused, very little short-term memory. Patient pulled out nasogastric tube, trying to pull off oxygen and touching drains.

Patient drowsy – rouses to speech. Restless at times – requires arm restrain – attempting to remove arterial line and external ventricular drain. Poor memory. Doesn't know she had surgery. Unable to focus on stroke scale well...

In total eight of the thirty patients were observed as being restless in some form. Of those eight patients five patients were diagnosed with clinical vasospasm. It can be hypothesized that restlessness plays a role in the detection of symptomatic vasospasm. This is a clinically relevant finding particularly when one considers the fact that restlessness is not part of the standard neurological record which the nurses' use as the standard neurological assessment tool.

Unusual

The following notations are documentation of observations in five patients whose demonstrated unusual behavior that is not detected in either the neurological record or the stroke scale.

Pt. has been restless more of the night. Up & down all over...Confused to place, couldn't remember year, inappropriate, month & day were known. Asked if head hurts couldn't tell me. Just "I feel different" couldn't elaborate.

Oriented to three spheres...Inappropriate at times, pulled out intravenous stating 'there was a bumblebee in it'. NIH unremarkable. And later with the same patient: at 1300 husband approached nurse with concerns patient agitation and concerns re: patient accusing behavior. This is apparently out of character for this patient.

GCS = 15, but inappropriate and query euphoric at times.

Crani check basically unchanged. Patient's husband stated he found patient improved cognitively. Patient remains drowsy but rousable. Once awake – quite alert & talkative to family. During checks, patient seemed to be harder to keep awake. Noted to have occasional odd behavior ie. Spooning her milk while container lid still closed. Family stated no odd behavior. Pt. seemed to move abruptly when she is awake...

GCS = 15, remains inappropriate, picking at air, licking fingers- see crani sheet.

These five patients demonstrate unusual behavior that is detected by the nurses and documented in the progress notes. The common trend with these patients is that the behavior observed cannot fit neatly into a category of the neurological record or the stroke scales. Some of the patients are noted to be restless, others demonstrate a possible perceptual difficulty, and another is found to demonstrate an inappropriate feeling of euphoria. It is relevant to note that two of the five patients were assessed as having the best score on the GCS during the observation of unusual behavior while the other three patients demonstrated changes in the GCS. Of the thirty patients in the study 5 patients had observation of unusual behavior and each of these patients experienced clinical

vasospasm. It could be hypothesized that unusual behavior plays a role in the diagnoses of symptomatic vasospasm.

Impulsive

The following examples will illustrate further documentation of the nurses' observations that demonstrate impulsive behavior and are not captured in either assessment scale. The examples are:

> *Patient. is drowsy but easily arousable. O x 3, not exact date. Talking to family members. Tends to be impulsive at times.*
>
> *Restless at night, bolting out of bed with slight aggression. Posey jacket. Oriented to two spheres. GCS = 14...patient poor short term memory and inappropriate at times.*
>
> *Oriented to three spheres, not exact date. Impulsive behavior attempts to pull out IV, crawl over side rails etc. Patient continually reminded not to touch intravenous and that he requires assistance to get up...*

These patients demonstrate changes in the level of consciousness such as drowsiness, and behaviors of aggression and impulsiveness. The charts were reviewed for the two patients that were documented as being impulsive, and it was found that different nurses had provided each of these descriptions of the patients'. Of the thirty patients in the study three patients were observed as being impulsive. Two of these three patients were diagnosed with clinical vasospasm and one can hypothesize that the demonstration of impulsive behavior has a role in diagnosing symptomatic vasospasm.

One patient demonstrated under activity with behavior as the nurse's progress notes indicate:

> *Staring at ceiling...vague look, not talkative*

This patient demonstrated opposite behavior to those who were restless, or aggressive or impulsive. This patient demonstrated this behavior throughout the entire hospital stay. It

was believed to be his nature to be quiet, and detached. He did not experience clinical vasospasm.

Summary of Qualitative Analysis

This analysis of the qualitative data provides further insight into the patients' neurological condition. Table 45 represents a summary of the hypotheses that have been generated from the qualitative analysis. One aspect that emerged reinforcing this point is the observations by the nurses' of non-specific changes that were not addressed in the standard neurological record or the stroke scale. It is suggested that these changes may be relevant to the diagnoses of clinical vasospasm.

Table 45

Summary of hypotheses generated from the qualitative data	
1.	It can be hypothesized that drowsiness plays a role in the diagnoses of clinical vasospasm.
2.	It can be hypothesized that the patient's decrease in ability to remain fully oreinted plays a role in the detection of symptomatic vasospasm.
3.	It can be hypothesized that the patient's inability to obey may play a role in the detection of symptomatic vasospasm.
4.	It can be hypothesized the observation of a limb drift in a patient plays major role in the diagnoses of symptomatic vasospasm.
5.	It can be hypothesized that pupil size does not play a role in the detection of clinical vaospsasm.
6.	It can be hypothesized that neglect does not contribute to the diagnoses of symptomatic vasospasm.
7.	It can be hypothesized that neglect does not contribute to the diagnoses of symptomatic vasospasm.
8.	It can be hypothesized that a fluctuation in neurological status plays a role in the detection of symptomatic vasospasm.
9.	It can be hypothesized that restlessness plays a role in the detection of symptomatic vasospasm.
10.	It could be hypothesized that unusual behavior plays a role in the diagnoses of symptomatic vasospasm.
11.	One can hypothesize that the demonstration of impulsive behavior has a role in the diagnoses of symptomatic vasospasm.

When comparing the standard neurological record to the stroke scale, the observation of limb drift is suggested to be a key assessment for early detection of clinical vasospasm. Limb drift is a required assessment of the stroke scale and it can be suggested that this should be added to the standard neurological record and made part of the standard neurological assessment record. The themes of fluctuating level of consciousness, drowsiness, decreased level of orientation, and visual deficit all are suggested to be relevant in the diagnoses of clinical vasospasm.

It can be suggested that nurses' often replicate information unnecessarily as the observations documented in the progress notes are currently contained in the GCS, which is the standard assessment tool, and a permanent record of the chart. The information that is likely relevant to capture in the nurses' progress notes is in relation to trends in the patients' behavior or observations noted by the nurses'. It is suggested that nurses should avoid replication and allow them time to focus on documenting findings that demonstrate trends of deterioration or improvement in the patients' neurological status.

Discussion

Introduction

The Nursing Model of Hospitalization Events provides a framework to analyze patients who have experienced a subarachnoid hemorrhage (SAH) (Smith, 1998). Typically these patients are admitted with the sudden onset of the acute illness. For those who experience a SAH the need for 24 hour nursing and medical care is essential (Oropello et al. 1996). Smith clearly depicts the nursing role and process as being both collaborative and independent. Patients who experience a SAH are at risk for the complication of vasospasm. Haley, Kassell, and Torner found that three months following a subarachnoid hemorrhage that vasospasm was the primary cause of disability and death for 75% of the population (1993). The early detection of clinical symptoms of vasospasm is critical as it leads to prompt intervention (Armstrong, 1998). One key component to the nursing process is ongoing assessment, diagnoses, and evaluation of the nursing care that is provided (Smith). The acute phase of illness of a patient who has experienced a SAH and is at risk for vasospasm requires frequent repetitive neurological assessment (Hickey, 1997). Smith delineates the independent role of the nurse in observation and detection of symptoms. Smith also points out that nurses' need to understand the significance of their observations and report these to the physician. Warnell (1996) agrees that a key role for the nurse is to notice changes in neurological status of patients and notify the neurosurgeon. Once the neurosurgeon is aware of changes in the patient's status then further collaboration will occur as the patient is provided with ongoing medical and nursing interventions (Counsel, Gilbert, Snively, 1995). It is important to point out that while the medical care is altered it is the nursing

assessments that will monitor the effectiveness of the medical care that has been instituted (Mitchell & Gallucci, 1991).

It becomes evident that the independent nursing action of assessing the patient is a significant role in the care of patients who have experienced a SAH. Rusy (1996) comments that it is the ongoing assessment by the nurse that is required to detect changes of symptomatic vasospasm, however little in the literature can be found on what the neurological assessment should entail. The standard neurological assessment, which consists primarily of the GCS, was compared to the stroke scale to determine if the stroke scale would detect symptoms of vasospasm earlier than the standard neurological record. It is relevant for the nurses who conduct the key assessments on patients 24 hours a day that the assessments provide the optimal information regarding the patients status.

There were thirty patients entered into the study and of those thirty patients fifteen were subsequently diagnosed with symptomatic vasospasm. The quantitative analysis and the qualitative analysis were both conducted and results analyzed in relation to the absence or presence of vasospasm. Although there were no significant differences between the vasospasm and non-vasospasm groups, several results suggest clinical relevance.

Ullman & Bederson (1996) articulate that symptomatic vasospasm may be characterized by general changes in either level of consciousness or a focal deficit. The GCS or the standard neurological record typically focuses on the assessment of the brain as a whole (Jennett & Teasdale, 1977). The stroke scale was designed to provide a valid assessment and ensure localization of functions would be detected in using the scale (Brott, et al, 1989). The results will be discussed with emphasis on focal and generalized

changes in neurological status.

The focal changes that are discussed include motor strength, verbal responses, language, facial movement, neglect, pupil size and reaction, extraocular movements. The generalized responses that will be further analyzed are level of alertness, best verbal response, best motor response, trends in fluctuation or stability of neurological status and the non-specific changes in neurological status that were not found in either the standard neurological record or the stroke scale.

In general, results were found to have clinical implications regarding the nurses' observations and documentation. It became evident that nurses at several times were unable to assess the patients and documented the items or categories as untestable. It was also found that the nurses frequently duplicated documentation on the standard neurological record and in the nurses' notes. The researcher felt it was an important nursing issue therefore it was analyzed and the categories of duplication of documentation and observations of untestable items will be discussed.

The main hypothesis:

"Patients experiencing symptomatic vasospasm will have changes in neurologic status detected earlier when nurses use a stroke assessment tool compared to the standard neurological assessment protocol"

was rejected since no statistically significant differences existed between the non-vasospasm and vasospasm groups. The retrospective quantitative analyses combined with the qualitative data are discussed in order to address the comparison of the two scales for early detection of symptomatic vasospasm. Several clinically relevant issues related to the findings will be discussed and implications for nursing will be highlighted.

Suggestions for future nursing research will also be provided.

Discussion of Focal Findings

The main components that will be discussed in the focal findings are the motor strength and function, verbal response, language, facial movement, visual deficit, pupil size and reaction, and extraocular movements. The repetitive documentation of the focal findings will also be addressed.

Motor Strength and Function

The standard neurological tool assessed limb strength using a range of strong, moderate, and weak and abnormal posturing, no response and flaccid or spastic. The stroke scale defines the difference in each limb function, as being no drift, drift, can't resist gravity, no effort against gravity, and no movement.

The prospective review of the standard neurological record and the stroke scale included analysis of the maximum score, minimum score, maximum positive and negative change, and range of each limb strength and showed no significant difference between the non-vasospasm and vasospasm groups. The qualitative data demonstrated that 7 patients had a fluctuation in motor strength. Of the 15 patients who experienced vasospasm, 6 patients demonstrated a fluctuating motor deficit according to the nurses progress notes. Of those 6 patients the nurse documented either an arm or leg drift in 5 of the 6 patients. The sixth patient was recorded as having an arm and leg weakness however no drift was documented in the nurses' notes. The observation of a limb drift was a clinically relevant finding in the detection of clinical vasospasm (Campbell & Edwards, 1997).

The standard neurological record requires the nurse to determine if the patients limb is

strong, moderate, or weak. These descriptions of limb strength are vague and can offer various interpretations to each clinician. The standard neurological record does not require the nurse to assess a limb drift. At times the nurse may indicate a drift on this record, however if the nurse does not document the presence of a drift, it remains unknown if the assessment has been conducted. The descriptions of limb function provided by the stroke scale offer clear guidelines to document the patients' strength, and include the required assessment of a limb drift. Based on these differences in the scales, and the results of the qualitative analysis it was deemed essential to compare these two categories to determine the consistency of the assessments documented.

A prospective analysis was completed to review limb strength and can be found in Tables 26 - 29. When reviewing the data for the right arm strength, there were 33 observations of a limb drift being present on the stroke scale. Of those 33 observations for the right arm, there were 11 concurrent observations documented as moderate strength and 22 documented were strong according to the neurological record. A similar finding occurred in relation to left arm strength. There were 39 observations recorded in the stroke scale that indicated the patient to have a left arm drift. Of those 39 observations for the left arm strength, 19 observations were documented as moderate, and 20 were documented as strong according to the neurological record. The discrepancy in these findings is a concern when the qualitative data suggests the importance of detecting a limb drift in relation to clinical vasospasm. Bader, Watson, and Skillman (1997) highlight that a focal weakness may occur in the arm or leg and is dependent on which cerebral vessel is involved in vasospasm.

When reviewing the data for leg strength and function similar results were found.

There were 14 observations from the stroke scale detecting a right leg drift. Of those 14 observations, there was concurrent documentation in the standard neurological record that scored the right leg as being weak 1 time, moderate 11 times, and strong 3 times. The left leg observations in the stroke scale demonstrated a leg drift 37 times. When compared to the neurological record, the concurrent observations recorded were weak 6 times, moderate 9 times, and strong 22 times.

There are times for each of the limb function assessments where the patient was observed to be weak according to the standard neurological record and was documented as no drift in the stroke scale. The reasons for the discrepancies are unknown however may require further investigation.

The stroke scale requires a specific assessment to be conducted on the patient. It includes arm and leg drift as an essential part of the assessment of limb strength. The stroke scale also includes specific guidelines for scoring the patients limb strength. The definitions and scoring are:

- No drift: no drift
- Drift: limb holds but drifts down before full time count, does not hit bed or other support
- Some effort against gravity: limb cannot get to or maintain limb, drifts down to bed, but has some effort against gravity
- No effort against gravity: limb falls
- No movement: no movement

For each of the individual limb strength assessments there are discrepancies that exist. Of key importance are the discrepancies that occur when the patient has been observed to

have a limb drift. Campbell and Bell (1997) state the finding of a limb drift is significant in detecting of vasospasm, and is necessary for the nurse to observe. It can be suggested that the standard neurological record should have the terms strong, moderate and weak to be replaced with terms that are more descriptive and less vague. The terms drift and no drift at minimum should be added to the standard neurological record. The framework provided by Smith's (1998) highlights the importance of the nurses' independent role of assessing the patient and bringing significant results to the physician's attention. It is relevant that the nurses provide a clear description of the patients' neurological findings when considering the diagnoses of symptomatic vasospasm. Table 46 reflects the existing motor assessment in the standard neurological record, and recommended changes.

Table 46

Demonstration of existing descriptions in the standard neurological record and recommended changes.	
Existing Descriptions	**Recommended Changes**
Arms	**Arms**
Strong	No Drift
Moderate	Drift
Weak	Can't resist gravity
	No effort against gravity
Flexion-Abnormal	Flexion-Abnormal
Extension-Abnormal	Extension-Abnormal
No Response & Spastic	No Response & Spastic
No Response & Flaccid	No Response & Flaccid
Legs	**Legs**
Strong	No Drift
Moderate	Drift
Weak	Can't resist gravity
	No effort against gravity
Extension	Extension
No Response & Spastic	No Response & Spastic
No Response & Flaccid	No Response & Flaccid

Verbal Response/ Language

The presence of a dysphasia, or difficulty with language has been noted in the literature to be one of the findings related to symptomatic vasospasm (Kongable, 1996). The standard neurological record requires the best verbal response to be assessed and documented and is more reflective of a generalized change in neurological status. The stroke scale does incorporate the focal assessment of the presence or absence of dysphasia and requires the nurse to conduct the assessment.

The prospective analysis of the category language in the stroke scale demonstrated no significant statistical difference between the vasospasm and non-vasospasm groups. Robinson (1992) highlighted the problems that have arisen when recording the observations of best verbal response from the GCS. Robinson pointed out that patients could be fully oriented, however, may experience dysphasia or be intubated and therefore would have no verbal response. A comparison between the best verbal response and language was completed in the prospective analysis. There were 18 observations that indicated the patient was mute according to the stroke scale, and was fully oriented according to the standard neurological assessment record. One could speculate that these patients were able to respond to orientation questions by nodding or writing the appropriate responses. This discrepancy highlights one of the problems known to exist with the standard neurological record. There were 35 observations of patients noted to have mild to moderate dysphasia, and 11 observations that indicated a severe dysphasia. Those observations were concurrently documented on the standard neurological record as observations of confusion. Based on this information it is unknown if the patient is dysphasic, or confused or both. Again, in terms of providing a detailed focal assessment

tool, the standard neurological record lacks in this perspective.

In the retrospective analysis the category of language detected an early major change for one patient who experienced vasospasm (refer to Table 35). Given the lack of significance in the results in this category, a change in the standard neurological scale cannot be suggested, however, the issue should be further analyzed to provide significant data. As mentioned by Bader et al (1997) those who experienced an aneurysm of the left middle cerebral artery may experience dysphasia during vasospasm because this vessel supplies blood to the area of the brain that controls speech.

Facial Movement

Both the quantitative and qualitative data analysis provides no significant difference between the non-vasospasm and vasospasm groups. The quantitative analysis was hindered by the invalid assessments that occurred in this category. There was repeated evidence that the nurses were scoring a weakness of a patient's eyebrow as a minor facial weakness. The weakness was commonly attributed the ptereonal nerve being affected during the operative procedure (Greenberg, 1997). During the observation period the reason for the weakness around the eyebrow was explained to the nurses by the medical staff. However, the researcher did not want to correct the nurses' documentation of the stroke scale during the observation period in order to prevent bias of results occurring. The onset of this weakness of the eyebrow required no additional nursing or medical care, and therefore the researcher determined the patient to be safe and did not intrude in this component of the assessment. This area should be investigated further as Ullman and Bederson (1996) comment on the need to observe for the onset of new focal deficits related to the vessels involved, which can lead to facial paresis or weakness.

In order for the nurses to benefit and learn from participating in this project the researcher will endeavor to make the following information available to the nurses. First the nurses need to be aware of the results of this category, including the definitions for each of the levels of facial weakness that exists in the stroke scale. Second, the researcher will develop a poster for the nurses on the unit with the following information:

- Clinical assessment of facial nerve strength.
- Anatomical correlates related to upper and lower motor facial nerve palsies.
- The anatomical role of the ptereonal nerve intra-operatively, and its clinical findings.

This poster could be left on the unit as a resource for nurses and can be used when the clinical issue arises, and the learning requires reinforcement.

Neglect

Neglect is a category that is contained within the stroke scale, and is not a component of the standard neurological record. In the prospective quantitative analysis the category of neglect demonstrated no significant statistical difference between the non-vasospasm and vasospasm group.

In the retrospective analysis the category of neglect was never demonstrated to detect an early major change in relation to the absence or presence of vasospasm. A sensory deficit was found in one patient as detecting an early major change in relationship to vasopsasm. Sensory changes or deficits are one of the criteria for neglect. The qualitative analysis showed in the nurses' progress notes there were five patients who demonstrated a neglect, and none of these patients experienced vasospasm. Based on this information it can be hypothesized that neglect contributes little to early detection of clinical vasospasm. Bader et al (1997) state that neglect can be one of the focal symptoms of

vasospasm, however, many authors do not cite neglect specifically as a symptom of vasospasm (Baker & Heros, 1990, Campbell & Edwards, 1997, & Flynn, 1989).

It is relevant to note that in the nurses' progress notes, the documentation regarding neglect was recorded as abnormal 100% of the time. The qualitative analysis shows that the nurses did not record observations of neglect if the patient was assessed as having no deficit in this area. It is usual practice for the nurses to document neglect in the progress notes if it has been detected. It is unknown if the nurses' were recording the observation of neglect because the assessment to detect neglect is required by the stroke scale. The unanswered question is, "Will the deficit of neglect always be detected without the prompt for the assessment existent on an assessment tool?" This would require further investigation to answer.

In general, it is significant that nurses remain astute and detect symptoms of neglect in their patients. The assessment of patients lends to proper nursing care and assistance that patients require (Smith, 1998). In order for nurses to assist the patient in activities of daily living, the presence of neglect must be identified and incorporated into the care provided.

Visual Deficit

A visual deficit is not a required assessment for the standard neurological record, however, it is a specific category contained within the stroke scale assessment. In the both the prospective and retrospective quantitative analysis a visual deficit demonstrated no significant statistical difference between the non-vasospasm and vasospasm groups. The literature commonly refers to focal changes occurring during vasospasm however Baderet al (1997) referred specifically to a one-sided visual field deficit that can occur.

The qualitative analysis demonstrated that the nurses did not document in the progress notes when the patient was observed to have no deficit. There were six notations in total regarding visual deficits. This represents a small portion of documentation noted in the nurses' progress notes.

The data do not support adding this as a category to the standard neurological assessment record. However, it is relevant that nurses detect these changes and assist the patient who will be adjusting to a change in their usual functioning. The needs of the patient are determined by the assessment conducted by the nurse, and plans of care that are collaborative between the nurse and the physician (Smith, 1998).

Pupil Size and Reaction

Pupil size and reaction is a component of the standard neurological record. It is a key assessment required when patients are assessed with the primary concern of increased intracranial pressure (Hickey, 1997). For patients who are at risk for vasospasm the physiology that is of importance indicates a lack of blood flow to particular areas of the brain, instead of a global increase in pressure of the intracranial components (Ullman & Bederson, 1996). Hence, pupil size and reaction was not analyzed in relation to the absence or presence of vasospasm.

Two of the thirty patients were documented in the qualitative analysis to have deficit in this area. Both patients exhibited a deficit that was stable, and was caused by reasons other than vasospasm. It is, however, important to maintain this assessment and documentation on the standard neurological record for patients being observed for the potential of increase in intra-cranial pressure.

Extraocular Movement

The observation of extraocular movements is a category in the stroke scale and is not part of the standard neurological findings. Hickey (1997) stated that cranial nerve deficits, such as extraocular movement could be a focal finding related to vasospasm. The prospective analysis demonstrated no significant difference between the non-vasospasm and vasospasm groups. The retrospective analysis showed that this function was not a factor in detecting early major changes. The qualitative data also demonstrated that three patients had a deficit in this area and of those three only one patient experienced vasospasm. It can be hypothesized that the ability for the patient to move their eyes in all directions does not play a key role in the detection of vasospasm. Further investigation would be required to conclude this hypothesis with confidence.

Repetitive Documentation Regarding Focal Findings

Within the observations of focal findings repetitive documentation occurred in the areas of pupil size and reaction, neglect, facial weakness, extraocular movements, and visual field deficit. These categories are primarily from the stroke scale which is anticipated because the stroke scale is developed to detect more focal findings that the standard neurological record (Brott et al, 1989, & Jennett & Teasdale, 1977). The nurses never commented on any category of the stroke scale in the progress notes if it was normal. One could speculate that the nurses did not document as much with the stroke scale as because it was viewed as a research tool and not part of the essential assessments required for the patients.

It will be important for nurses to understand there is little relevance in documenting observations that are not currently recorded in the assessment tool that is being used.

Discussion of Generalized Findings

The components of the generalized findings that are discussed are level of alertness, best verbal response, best motor response, fluctuation versus stability in neurological status, and non-specific changes in neurological status. The issue of repetitive documentation will also be addressed regarding the generalized findings.

Level of Alertness

Patients who experience vasospasm may exhibit a generalized decrease in neurological function (Ullman & Bederson, 1996). The degree of alertness was analyzed in the from the nurses' progress notes. Of the thirty patients entered in the study, 24 of those patients were documented as being drowsy at some point during the observation period, and 11 of the 24 patients were found to experience vasospasm. In the prospective analysis the category level of consciousness of the stroke scale demonstrated no significant statistical difference between the non-vasospasm and the vasospasm groups. In the retrospective analysis the level of consciousness category of the stroke scale was not found to detect any early major changes.

The GCS has three main categories that are eye opening, best verbal response, and best motor response. All three categories are assessed to determine the patients overall level of consciousness (Jennett & Teasdale, 1977). The standard neurological tool consists primarily of the GCS. Eye opening was analyzed prospectively and demonstrated no significant difference between the non-vasospasm and the vasospasm groups. In the retrospective analysis eye opening was found to determine one early major change where the patient was less able to open the eyes, however the change was not associated with vasospasm.

It is relevant to point out that the documentation in the progress notes regarding eye opening seemed to be reflective of the patients' fluctuation in status. These recording in the progress notes provide slightly more detail than checking off the appropriate box in the standard neurological record. The fact that the patients ability to open their eyes is diminished at times suggests a fluctuation in status, and the fluctuation is where the nurses should focus their attention. Only when the patients' status remained stable would eye opening be captured adequately by the standard neurological record.

There are some similarities between the stroke scale category level in consciousness and the category of eye opening in the standard neurological record. The researcher felt a comparison of the two could provide additional information. One of the reasons the GCS was invented was to describe a patients level of consciousness by behaviors to avoid vague terms such as drowsy, stuporous, obtunded, comatose (Jennett & Teasdale, 1977). Many of the observations between the stroke scale and the GCS did coincide. However, there were 146 observations where the patients were drowsy according to the stroke scale, and opening eyes spontaneously according to the standard neurological record. There were also observations where the patients were recorded as being alert according to the stroke scale, and were documented along the entire continuum of eye opening of the GCS. The stroke scales provides the nurse with vague terms to apply to the patient, whereas the GCS gives detailed descriptions for the nurse to use to describe the patient. In this category the GCS provides clearer definitions for the evaluation of the patient. It is suggested that the addition of this category to the standard neurological record would be of no benefit.

Best Verbal Response

One of the three main categories in the GCS that provides a description of generalized level of consciousness is the best verbal response. When patients' experience generalized deficits in this area it is displayed as confusion or inappropriate verbal responses. Confusion and inappropriate responses have been described as symptoms of vasospasm (Barker & Heros, 1990, Flynn, 1989, & Bell & Kongable, 1996). The prospective data analysis demonstrated no significant difference between the non-vasospasm and the vasospasm groups in this response. The qualitative analysis showed that of the six patients' who remained fully oriented throughout the observation period, five of those patients did not experience vasospasm. The nurses described in detail what the patient was oriented to 22% of time in the progress notes. Twenty- four of the thirty patients demonstrated a fluctuating level of responses during the observation period, and fifteen of those patients experienced vasospasm. The nurses did not document any observations regarding the stroke scale in the progress notes. The retrospective analysis demonstrated that the level of consciousness questions detected an early major change for two patients (refer to Table 36) however neither of these two patients experienced vasospasm.

For the assessment of orientation in the standard neurological record it has been the nurses' usual practice to ask the patient what their name is, where are they, and what is the date. The stroke scale category of level of consciousness questions requires the nurse to ask the patient what the month is, and what his or her age is. These categories are similar and although neither demonstrated significant differences between the vasospasm and non-vasospasm groups the researcher thought a comparison between the two may provide additional information to the clinical picture of the patients. There were 7

observations noted when the patients answered both questions in the stroke scale correctly but were scored as no verbal response on the standard neurological record. There were also 13 observations recorded when the patient was fully oriented according to the standard neurological record and were found to answer both questions wrong on the stroke scale. The reason for these discrepancies cannot be explained without further investigation.

Kongable (1996) describes general changes in level of consciousness such as disorientation or confusion as a symptom of vasospasm. Disorientation is evidenced when the patient cannot answer all of the orientation questions required by either the standard neurological record or the stroke scale. Disorientation can occur for a variety of reasons, such as low serum sodium, hydrocephalus, medication related disorientation, or delirium. When a patient demonstrates confusion all factors must be considered and ruled out prior to accounting the change to vasospasm. The analysis of this category demonstrates the difficulties that exist in diagnosing patients with symptomatic vasospasm.

Best Motor Response

The third main category within the GCS as developed by Jennett and Teasdale (1977) is the best motor response. The three components of eye opening, best verbal response, and best motor response encompass the three main areas of assessment for generalized level of consciousness with the GCS. Jennett & Teasdale developed these descriptors to reduce vagueness and provide clarity for clinicians. The prospective analysis demonstrated there was no statistically significant difference between the vasospasm and non-vasospasm groups when assessing the best motor response. The retrospective

analysis demonstrated that the best motor response was not did not detect an early major change. This category did not demonstrate significant findings related to the detection of early vasospasm.

The category of the best motor response for the standard neurological record is similar to the category of level of consciousness commands in the stroke scale. When the patient is assessed using the stroke scale the patient must obey commands which are to open and close the eyes, and to grip and release the nurses' hands (Brott et al 1989). The standard neurological record has a spectrum of motor responses the nurse can use to score the patient. The best response is the patients who are able to obey. There is no information regarding what commands the nurse should request the patient to obey, however it is common to request the patient to squeeze the nurses' hands, raise their arms, or stick out their tongue. There is no standard offered to say how many commands the patient needs to follow in order to be documented as the best motor response. The researcher felt it would provide further information if these two categories were compared.

There were 671 observations recorded where the patient was scored at the best level for both scales. There were 49 observations noted when the patients were obeying one command for the stroke scale and 13 observations where the patient was not obeying either command, and yet the concurrent observations on the standard neurological record were documented as obeying. There is discrepancy between the observations when analyzed concurrently. The discrepancies may be due to the fact that the stroke scale provides exact information regarding the assessment and how the observations were to be recorded. The standard neurological record does not provide this specific information and by the vagueness may lend itself to a variety of interpretations. It is not unexpected that

these issues arise during the investigation given the fact that symptomatic vasospasm may present with focal findings and the GCS is primarily intended to assess patients with traumatic injury (Jennett & Teasdale, 1977). For patients who have suffered a SAH the results suggest the generalized components of the GCS may not detect the focal symptoms. This was not statistically significant for this study, however, further investigation with a larger sample size would be required to further analyze this issue.

Fluctuation versus Stability

There was a trend in the documentation regarding the patients' general neurological status and whether it was stable or fluctuating. Campbell and Edwards (1997) comment that nurses need to assess the patient frequently, often hourly, to determine changes in neurological status in order to detect symptoms of vasospasm.

Six of the thirty patients in the study were observed to be fluctuating in their neurological status according to the nurses' progress notes. Of these six patients who fluctuated four were diagnosed with symptomatic vasospasm. It is important that the nurses' comment on these trends for the shift that they are working. As Smith describes in the Nursing Model of Hospitalization Events (1998) the nurse provides care for patients 24 hours each day. One aspect of nursing care is to ensure adequate communication to health care professionals regarding the patients status. Observations and documentation regarding the patients' general status remain helpful.

When conducting the retrospective analysis it became evident that the patients status fluctuated frequently. The clinical issue was to define for the analysis what constituted a major change which will discussed later. However the issue is reflective of clinical practice because it is also necessary to define the relevance of a patient whose status

fluctuates. There was no significance between the vasospasm and non-vasospasm groups related to fluctuation and stability.

Non-Specific Changes in Neurological Status

Three main sub-categories that emerged in the findings, which will be discussed here, are restlessness, impulsive, and unusual behavior. Some of the patients demonstrated more than just one of these characteristic behaviors. For example one patient was observed and documented as being restless and also demonstrated unusual behavior. For clarity purposes the discussion regarding non-specific behaviors will be presented by the behavior exhibited, and not by specific patients.

Restlessness is a behavior that neurological patients' demonstrate. This has been evidenced and documented in the brain injury population (Hagen, Malkmus, & Durham, 1979). Impulsive behavior and aggressiveness are frequently noted along with restless behavior. The Ranchos Los Amigo Scale has one level of cognitive functioning that describes these behaviors and it is entitled the confused-agitated level (Hagen et al). This level describes the patient to have a heightened level of activity, is internally confused, may show bizarre behavior, may cry out or scream, pull out tubes and be aggressive. The patient may also demonstrate lack of awareness of surroundings and have a very poor short-term recall of event, and is agitated but not purposefully to an exact stimulus (Hagen et al). This certainly appears to be similar to the behaviors demonstrated by the patients investigated for early detection of vasospasm. In this study the patients were restless, impulsive, pulling out intravenous tubes, nasogastric tubes, and external ventricular catheters, seeing bumblebees in the intravenous tubing, picking at the air, crawling out of bed, aggressive and needing to be restrained, and bolting out of bed.

These examples provide a summary of the nurses' observations that were documented in the nurses' progress notes.

The qualitative analysis demonstrated that of the thirty patients eight were documented as being restless and five of those eight patients were diagnosed with clinical vasospasm. This is a significant finding and as stated previously requires further nursing research to further define and establish the link of restlessness to vasospasm. In the literature diffuse symptoms of vasospasm are described as disorientation, lethargy, agitation, restlessness (Rusy, 1996). Kongable (1996) describes subtle changes such as intermittent disorientation as a symptom of vasospasm. One could suggest that a patient who is intermittently disoriented might demonstrate restless behavior. A literature review searching stroke, restlessness and impulsiveness found little information. One study was conducted to compare transcranial color coded sonography to magnetic resonance angiography, and within the population 4 out of 44 patients were too restless to have the magnetic resonance angiography completed (Kenton, Martin, Abott, & Moody, 1997).

Impulsiveness was another behavior that became evident throughout the qualitative analysis. Of the thirty patients entered into the study, three demonstrated impulsive type behavior, and of those three, two patients experienced symptomatic vasospasm.

There was also a sub-category of unusual behaviors and five of the thirty patients demonstrated unusual behavior, and each of these five patients experienced clinical vasospasm. This would demonstrate that unusual behavior is relevant to the detection of clinical vasospasm.

These behaviors are also associated with other clinical disorders. The following unusual behaviors were observed and documented by the nurses in the progress notes:

- Picking at the air, licking fingers
- Spooning the milk from a closed container
- A comment by the patient "I just feel different"

These behaviors demonstrate non-specific behaviors, which are similar to patients who experience seizures. A person who experiences temporal lobe seizures is described to have automatisms (Hickey, 1997). Engel (1989) describes these seizures as phenomena that can include psychic, autonomic, olfactory, and gustatory symptoms, and commonly and sensation of something rising in the epigastric region. Automatisms are described as a coordinated automatic behavior that occurs with an altered level of consciousness, and typically the patient is unaware or amnestic about the event (Hickey & Engel).

It has been shown that people with epilepsy may have a warning that a seizure is starting, and it is called the aura (Engel). Hickey stated the aura may consist of a visual, auditory, visceral, or gustatory experience.

It is unknown if the patients' who demonstrated the automatisms were having seizures. There was no documentation by the nurses whether the patients were aware of their behavior at the time. There also were no tests done, such as the electroencephalogram to determine if seizure activity was present.

The patient who talked about feeling different may have been experiencing an aura. It is also possible that the patient was aware in some form that he or she was not well, or was going to become worse. Studies have demonstrated that patients with a decrease in level of consciousness are able to perceive thoughts about themselves although not be in touch with the external environment (Lawrence, 1995, & Tosch, 1988). It can be suggested that these non-specific changes in behavior are related to clinical vasospasm,

however further investigation would be required to state this with confidence.

The findings provide the researcher with more questions than answers, and would require further investigation to determine the significance of these behaviors related to clinical vasospasm. It has been noted that of the thirteen patients, who experienced non-specific behaviors, two were found to have a score of fifteen on the GCS and would indicate that the patient should have no neurological deficit. None of these non-specific behaviors are included in either standard neurological record or the stroke scale. It can be suggested that the nurses should focus on these behaviors when they are present in the patients. These behaviors should be observed and well documented to provide further information about the patients' neurological status. The nurses' need to consider all factors that may be present when the patient exhibits these non-specific behaviors. For example, does the patient have electrolyte imbalance or medications in their system that may attribute to these behaviors, or perhaps the potential of a seizure exists.

One aspect remains clear that these behaviors may go undetected by the nurse if not observed closely. This continues to demonstrate the need for astute observation by the nurses' during the acute phase of the patients illness (Smith, 1998).

Repetitive Documentation Regarding Generalized Observations

Throughout the qualitative analysis there was a common trend noted of repetitive documentation that occurred in level of alertness, best motor response, and best verbal response. The repetition occurred from the observations that are currently contained in the standard neurological record and are documented again in the nurses' progress notes. This demonstrates the usual practice of the nurses' in their documentation, which follows the outline of the standard neurological record. In contrast the nurses seldom documented

repetitively in the progress notes regarding the observations of the stroke scale.

Smith (1998) clearly describes the relevance of the nurse who observes and cares for the patient during their acute phase of their illness. Nurses have a legal responsibility to document their observations in the patient's chart. It would be more beneficial, and time efficient for the nurses' to document observations that are unique and provide a description of the patient that the standard neurological record does not. The researcher recommends that the nurses' change their practice of documenting observations in the progress notes that are already contained in the standard neurological record.

Observations and Untestable Items

There were several times when the nurses' noted on either the stroke scale or the standard neurological record that they were unable to assess the patient. These notations for the specific categories were given the code number nine and considered to be untestable items. Goldstein, Betrels and Davis (1989) found the items most frequently untestable were neglect and dysarthria. Lyden et al (1994) found the stroke scale could be used reliably with novice experts after learning the assessment. They also demonstrated that the categories of ataxia, language, and facial weakness had the most variation amongst the clinicians. As noted in Table 23 the frequency of untestable items was much larger for the stroke scale than for the standard neurological record. As shown it Table 23 untestable items were not related to the presence or absence of vasospasm. The untestable items from the two scales that that will be addressed are level of consciousness, eye opening, level of consciousness questions, best verbal response, motor responses and limb strength, gaze, visual field, extraocular movements. The areas of fatigue, headache and the patients' ability to cooperate with the assessments became evidenced in the qualitative analysis and are explored.

Heinemann et al (1997) found that level of consciousness, gaze, and visual field testing were found to be poor fits, or more difficult to assess due to other factors affecting the patients. The quantitative analysis demonstrated no significant difference between the two scales for early detection of symptomatic vasospasm, therefore the hypothesis is rejected. The similarities between the vasospasm and non-vasospasm groups reflect one of the reasons for diagnosing patients with symptomatic vasospasm. For example when

testing eye opening of the standard neurological patients were noted to open their eyes spontaneously or to speech. Whereas similar testing of level of consciousness using the stroke scale showed the items recorded as untestable. Furthermore, the category of eye opening for the standard neurological record was never recorded to be untestable. The stroke scale has the level of consciousness category described by alert, drowsy, stuporous, or coma. It is difficult to understand how this item would be untestable, and it could be suggested that they were coded incorrectly.

It was also demonstrated that there were untestable items for each levels of response using the stroke scale for level of consciousness questions. Heinemann et al (1997) found this category difficult to assess consistently due to impairments of patients, for example aphasia would make a difficult component to assess. Compared to the best verbal response in the standard neurological record where no untestable items were recorded. There were no untestable items demonstrated for the component in the GCS. The stroke scale does provide guidelines for scores for patients who were aphasic, stuporous, intubated, or poorly able to articulate their speech. These certainly are the common abnormal observations for this group of patients, yet the nurses' indicated frequently that they were unable to assess the patients. It can be suggested that the nurses' did not recall or investigate the options for these codes and hence coded the item as untestable.

For motor responses assessed there were 40 frequencies of the observation that the patients were obeying commands according to the GCS and yet they were concurrently untestable compared to the stroke scale. Goldstein, Bertels, and Davis (1989) found the stroke scale to have moderate inter-rate reliability, and found no specific problems with this category. The GCS allows for the continuum of the patient to be observed as

anything from obeying commands to no movement. The stroke scale asks for ability to respond to two simple commands and they scored 0 points if able to obey 2 commands, 1 point for one command, and 2 points if unable to obey either command. One would think if the patient were too drowsy or unable to understand the commands that they would score 2 points. This does not however appear to have consistently been documented correctly.

The analysis for each of the four limb strengths was analyzed and compared between the two scales. For each limb the standard neurological record indicated no response and flaccid, and the stroke scale was documented as untestable. The higher numbers of frequencies occurred when the limbs were documented as weak, moderate, or strong for the standard neurological record and were documented as untestable for the stroke scale. The stroke scale tool required a specific assessment by having the patient hold one limb up at a time for a certain length of time, the arms was 10 seconds and the legs was 5 seconds. One could suggest that if the patients were unable to follow the commands for the drift the nurses' might have scored them as untestable. However the guidelines for the stroke scale indicate that only if the limb has been amputated or has a joint fusion should it be considered as untestable. These guidelines were available for the nurses to refer to during the observation period. The scale was tested previously for inter-rater reliability and leg strength was found to be an more reliable measure of strength than stroke scales developed previously (Goldstein, Bertels, & Davis, 1989). It can be suggested that these items were not always scored correctly.

Several times the patients were scored as untestable for gaze and the visual categories for the stroke scale. These categories do require patient cooperation for the assessment.

Heinemann et al (1997) found both gaze and visual testing to be more sensitive to the patients overall condition, and led to less reliable results. Again the guidelines provide examples of how to test the patient if the patient is not alert enough. These were discussed in the educational sessions for the nurses, and the guidelines were available for the nurses' and were clipped to the patients' bedside chart.

The qualitative analysis also demonstrated the difficulty that patients had completing the stroke scale. Documentation was recorded noting patients who weren't able to cooperate for the stroke scale, or participated with reluctance, or refused to participate. In one observation a nurse commented that the patient was more alert and therefore was able to participate with the stroke scale assessments. There was never any documentation in the nurses' progress notes as to why the patient was unable to participate for the standard neurological record.

One nurse documented the observation that the patient refused to participate in the stroke scale assessments at times. It is usual practice for the nurses to document patients' refusal to participate in procedures, or nursing care, for patients with a decrease in neurological status may be confused and will refuse care such as medications, intravenous, tube feeds. Because the stroke scale required more active involvement from the patients one could see a confused patients refusing to cooperate with the assessments. There was never any mention brought forward to the researcher, during the observation period that a patient wanted to withdraw from the study.

Several patients in the study complained of severe headaches during the observation period and this may have contributed to the ability for the patients' cooperation or willingness to participate with the additional assessment. It was emphasized that the

patients could withdraw from the study at any time. Given the patient's intermittent refusal to complete the assessments, it is likely that the patients' neurological status prevented him or her from cooperating, or that a severe headache could limit the patients' willingness to participate. This combined with the nurses' knowledge that the stroke scale assessment was not mandatory, because it was for research, the stroke scale items may not have been adequately tested.

In summary there could be several reasons for the nurses' high frequency of documenting the patient as untestable for the stroke scale.

1) The educational sessions may not have provided enough examples of scoring for the patients who were drowsy.
2) The nurse simply may have forgotten the guidelines taught in the educational sessions.
3) The nurses also may have decided any patient who could not cooperate with the required assessment was unsuitable for scoring. The stroke scale requires the patient to read sentences aloud, look at pictures and name them, identify sensory stimuli, and move their legs and arms in a smooth fashion, as well as the assessments of gaze, visual fields, motor strength previously mentioned. The standard neurological record requires less active input from the patient in order to complete the required assessment.
4) It is possible the nurses detected the patients' fatigue by the additional assessment and did not emphasize the assessment and scoring for the stroke scale as much as the standard neurological record. Although the order of the assessments were randomized, it is possible if the patient was fatigued the nurses may have felt it

necessary to complete the necessary assessment, the standard neurological record regardless of randomization.

The answer to this question cannot be discerned from the analysis of this data. Further investigation is necessary to understand the discrepancy between items noted as untestable within the stroke scale compared with the standard neurological record.

Early Detection

The qualitative analysis showed that nurses observed and recorded five patients who demonstrated changes in the stroke scale prior to the standard neurological record. Of these five patients three of them were diagnosed with clinical vasospasm. It is clinically significant that three patients may have been diagnosed with symptomatic vasospasm earlier because of the early detection of symptoms by using the stroke scale.

For the three patients who were diagnosed with symptomatic vasospasm one patient had no specific observations documented in the nurses' progress notes. The other two patients who experienced vasospasm had a limb drift, facial weakness, sensory neglect, and difficulty speaking identified as changes that occurred. These changes were detected by the stroke scale and not by the standard neurological record. It is clinically relevant that the assessment of a limb drift was noted to be the early change in the stroke scale which lead to the diagnoses of vasospasm in comparison to the standard neurological tool, which does not require the assessment of a limb drift. Evidence from the qualitative data suggested that the presence of a limb drift was clinically relevant and this determined that a change in one point rather than two for motor strength of the stroke scale was a major change. The qualitative analysis also suggested that evidence of difficulty speaking or dysphasia may be key in early detection of vasospasm, so a major change was also defined as having a one point change rather than two.

The retrospective analysis was conducted in order to answer the question of which assessment tool would detect the early neurological changes in symptomatic vasospasm. The definition of what constitutes a major change was required to conduct the analysis. In a previous study conducted by Haley et al (1997) the GCS and the stroke scale were used

for assessing the patients and a change of two points in both scales was considered a major change. This formed the basis of definition for the retrospective analysis, however it could in some instances not be uniformly applied since the data in this study required a different definition of a major change for motor function. The qualitative and the prospective quantitative analysis did not yield clear definitions for the standard neurological record.

Inconsistencies in the nurses' observation regarding the patients limb strength were shown in Tables 28-31. It was found that patients with a limb drift arm or leg could be documented on the standard neurological record as being strong, moderate, or weak. Many clinicians however would suggest that a patient who had been previously strong with arm and leg movement and then became weak would be defined as having a major clinical change. For the purpose of this study observation formed the basis for the analysis. Two main groups were defined as such:

1) Group one having a major change of limb strength scored as two points on the standard neurological record.
2) Group two was defined to have a major change scored as one point for motor strength and for the rest of the standard neurological record a major change was scored as two points.

The stroke scale was consistently defined to have a major change scored as two points, except for each limb function where a major change was scored as a one-point change.

Given the uncertainty of the role of the untestable items the researcher decided to conduct the retrospective analysis treating the untestable items in one analysis as a major change (two-point change) and in a second analysis as a minor change (one-point

change).

Group One

Table 33 represents the results giving the standard neurological record and the stroke scale the tightest or narrowest definitions of a major clinical change. The observations are defined to consider the untestable items as a minor change or a one-point change for both scales, and the motor strength of the standard neurological record is defined as a one-point change. For example if a patient had demonstrated a limb drift on the stroke scale this would be defined as a major change, and concurrently if the patients limb strength changed from strong to moderate, this too would be defined as a major change. This data demonstrated overall that the stroke scale detected early major changes more frequently regardless of the outcome of vasospasm. The stroke scale detected symptomatic vasospasm earlier than the standard neurological record seven times. The early detection of vasospasm by the standard neurological record first occurred twice.

Specific categories in both scales were analyzed to determine which were responsible for the early detection of symptomatic vasospasm (refer to Tables 36-37). The comparison of categories and the detection of changes in the absence or presence of vasospasm demonstrated no significant difference. What is relevant in this analysis is that the categories of limb strength were responsible for the most frequently detected early major changes.

Group Two

Table 35 represents the results with the loosest or widest definitions for both scales. The observations of untestable items were considered to be a major change for both scales, and the motor strength assessment defined a major change as two-point change in

the standard neurological record. For example if a patient demonstrated a limb drift on the stroke scale, it would be defined as a major change, but for the standard neurological record the patients' strength would have to go from strong to weak to be considered a major change. The analysis in this Table demonstrates that the stroke scale detects early changes more frequently given this wider range of definitions regardless of the absence or presence of vasospasm. In terms of detecting early major changes for vasospasm the stroke scale was found to accomplish this prior to the standard neurological record 10 times. The reverse only occurred once.

The comparison of the specific categories for the detection of early changes in the absence or presence of vasospasm demonstrated no statistical difference (refer to table 36 and 37). The analysis does however demonstrate that if a two-point change is required in motor strength on the standard neurological record then the stroke scale will detect the symptoms earlier. The results showed that with these definitions the stroke scale demonstrated fourteen categories that detected early major changes compared to one category in the standard neurological record. This group also demonstrated that motor strength detected the majority of early major changes. In the second group the detection of dysphasia was responsible for an early major change two times. It is important to understand some of the major changes could have occurred concurrently. However it is relevant that impaired ability to speak becomes noticeable within these definitions.

For both groups the stroke scale detected the majority of major changes regardless of the presence or absence of vasospasm. Although there is no significant difference between the two groups it becomes clinically relevant when attempting to find the best tool for nurses' to assess patients at risk for vasospasm.

It is uncertain which data truly represents the population however given the results from Group one, which has the tightest definitions for both scales, there is clinically relevant data to demonstrate that the stroke scale may detect the earliest symptoms of clinical vasospasm. This cannot be proven statistically, however one could argue that in a group of thirty patients seven patients had symptoms of vasospasm detected earlier using the stroke scale and this is clinically relevant. Oropello, Weiner, and Benjamin (1996) highlight the variability of symptoms of vasopasm as they can change hour to hour or minute to minute. Early detection of changes in neurological status is relevant in order to adjust the medical and nursing care of the patient in the efforts to prevent stroke (Powsner, O'Tuama, Jabre, & Melham, 1998). This again relates to the Smith model that states the critical component of nursing care is that it is provided 24 hours each day. Hence the repeated neurological assessment provides a key component to detect early changes in the patients neurological status when detecting symptomatic vasospasm.

Conclusions

Oropello, Weiner and Benjamin (1996) comment that vasospasm is rarely diagnosed with certainty. Often the diagnoses of vasospasm is often done by exclusion using a CT scan to rule out other neurological problems, while the patient is in the classic timeframe for vasospasm, and has no other identifiable cause for the neurological deficit (Haley et al, 1997). Transcranial doppler is another diagnostic test to determine the patients intracerebral blood flow velocities, and will detect an increase in blood flow when vasospasm is present, and may precede clinical symptoms (Mizuno et al, 1994). During the study period the transcranial doppler test was not available or part of current practice at the study site. Faylor (1999) and Bell et al (1994) state that transcranial dopplers along with the GCS and lab values the nurse can predict impending vasospasm.

The quantitative analysis demonstrated no statistically significant difference between the two scales for early detection of symptomatic vasospasm. Therefore the hypothesis that patients experiencing symptomatic vasospasm will have changes in neurological status detected earlier when nurses use a stroke assessment tool compared to the standard neurological assessment record was rejected. This was in part due to clinical similarities between the vasospasm and non-vasospasm groups. Despite lack of statistical significance between the two scales, changes in motor strength documented on the stroke scale contributed to the detection of early major changes for symptomatic vasospasm. The change in motor strength is also supported by the comparison of the two scales in the qualitative analysis. The standard neurological record does not require the nurse to assess for a limb drift, and contains vague terms such as strong, moderate and weak resulting in inconsistencies in documentation of motor strength. It can be argued therefore that the

stroke scale is a more accurate tool for use in detecting changes in motor strength. Overall, the retrospective analysis suggests that the stroke scale detected early changes more frequently than the standard neurological record. When summarizing the frequencies of motor strength as a category for early detection, the stroke scale consistently detected early major changes more often than the standard neurological record regardless of the definition of motor change in the standard neurological record. There was no statistically significant difference related to the absence or presence of vasopasm.

The analysis suggests that there is clinical relevance for early detection of symptomatic vasospasm in the limb function category when using the stroke scale. The researcher recommends based on clinical relevance that the standard neurological record is not adequate in the category of motor strength and could be altered using the stroke scale for improved detection of symptomatic vasospasm (refer to Table 46). This is suggested for patients who have experienced a subarachnoid hemorrhage and are at risk for vasospasm.

Limitations

One of the limitations of the study was inter-rater reliability. Several different nurses were involved in the assessments of the patients. This could have led to some of the inconsistencies that occurred in the documentation for both scales. There were several items in the stroke scale that were determined to be untestable by the nurses. It was difficult to ascertain the reason that these items were judged untestable. The result therefore, was the potential clinical relevance of these items in enhancing early recognition of symptomatic vasospasm was lost.

A second limitation was the lack of detailed nurses' documentation regarding behaviors that are not captured in either assessment tool. Patients who experience symptoms such as restlessness, impulsiveness, and unusual behavior require keen observation and documentation by the nurse. Details regarding these types of behaviors may allow the clinicians and researchers to determine their role and significance regarding symptomatic vasospasm.

The third limitation for the study concerned the current standard of practice at the investigation site, where nursing observations in monitoring and evaluating patients at risk of developing symptomatic vasospasm is not supported by transcranial doppler monitoring devices. This technology will be available at the institution in the near future, and a second study for early detection of cerebral vasospasm should be conducted. A second study should include the use of the transcranial doppler device, items from the stroke scale, the usual neurological record, and nursing observation of patient behaviors not captured by either scale. The prospective analysis demonstrated that the non-vasospasm and vasospasm groups were quite similar. One could argue that the

transcranial doppler would have been beneficial in the diagnoses of symptomatic vasospasm, and may have altered the findings. The design utilized reflected the current standard of practice at the investigation site. Although the lack of technology increases the importance of nursing observations the optimum would be for both the nurses observation along with the transcranial doppler results to monitor and evaluate the patients. The monitoring of neurological status along with appropriate technology would be a consideration for future investigations.

Nursing Implications

This study has several findings that have implications for nursing. The discrepancies that occurred when documenting the observations of the patients' neurological status in several categories demonstrates the need to reevaluate these aspects of nursing assessment and to promote improved reliability. So that trends in patients' neurological status are seen to be consistent amongst the nurses.

One of the main implications for nursing is the need to change practice for the documentation of observations in the nurses' progress notes. Nurses need to understand that documentation of observations that are recorded on a neurological assessment sheet is repetitive. The nurse should focus on the astute observations required for the patient who is at risk for vasospasm and provide information trends in neurological status.

It was also found that nurses observe and document patients' non-specific behaviors such as restlessness, impulsiveness, and unusual behaviors. The observations are not only relevant to the diagnoses of vasospasm, but are key to planning care for the patients. Patients who are restless and impulsive require careful observation and investigation to determine the potential causes, and provide a safe comfortable environment for the patient. With the keen observations of a nurse the patient who demonstrates unusual behaviors may have the cause determined and effective treatment instituted. Nurses need to understand the importance of the non-specific behaviors and have them addressed accordingly.

There was evidence to suggest that the standard neurological record, in particular the components of motor strength are not adequate to detect early symptoms of vasospasm. There were also findings that suggested nurses do not define the varying levels of

strength consistently when using the standard neurological record. There are implications for nurses that these inconsistencies may exist when the standard neurological record is used for patients with other neurological problems. This tool is used to assess all patients who have had or will have a cranial surgery. There is also the concern for patients with other neurological problems such as a brain tumor, the evidence of a limb drift would be a significant clinical finding, and it may not be detected by using the standard neurological record. These implications are relevant to nursing and providing optimal nursing care.

The model utilized for the study provides a framework for the role of nurses who care for patients with an acute illness. This study focused on the independent role of the nurse and the assessment that is conducted on a continual basis to ensure changes in status was detected. The framework from Smith's (1998) model also discusses the collaborative role that nurses have with physicians in order to provide care for the patient. One of the collaborative roles for the nurse would be to communicate any changes in the patients' status to the physician so that adequate treatment measures may be carried out. It would be valuable to research the issue of communication between nurses, and between nurses and physicians to determine effective methods throughout these interactions.

Nursing research continues to expand nursing knowledge. This is the third research project with a nursing focus that has been conducted on the unit in the last 15 years. Nurses need exposure to clinical research to understand the relevance of these investigations to nursing care. There was a suggestion that the stroke scale used in the study was not always completed accurately. This may in part be related to the lack of understanding on the nurses' part that research requires rigor. The scale needed to be

completed with rigor to be able to compare the two tools adequately. The researcher plans to present the findings to the nurses on the unit, and provide information about the research process, and the necessity of rigor. This may enhance the nurses understanding and appreciation of the research process.

The nurses detected deficits in the patients such as neglect, visual deficits, and dysphasia and did document on the patients'' abnormal responses in the nurses' progress notes when they were present. It is unknown if these abnormal findings would be detected without the use of the stroke scale. A variety of neurosurgical patients can exhibit these problems and it relevant to nursing to detect them when they occur. Assessment of the patient leads to the nursing care of the patient (Smith, 1998), and therefore the assessment needs to be accurate.

Smith (1998) addresses the issue that nursing process and care should relate to outcomes such as length of stay and discharge. Future research should focus on the early detection of vasospasm related to the outcome of discharge.

Recommendations for Future Research

Future research is required to investigate the role of a limb drift, and a category with ranges of motor strength that is well defined in relation to the detection of early vasospasm. The researcher would recommend the use of the transcranial doppler along with the neuroscience nurses' assessments to provide the information in the detection of symptomatic vasospasm.

The observation and detection of non-specific behaviors requires investigation to determine their role in the detection of symptomatic vasospasm. These observations of restlessness, impulsiveness, and unusual behavior leave the researcher with more questions regarding generalized changes in level of consciousness during the experience of vasospasm.

A study to investigate the effectiveness of communication between the nurses and physicians when discussing changes in neurological status follows the continuum of the Model for Hospitalization Events by Smith (1998). Once the nurse detects a change in the patient status how is that effectively communicated to the physicians, which is necessary to consider a change in the patients' treatment plan.

Further research is indicated to assess the standard neurological record for consistency amongst nurses when caring for patients with a variety of neurological illnesses.

Final Summary

This study to critically analyzed the current method of nursing assessments for patients who may experience symptomatic vasospasm. The two assessment scales were compared with the prospective and retrospective quantitative analysis, with a qualitative analysis to enrich the findings.

The two groups of patients were those who experienced vasospasm, and those who did not. The researcher could not conclude that the stroke scale would detect symptoms of vasospasm earlier than the standard neurological record since the stroke scale did not provide earlier detection of vasospasm compared to the standard neurological record. Further investigation would be required, however the analysis provided clinically relevant information to suggest that the motor function category of the standard neurological record may not detect the early changes of vasospasm. The description of motor strength being strong, moderate and weak are too vague, and the lack of a required assessment of a limb drift suggest the standard neurological record to be less than adequate.

The qualitative analysis provided in-depth information primarily regarding the patients' clinical findings that were not captured in either of the assessment tools. There was suggestion that these non-specific behaviors play a role in the detection of early vasospasm.

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Appendix A

Health Sciences Centre

NEUROLOGICAL RECORD

MISCELLANEOUS

RESPIRATIONS
NORMAL - N

PUPILS

Date:

Ward:

Full Name:

Year of Birth:

Hospital Number:

Physician:

DATE														
TIME														
GLASGOW COMA SCALE	EYE OPENING	SPONTANEOUS	4											
		TO SPEECH	3											
		TO PAIN	2											
		NONE	1											
	BEST VERBAL RESPONSE	ORIENTED	5											
		CONFUSED	4											
		INAPPROPRIATE	3											
		INCOMPREHENSIBLE	2											
		NONE	1											
	BEST MOTOR RESPONSE	OBEYING	6											
		LOCALIZING	5											
		FLEXION WITHDRAWAL	4											
		*FLEXION ABNORMAL	3											
		**EXTENSION ABNORMAL	2											
		NONE	1											
	GSC SCORE		15											
PUPILS	1mm • 3mm ● 5mm ● 7mm ●	SIZE / REACTION	R											
			L											
		TEMP												
		PULSE												
		RESP/CODE												
		BLOOD PRESSURE												
		ICP												
		MAP												
LIMB MOVEMENTS & TONE	ARMS	- to pain - to touch - spont ⊖⊖⊕	STRONG											
			MODERATE											
			WEAK											
			FLEXION - ABNORMAL											
			EXTENSION - ABNORMAL											
		NO RESPONSE & SPASTIC												
		NO RESPONSE & FLACCID												
	LEGS	- to pain - to touch - spont ⊖⊖⊕	STRONG											
			MODERATE											
			WEAK											
			EXTENSION											
		NO RESPONSE & SPASTIC												
		NO RESPONSE & FLACCID												
SIGNATURE														

FORM # 82039 REV 91

Appendix B

NIH STROKE SCALE

DATE:														
TIME:														
Level of Consciousness	Alert	0												
	Drowsy	1												
	Stuporous	2												
	Coma	3												
LOC Questions	Answers both correctly	0												
	Answers one correctly	1												
	Incorrect	2												
LOC Commands	Obeys both correctly	0												
	Obeys one correctly	1												
	Incorrect	2												
Gaze	Normal	0												
	Partial gaze palsy	1												
	Forced deviation	2												
Visual	No visual loss	0												
	Partial hemianopia	1												
	Complete hemianopia	2												
	Bilateral hemianopia	3												
Facial Palsy	Normal	0												
	Minor	1												
	Partial	2												
	Complete	3												
Motor Arm (Right) (Left)	No drift	0												
	Drift	1												
	Can't resist gravity	2												
	No effort against gravity	3												
	No movement	4												
Motor Leg (Right) (Left)	No drift	0												
	Drift	1												
	Can't resist gravity	2												
	No effort against gravity	3												
	No movement	4												
Limb Ataxia Arm (Right) (Left)	Absent	0												
	Present in one limb	1												
	Present in two limbs	2												
Limb Ataxia Leg (Right) (Left)	Absent	0												
	Present in one limb	1												
	Present in two limbs	2												
Sensor	Normal	0												
	Partial loss	1												
	Dense loss	2												
Neglect	No neglect	0												
	Partial neglect	1												
	Complete neglect	2												
Dysarthria	Normal articulation	0												
	Mild to moderate dysarthria	1												
	Near unintelligible or worse	2												

Appendix B

Language	No aphasia	0											
	Mild to moderate aphasia	1											
	Severe aphasia	2											
	Mute	3											
Distal Motor Function (Right)	Normal	0											
(Left)	Partial extension	1											
	No extension	2											

NATIONAL INSTITUTES OF HEALTH STROKE SCALE FORM

INITIALS	SIGNATURES

Appendix C

World Federation of Neurologic Surgeons Scale	
Grade 1	GCS = 15 with no headache or focal signs
Grade 2	GCS = 15 with headache, and nuchal rigidity, but no focal signs
Grade 3	GCS = 13-14 with headache, nuchal rigidity, or focal signs
Grade 4	GCS = 9-12 with headache, nuchal rigidity, focal signs
Grade 5	GCS = 8 or less, headache, nuchal rigidity, focal signs

Report of World Federation of Neurological Surgical Committee, 1988, p.985-6

Appendix D

820 SHERBROOK STREET
WINNIPEG MANITOBA R3A 1R9

DIAL DIRECT (204) 787-4587
FAX (204) 787-4547

THE DIRECTOR OF RESEARCH

MEMORANDUM

DATE: March 19, 1999

TO: Kathy Doerksen, Principal Investigator, GD208

FROM: Karen Shaw, Research Department, MS748B

SUBJECT: **RESEARCH PROTOCOL: A COMPARISON OF A STANDARD NEUROLOGICAL ASSESSMENT TOOL TO A STROKE SCALE FOR DETECTING SYMPTOMATIC CEREBRAL VASOSPASM.**
Research Impact #: RI99:034

After reviewing this study with the HSC Research Impact Committee Members, impact on the Medical Information Department has been identified.

In the event retrieval of the HSC medical record is required by the investigator, co-investigator, other study team members, study sponsor or agents of regulatory bodies, **a charge of $2 per record will be levied. Please let me know if the study budget can support this charge, should it become necessary.** Once I have your assurance approval for Medical Information will be forwarded to Dr. Luis Oppenheimer, Director of Research.

Please contact Nadine Mann, retrospective Audit Technician, directly @4272, or ask for her at the main reception desk in the Medical Information Department when charts are required. Please provide her with the Research Impact and HSC account numbers for your study and she will coordinate your request. If you have any questions with regard to the above please call me at 787-4968. Thank you for your assistance.

cc: Ms Gail Grimsen, Manager, Health Information

Appendix E

FACULTY OF NURSING

Winnipeg, Manitoba
Canada R3T 2N2

Tel (204) 474-7482
Fax (204) 474-7682

Kathy Doerksen
71 Inch Bay
Winnipeg, Manitoba
R2Y OX2

April 26, 1999

Dear Ms. Doerksen:

Re: Proposal #99/14: A comparison of a standard neurological assessment tool to a stroke scale for detecting symptomatic cerebral vasospasm.

Thank you for your letter of April 20, 1999. With the changes and clarifications outlined, the above proposal is approved.

I would like to take this opportunity to wish you every success with this project.

Sincerely,

Susan McClement

Susan McClement RN PhD(c)
Associate Chair
Ethical Review Committee

Appendix F

Disclaimer form for the Nurses

As a nurse on the neuroscience unit at the Health Sciences Centre you have been invited to participate in the research study entitled "A comparison of a standard neurological assessment tool to a stroke scale for detecting symptomatic cerebral vasospasm", conducted by Kathy Doerksen, a Master of Nursing student at the University of Manitoba. The goal of the project is to explore the efficacy of the NIH-NINDS Stroke Scale in assessing symptoms of patients experiencing cerebral vasospasm, and to compare this scale to the standard neurological assessment tool, which consists primarily of the Glasgow Coma Scale. Through administering the Stroke Scale, in addition to the standard neurological assessment tool, and participating in an educational program to enable you to administer the Stroke Scale, you will be agreeing to take part in this study. The Ethical Review Committee of the Faculty of Nursing has approved the study.

Your participation will involve viewing a video entitled NIH Test Scale, participating in a additional teaching sessions provided by Kathy Doerksen in use of the Scale, and administering the Stroke Scale and the standard neurological assessment tool to the study patients in the sequence protocol on the neuroscience unit. Your identity is confidential, and will not be revealed in reporting results of the study. Data will be obtained from the assessment tools and the nurses' notes. Only the researcher, the research assistant and her Thesis Chair will have access to the data collected. Participation is voluntary. You may withdraw from the study at any time without penalty by informing Kathy Doerksen of your wishes.

There will be no direct benefit to your participation, however it is anticipated that the study will provide useful information about the assessment of symptoms in patients experiencing cerebral vasospasm.

Results of the study will be presented to the nurses on the neuroscience unit, and the neurosurgeons will be invited to attend. The researcher may also present the findings to other interested health care professionals. It is the intent of the researcher to publish the findings in a refereed journal. If you have any questions regarding the study or your role in the project you may contact Kathy Doerksen at 235-3163, or Dr. Barbara Naimark, the Chair of her Thesis Committee at 474-7467.

We recognize the importance of your participation. Thank-you.

Please send me a copy of the summary of the research report.

Send to: _____(name)

_____(address)

Appendix G
Instructions and Scale Definitions

Instructions	Scale Definition
1a. Level of Consciousness: The investigator must choose a response, even if a full evaluation is prevented by such obstacles as an endotracheal tube, language barrier, orotracheal trauma/bandages. A 3 is scored only if the patient makes no movement (other than reflexive posturing) in response to noxious stimulation.	0 = Alert; keenly responsive. 1 = Not alert, but arousable by minor stimulation to obey, answer, or respond. 2 = Not alert, requires repeated stimulation to attend, or is obtunded and requires strong or painful stimulation to make movements (not stereotyped). 3 = Responds only with reflex motor or autonomic effects or totally unresponsive, flaccid, areflexic.
1b. LOC Questions: The patient is asked the month and his/her age. The answer must be correct - there is no partial credit for being close. Aphasic and stuporous patients who do not comprehend the questions will score 2. Patients unable to speak because of endotracheal intubation, orotracheal trauma, severe dysarthria from any cause, language barrier or any other problem not secondary to aphasia are given a 1. It is important that only the initial answer be graded and that the examiner not "help" the patient with verbal or non-verbal cues.	0 = Answers both questions correctly. 1 = Answers one question correctly. 2 = Answers neither question correctly.
1c. LOC Commands: The patient is asked to open and close the eyes and then to grip and release the non-paretic hand. *Substitute* another one step command if the hands cannot be used. Credit is given if an unequivocal attempt is made but not completed due to weakness. If the patient does not respond to command, the task should be demonstrated to them (pantomime) and score the result (i.e., follows none, one or two commands). Patients with trauma, amputation, or other physical impediments should be given suitable one-step commands. Only the first attempt is scored.	0 = Performs both tasks correctly 1 = Performs one task correctly 2 = Performs neither task correctly
2. Best Gaze: Only horizontal eye movements will be tested. Voluntary or reflexive (oculocephalic) eye movements will be scored but caloric testing is not done. If the patient has a conjugate deviation of the eyes that can be overcome by voluntary or reflexive activity, the score will be 1. If a patient has an isolated peripheral nerve paresis (CN III, IV or VI) score a 1. Gaze is testable in all aphasic patients. Patients with ocular trauma, bandages, pre-existing blindness or other disorder of visual acuity or fields should be tested with reflexive movements and a choice made by the investigator. Establishing eye contact and then moving about the patient from side to side will occasionally clarify the presence of a partial gaze palsy.	0 = Normal 1 = Partial gaze palsy. This score is given when gaze is abnormal in one or both eyes, but where forced deviation or total gaze paresis are not present. 2 = Forced deviation, or total gaze paresis not overcome by the oculocephalic maneuver.

3. Visual: Visual fields (upper and lower quadrants) are tested by confrontation, using finger counting or visual threat as appropriate. Patient must be encouraged, but if they look at the side of the moving fingers appropriately, this can be scored as normal. If there is unilateral blindness or enucleation, visual fields in the remaining eye are scored. Score 1 only if a clear-cut asymmetry, including quadrantanopia is found. If patient is blind from any cause score 3. Double simultaneous stimulation is performed at this point. If there is extinction patient receives a 1 and the results are used to answer question 11.	0 = No visual loss 1 = Partial hemianopia 2 = Complete hemianopia 3 = Bilateral hemianopia (blind including cortical blindness)
4. Facial Palsy: Ask, or use pantomime to encourage the patient to show teeth or raise eyebrows and close eyes. Score symmetry of grimace in response to noxious stimuli in the poorly responsive or non-comprehending patient. If facial trauma/bandages, orotracheal tube, tape or other physical barrier obscures the face, these should be removed to the extent possible.	0 = Normal symmetrical movement 1 = Minor paralysis (flattened nasolabial fold, asymmetry on smiling) 2 = Partial paralysis (total or near total paralysis of lower face) 3 = Complete paralysis of one or both sides (absence of facial movement in the upper and lower face)
5 & 6. Motor Arm and Leg: The limb is placed in the appropriate position: extend the arms (palms down) 90 degrees (if sitting) or 45 degrees (if supine) and the leg 30 degrees (always tested supine). Drift is scored if the arm falls before 10 seconds or the leg before 5 seconds. The aphasic patient is encouraged using urgency in the voice and pantomime but not noxious stimulation. Each limb is tested in turn, beginning with the non-paretic arm. Only in the case of amputation or joint fusion at the shoulder or hip may the score be "9" and the examiner must clearly write the explanation for scoring as a "9".	0 = No drift, limb holds 90 (or 45) degrees for full 10 seconds. 1 = Drift, Limb holds 90 (or 45) degrees, but drifts down before full 10 seconds; does not hit bed or other support. 2 = Some effort against gravity, limb cannot get to or maintain (if cued) 90 (or 45) degrees, drifts down to bed, but has some effort against gravity. 3 = No effort against gravity, limb falls. 4 = No movement 9 = Amputation, joint fusion explain: _____ **5a. Left Arm** **5b. Right Arm**
	0 = No drift, leg holds 30 degrees position for full 5 seconds. 1 = Drift, leg falls by the end of the 5 second period but does not hit bed. 2 = Some effort against gravity; leg falls to bed by 5 seconds, but has some effort against gravity. 3 = No effort against gravity, leg falls to bed immediately. 4 = No movement 9 = Amputation, joint fusion explain: _____ **6a. Left Leg** **6b. Right Leg**

7. Limb Ataxia: This item is aimed at finding evidence of a unilateral cerebellar lesion. Test with eyes open. In case of visual defect, insure testing is done in intact visual field. The finger-nose-finger and heel-shin tests are performed on both sides, and ataxia is scored only if present out of proportion to weakness. Ataxia is absent in the patient who cannot understand or is paralyzed. Only in the case of amputation or joint fusion may the item be scored "9", and the examiner must clearly write the explanation for not scoring. In case of blindness test by touching nose from extended arm position.	0 = Absent 1 = Present in one limb 2 = Present in two limbs If present, is ataxia in Right arm 1 = Yes 2 = No 9 = amputation or joint fusion, explain _____ Left arm 1 = Yes 2 = No 9 = amputation or joint fusion, explain _____ Right leg 1 = Yes 2 = No 9 = amputation or joint fusion, explain _____ Left leg 1 = Yes 2 = No 9 = amputation or joint fusion, explain _____
8. Sensory: Sensation or grimace to pin prick when tested, or withdrawal from noxious stimulus in the obtunded or aphasic patient. Only sensory loss attributed to stroke is scored as abnormal and the examiner should test as many body areas (arms (not hands), legs, trunk, face) as needed to accurately check for hemisensory loss. A score of 2, "severe or total," should only be given when a severe or total loss of sensation can be clearly demonstrated. Stuporous and aphasic patients will therefore probably score 1 or 0. The patient with brain stem stroke who has bilateral loss of sensation is scored 2. If the patient does not respond and is quadriplegic score 2. Patients in coma (item 1a = 3) are arbitrarily given a 2 on this item.	0 = Normal; no sensory loss. 1 = Mild to moderate sensory loss; patient feels pinprick is less sharp or is dull on the affected side; or there is a loss of superficial pain with pinprick but patient is aware he/she is being touched. 2 = Severe to total sensory loss; patient is not aware of being touched in the face, arm, and leg.
9. Best Language: A great deal of information about comprehension will be obtained during the preceding sections of the examination. The patient is asked to describe what is happening in the attached picture, to name the items on the attached naming sheet, and to read from the attached list of sentences. Comprehension is judged from responses here as well as to all of the commands in the preceding general neurological exam. If visual loss interferes with the tests, ask the patient to identify objects placed in the hand, repeat, and produce speech. The intubated patient should be asked to write. The patient in coma (question 1a = 3) will arbitrarily score 3 on this item. The examiner must choose a score in the patient with stupor or limited cooperation but a score of 3 should be used only if the patient is mute and follows no one step commands.	0 = No aphasia, normal 1 = Mild to moderate aphasia; some obvious loss of fluency or facility of comprehension, without significant limitation on ideas expressed or form of expression. Reduction of speech and/or comprehension, however, makes conversation about provided material difficult or impossible. For example in conversation about provided materials examiner can identify picture or naming card from patient's response. 2 = Severe aphasia; all communication is through fragmentary expression; great need for inference, questioning, and guessing by the listener. Range of information that can be exchanged is limited; listener carries burden of communication. Examiner cannot identify materials provided from patient response. 3 = Mute, global aphasia; no usable speech or auditory comprehension.
10. Dysarthria: If patient is thought to be normal an adequate sample of speech must be obtained by asking patient to read or repeat words from the attached list. If the patient has severe aphasia, the clarity of articulation of spontaneous speech can be rated. Only if the patient is intubated or has other physical barrier to producing speech, may the item be scored "9", and the examiner must clearly write an explanation for not scoring. Do not tell the patient why he/she is being tested.	0 = Normal 1 = Mild to moderate; patient slurs at least some words and, at worst, can be understood with some difficulty. 2 = Severe; patient's speech is so slurred as to be unintelligible in the absence of or out of proportion to any dysphasia, or is mute/anarthric. 9 = Intubated or other physical barrier, explain _____

11. Extinction and Inattention (formerly Neglect): Sufficient information to identify neglect may be obtained during the prior testing. If the patient has a severe visual loss preventing visual double simultaneous stimulation, and the cutaneous stimuli are normal, the score is normal. If the patient has aphasia but does appear to attend to both sides, the score is normal. The presence of visual spatial neglect or anosagnosia may also be taken as evidence of abnormality. Since the abnormality is scored only if present, the item is never untestable.	0 = No abnormality. 1 = Visual, tactile, auditory, spatial, or personal inattention or extinction to bilateral simultaneous stimulation in one of the sensory modalities. 2 = Profound hemi-inattention or hemi-inattention to more than one modality. Does not recognize own hand or orients to only one side of space.

Additional item, not a part of the NIH Stroke Scale score.

A. Distal Motor Function: The patient's hand is held up at the forearm by the examiner and patient is asked to extend his/her fingers as much as possible. If the patient can't or doesn't extend the fingers the examiner places the fingers in full extension and observes for any flexion movement for 5 seconds. The patient's first attempts only are graded. Repetition of the instructions or of the testing is prohibited.	0 = Normal (No flexion after 5 seconds) 1 = At least some extension after 5 seconds, but not fully extended. Any movement of the fingers which is not command is not scored. 2 = No voluntary extension after 5 seconds. Movements of the fingers at another time are not scored. a. Left Arm b. Right Arm

Appendix H
Consent Form

STUDY NAME: A comparison of a standard neurological assessment tool with a stroke scale for detecting symptomatic cerebral vasospasm.

INVESTIGATOR: Kathy Doerksen, graduate student, University of Manitoba Master of Nursing Program

If I (or an authorized third party) decide to sign this consent form, my signature means that:

1. I understand that I have been asked to participate in this study because I have experienced a bleed form a blood vessel in my brain. I understand that this may lead to a condition called "vasospasm", which is a spasm of a blood vessel in the brain that my lead to a temporary decrease in blood flow to that part of my brain.
2. I agree that in addition to having the usual neurological assessment by the nurse he/she will administer an additional neurological assessment tool which will assess the following:
   a) My awareness of my surroundings
   b) My ability to perform a simple function upon request
   c) The movement in my eyes and face
   d) The strength and movement in my arms and legs
   e) The ability to feel my face, legs, arms, and trunk
   f) My ability to speak
   g) My ability to see the space around me
3. I agree that Kathy will collect information from my chart that will include information about my medical condition, age, and the assessments performed by the nurses.
4. I can withdraw from the study at any time without penalty or effect on my care.
5. I understand that all information will immediately be assigned a code number and my identity will be protected.
6. I understand that collected information may be shared in confidence with the Chair of Kathy's Thesis Committee.
7. I understand there may be no direct benefits to me from participating in the study. I know too, it is anticipated that the research may provide information on the value of the new assessment tool that could be of benefit in the future care of patients experiencing vasospasm.
8. I have had my questions answered satisfactorily, and I agree to participate in the study.

9. If I have any other questions at any time during the study, I can reach Kathy Doerksen at 235-3163 or her Thesis Chair Dr. Barbara Naimark at 474-7467.
10. I will be given a copy of the consent form.

We recognize the importance of your participation. Thank-you.

I agree to participate in this project.

Your signature _____ Date _____

Research assistants
Signature_____ Date _____

On behalf of my _____ who is unable to provide consent at this time. I agree to his/her participation in this project.

Your signature _____ Date _____

Research assistants
Signature_____ Date _____

Please send me a copy of the summary of the research report.

Send to: _____(name)

_____(address)

Appendix I

Continuing Participation Consent

Your are now able to decide if you wish to continue participating in this research. The project has been described to you, and the consent form has presented to you. All your questions have been answered. Your signature below indicates that you agree to continue to participate in this project.

Your signature _____ Date_____

Researchers
Signature _____ Date _____