Neurological Assessment in the Acute Care Practice Environment of Northern Ontario Hospitals: A Review of the Literature

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Abstract

Traumatic brain injury (TBI) is a leading cause of death and disability in developed countries and in Ontario. Trauma is the primary cause of neurological injury contributing to disability and loss of productive years. Neurological assessment remains the cornerstone to identifying evolving injury and planning care. A comprehensive assessment including all components related to neurological function, such as Glasgow Coma Scale (GCS), pupillary size and light reactivity, limb strength and vital signs, is paramount if the nurse is to initiate prompt action by medical personnel meant to improve survival outcomes and minimize long term sequelae. Clinical surveillance is essential in the identification of physiological changes and is vital in deciding whether computerized tomography (CT) is necessary. This is especially important in regions where a return trip for diagnostic testing can extend the length of time in reaching a medical diagnosis and treatment.

Recent studies have indicated gaps in the documentation of neurological assessment. Numerous studies have examined factors that influence patient outcomes following TBI, few have looked at the short-term outcomes of immediate care for mild TBI and none could be found to suggest on-going clinical surveillance provided in the first six hours contributed to positive or negative outcomes.

Keywords: traumatic brain injury, head injury, epidemiology, emergency department, clinical assessment, nursing assessment, adult, Glasgow Coma Scale, vital signs, documentation, chart review, northern and rural health, Ontario

Abrégé

Le traumatisme cérébral (TC) est une des principales causes de décès et d'invalidité dans les pays développés et en Ontario. Le traumatisme est la principale cause de lésions neurologiques contribuant au handicap et à la perte d'années productives. L'évaluation neurologique demeure la pierre angulaire de l'identification des blessures évolutives et des soins de planification. Une évaluation complète comprenant toutes les composantes liées à la fonction neurologique, telles que l'échelle de coma de Glasgow (GCS), la taille pupillaire et la réactivité à la lumière, la résistance des membres et les signes vitaux est primordiale si l'infirmière doit initier une action rapide par le personnel médical visant à améliorer les résultats de survie et de minimiser les séquelles à long terme. La surveillance clinique est essentielle dans l'identification des changements physiologiques et est essentielle pour décider si la tomodensitométrie est nécessaire. Cela est particulièrement important dans les régions où un voyage de retour pour les tests de diagnostic peut prolonger la durée de l'atteinte d'un diagnostic et un traitement médicaux.

Des études récentes ont montré des lacunes dans la documentation de l'évaluation neurologique. De nombreuses études ont examiné les facteurs qui influent sur les résultats des patients à la suite d'un TC, peu ont examiné les résultats à court terme des soins immédiats pour le TBI léger et aucun ne pouvait suggérer que la surveillance clinique continue fournie dans les six premières heures a contribué aux résultats positifs ou négatifs.

Mots clés : traumatisme cérébrale, traumatisme crânien, épidémiologie, service d'urgence, évaluation clinique, évaluation infirmière, adulte, échelle de Coma de Glasgow, signes vitaux, documentation, revue de dossiers, santé du Nord et de la région rurale, Ontario

Traumatic brain injury (TBI) is a leading cause of death and disability in developed countries and trauma is the primary cause of neurological injury contributing to disability and loss of productive years (Canadian Institute for Health Information (CIHI), 2007a; Collie, 2009; World Health Organization (WHO), 1995). The prevalence of TBI in Canada is estimated at 600 per 100,000 population and studies generally agree that 70-90% of all TBI are mild in severity with victims achieving full recovery in 3-12 months (Cassidy et al., 2004; Colantonio, 2016; Iverson, 2010; Ontario Neurotrauma Foundation, 2010). Despite the devastation of multiple injuries, a brain injury is the single most important determinant of a patient's outcome (Stewart, Girotti, Nikore, & Williamson, 2003) from disability to death (Canadian Institute for Health Information (CIHI), 2006a, 2007a, 2007b; Dagher, Richard-Denis, Lamoureux, DeGuise, & Feyz, 2013; Ontario Neurotrauma Foundation, 2010). Surviving a head injury can mean living with long-term sequelae that can even be life-long according to longitudinal studies (Huang, Ho, & Yang, 2010). As Canada is a vast country with a diversity in geography, there is also variation in living conditions between those residing in population centres and urban areas as well as from province to province (Canadian Institute for Health Information (CIHI), 2006b). The aim of this paper is to review the available literature with preference to scholarly research, however other sources of available data are also considered for their contribution to completing a picture of TBI in northern Ontario, Canada provided that the sources contributed reliable and verifiable information.

Methods

A comprehensive review of the literature was conducted for research of epidemiologic trends related to rates of TBI in northern Ontario and followed up with a focused search of research related to traumatic injuries associated with TBI, care provision and documentation. As the sparsity of relevant research in some topics such as epidemiology and assessment practices is to be noted, several databases were consulted; CINAHL, Proquest Health and Medicine, Proquest Nursing and Allied Health, Medline, PubMed, Google and Google Scholar. Government institutions at various levels and their associated websites were also consulted for data, reports and white papers; Canadian Institute of Health Information (CIHI), Health Canada, Statistics Canada, Ontario Ministry of Health and Long-Term Care, the North East Local Health Integration Network and the Sudbury and District Health Unit. General search headings included: traumatic brain injury, head injury, epidemiology, emergency department, clinical assessment, nursing assessment, adult, Glasgow Coma Scale, vital signs, documentation, chart review, northern and rural health, Ontario. Where search engines permitted, exclusions for 'stroke' and 'pediatric' were entered.

Epidemiology of TBI

A national study of the determinants of population health highlighted variations between Canadians according to the proximity of densely populated centers and compared to rural areas. The authors reported higher mortality rates from injury and motor vehicle collisions for residents in rural areas and as the influence of a metropolitan area decreased, the rates of mortality, regardless of cause, increased (Canadian Institute for Health Information (CIHI), 2006b). More recently, the leading causes of unintentional injury and suicide in Canadian adults was studied across the urban-rural continuum (Burrows, 2013). The study reconfirmed urban-rural gradients in adult mortality rates were more pronounced for unintentional motor vehicle and serious

injuries. Both papers provide a wide and better understanding of injury patterns in rural Canada, however without the focus on specific regions. Injuries associated with TBI were not specifically highlighted, neither the report nor the study.

After adjusting for population size, an overall downward trend in incidence rates of head injury admissions was reported in Ontario between 1994 and 2004. Although admission rates for the 60+ age group decreased from 105.4 to 90.1 per 100,000/population, this age group gained a net lead on other demographic groups (Canadian Institute for Health Information (CIHI), 2006a). Historically, incidence rates, regardless of severity, were higher for young males aged 15-19 years (Collie, 2009) however, adult cases 65 years and over are now in the lead. In Ontario, unintentional injuries accounted for over 70% deaths, 80% of hospitalizations, 95% of emergency department (ED) visits and 90% of partial and total disabilities (SMARTRISK, 2009). Motor vehicle collisions and falls are the most frequent causes of injury (Canadian Institute for Health Information (CIHI), 2002; Colantonio, Parsons, Vander Laan, & Zagorski, 2009; SMARTRISK, 2009) but falls are more frequently associated as a cause of injury for those over 65 years (Canadian Institute for Health Information (CIHI), 2006a). This is of concern in the North East Local Health Integrated Network (NELHIN) as the median age of residents is higher than the provincial norm (42.9 versus 39.0 years) (Statistics Canada, 2006) and because researchers have reported that the combination of advanced age and falls were associated with the poorest outcome following TBI with older patients having longer hospitalizations and lower odds of being discharged home (Butcher et al., 2007; Dagher et al., 2013; Mushkudiani et al., 2007).

Pickett and colleagues (2004) conducted a review of the Ontario Trauma Registry Minimum and Comprehensive Data Sets over a 5-year period, examining the causes associated with blunt head trauma across the province from 2009-2011. In this study, the researchers reported unintentional falls and transport accidents were the leading external causes of head injury for the province. Most importantly, total injury rates for blunt head trauma in northern Ontario exceeded provincial norms with unintentional falls, transport accidents and other road vehicles, unintentional and intentional strikes by another person yielding the highest annual rates of injury per 100,000/population (Pickett, Simpson, & Brison, 2004). While this study was not duplicated or the findings reconfirmed for population trends, the Ontario Injury Prevention Resource Center corroborates a higher injury rate, reporting that ED visits and rates of hospitalization for head injuries are respectively 1.5 times and 1.7 times higher in northern Ontario than provincial norms (Compass, 2008). A comparison across the age groups of annual rates of head injury and hospitalization for head injury were again higher than provincial norms for the districts of Sudbury, Timiskaming and Porcupine, each reporting head injury rates at 1.5 times the provincial rates with confirmation of these findings in their 2012 annual reports (Ontario Injury Prevention Resource Centre (OIPRC), 2012; Porcupine Health Unit, 2012). No other study could be found that would have examined overall rates and causes of head injuries in northern Ontario despite the availability of data. In a white paper to the Ontario Ministry of Health and Long-Term Care (MOHLTC), the Institute for Clinical Evaluative Sciences (ICES) reported the frequency of acquired brain injury for each of the Local Health Integration Networks (LHINs). The highest crudes rates of TBI over a five-year period were attributed to the North West (NW) and North East (NE) LHINs, respectively with 515.4 and 468.9 per 100,000/population. The NELHIN ranked highest for crudes rates where no TBI or concussion (202.4) were recorded and the NWLHIN ranked first for confirmed TBI (38.5) and concussion (242.5) (Colantonio, 2016). By comparison, rates of head injury by external causes from 1994-

1999 were reported at rates of 106.7 per 100,000/population for the northern region (Pickett et al., 2004) which presumably included both the NELHIN and NWLHIN, however as the sampling methods included data solely from large urban referral centers, cases treated exclusively in rural communities were not accounted for in the data. Although the geographic boundaries between northern and southern Ontario may fluctuate, it would have minimal impact on total geographic boundaries as the provincial borders to the north, east and west remain unchanged. Therefore, any difference in overall rates of injury in this region or in their reporting could have provided an opportunity for further analysis with similar sampling methods.

Neurological assessment

The Glasgow Coma Scale (GCS) and its derivatives were developed over 40 years ago in response to a need to standardize the measurement of impaired consciousness. The GCS captures eye movement, verbal and motor response recorded over a 15 point scale with a minimum score of 3 when all responses are absent (Teasdale & Jennett, 1974). Originally designed to assess coma in TBI, application of the GCS has been extended to post-resuscitative evaluation of coma in cases of anoxic injury with its use established in the ED (Gill, Reiley, & Green, 2004) and critical care. (Heron, Davie, Gillies, & Courtney, 2001; Jennett, 2005) Jennett (2002) remarked the GCS was by far the most frequently utilized and researched measurement scale for assessment of neurological function in North America and it continues to be included in research studies. Use of the GCS in neurological assessment is endorsed by the WHO as part of the standards of surveillance in neuro-trauma and it is a clinical feature captured worldwide in the International Classification of Disease Codes (World Health Organization (WHO), 1995) making it a ubiquitous instrument in modern-day health care for the surveillance and management of patients. It is an integral component of the *Canadian CT Rules* (Stiell, Lesiuk, Wells, Coyle, et al., 2001; Stiell, Wells, et al., 2001) for decisions regarding diagnostic testing following head injury. The psychometric properties of this instrument (Gill et al., 2004; Gill, Windemuth, Steele, & Steven, 2005; Heron et al., 2001), its clinical application (Al-Salamah et al., 2004; Costanti Settervall, Cardoso de Sousa, & Fürbromger e Silva, 2011; Iankova, 2006; Jain, Dharap, & Gore, 2008; Jennett & Bond, 1975) and interdisciplinary use (Heron et al., 2001; Waterhouse, 2008) are well established in the literature and worldwide (Costanti Settervall et al., 2011; Jain et al., 2008; Tasseau, Rome, Cuny, & Emery, 2002).

Table 1.1 – Glasgow Coma Scale

Glasgow Coma Scale						
	Eyes open		Best verbal response		Best motor response	
	Spontaneously	4	Oriented	5	Obey commands	6
	To speech	3	Confused	4	Localise pain	5
	To pain	2	Inappropriate words	3	Withdrawal to pain	4
	None	1	Incomprehensible sounds	2	Flexion to pain	3
			None	1	Extension to pain	2
					None	1
GCS = 15-13 (mild)		GCS =12-9 (moderate)		GCS= 8-3 (severe)		
Adapted from Teasdale & Jennett (1974)						

Predicting outcomes for head injury

It is understood that the risk of complications increase with injury severity and the presence of clinical indicators and conditions. A seemingly mild injury can progress and become a life-threatening event, and an injury that appears severe may recover once the influence of factors, such as drugs, alcohol, hypotension or hypoxemia, recede and normal function resumes (Jennett, 2002; McHugh et al., 2007; Ronning, 2015). It has been well-established in the field of brain physiology that as cerebral reserves of glucose and oxygen are minimal and that these energy stores are exhausted quickly when blood flow is interrupted or impeded, resulting in permanent injury (Lucas, 2009; Mejerhans, 2010; Mintun, 2001). For this reason, any alteration in brain function or other evidence of brain pathology must be identified at the earliest possible moment since the brain is very sensitive to fluctuation in blood flow. The fundamental purpose of assessment and surveillance is to detect any variance from normal, to allow for timely reaction and treatment and to prevent and minimize the course of adverse events.

The studies examining the factors that influence patient outcomes following moderate and severe TBI, has been growing steadily. The International Mission on Prognosis and Analysis of Clinical Trials (IMPACT) examined admission data prospectively collected on 8,509 patients with moderate to severe TBI (i.e. GCS < 12) with outcome as measured by Glasgow Outcome Scale at six months after injury. In this study, the strongest predictors of the outcome following a TBI were age, GCS motor score and pupillary reactivity. The prognostic model that combined these variables could be further improved by considering computerized tomography (CT) characteristics, secondary insult resulting from hypotension and hypoxia, and laboratory parameters such as glucose and hemoglobin (Steyerberg et al., 2008). Exposure to hypoxia, hypotension or hypothermia was also strongly associated with poorer outcomes, even after adjustment for age, GCS motor score, pupil reaction and CT characteristics (McHugh et al., 2007). This can be explained by the physiological relationships between brain function and vital signs (VS). Damage to the hypothalamus can affect temperature regulation and increased intracranial pressure can result in bradycardia, hypertension and changes in respiration. Cerebral herniation can bring forth tachycardia and hypertension along with apnea (Batson & Thompson, 2008; Smeltzer & Bare, 2004; Swan, 1995). The mortality rates for patients with acute head injuries and whose systolic blood pressure (SBP) < 100 mmHg or with SBP > 140 mmHg is higher than for normotensive patients. Patients older than 60 years of age also had higher mortality rates compared to younger patients, suggesting that intracranial compliance decreases with age (Zafar et al., 2011).

Strong prognostic value was also associated with causes of injury and long-term outcome in moderate to severe TBI. Some studies reported better outcomes for injuries related to road traffic accidents and assaults whereas injuries from falls were reported to have poorer outcomes as these cases were more often associated with older age groups (Butcher et al., 2007). Data collected on 1,039 patient in a 1992 study conducted in inner city Toronto identified patient age ($p \leq 0.001$), GCS score ($p \leq 0.001$), pupillary inequality ($p \leq 0.05$) and injury from falling ($p \leq 0.001$) as independent predictors of the presence of operable intracranial hematoma. (Gutman et al., 1992) The incidence of intracranial hematoma from TBI increases threefold for patients over 50 years old than for patients less than 30 years of age, and not surprisingly the incidence increased with decreasing GCS score. However, even in cases of mild injury with GCS scores of 13 to 15, patients presenting with other risk factors had a substantial incidence of operable hematoma and of those over 40 years of age who were also injured in a fall, there was a 29%

incidence of operable intracranial bleed, even with GCS scores of 13 and up (Gutman et al., 1992). Patient outcome could then be predicted based on the nature of the injury and clinical symptoms. Factors related to poor outcomes therefore are important knowledge for the treating clinician and should serve as an alert for potential risk of evolving injury such as intracranial bleeding.

Clinical surveillance

The physiology behind VS, the measurement standards and fundamental scientific principles, is undisputable as each component remains a good indicator of patient stability (Goldhill & McNarry, 2004; Swan, 1995; Wagner, Johnson, & Kidd, 2006). The predictive value of VS assessment in avoiding life-threatening events, especially when combined with other clinical indicators is gaining momentum. Recent international studies of serious adverse in-hospital events have examined the relationship between the observation of abnormal VS findings and patient outcomes to assess the prognostic value for potential life-threatening events. Australian researchers (Harrison, Jacques, Kilborn, & McLaws, 2005; Jacques, Harrison, McLaws, & Kilborn, 2006) examined the prevalence of recordings the 'signs of critical conditions and emergency responses' (SOCCER) in hospital wards. A retrospective cross-sectional survey of 3,160 general medical-surgical adult admissions over a 14-day period reported abnormal pulse oximetry (SpO₂), blood pressure (BP), pulse/heart rate (HR) were among the top four early signs (ES) of serious adverse event (SAE) and abnormal respiratory rate (RR) and GCS score ranked 11 and 12 respectively. Neither the total nor the mean frequency of VS observations were reported, but 54.7% of admissions had at least one recording of ES and 24% of admission had 10 or more recordings of ES of SAE. The top four late signs of SAE included abnormal SpO₂, pulse, BP and GCS; 33.1% of admissions had combinations of recordings that met the criteria for activating a rapid response team. The relationship between VS as clinical indicators was later re-examined by Mitchell and colleagues (Mitchell et al., 2010) in a prospective controlled treatment trial to train staff in detecting the clinical deterioration of patients. A total of 1,157 control and 985 intervention subjects were studied over a four-month period. The authors found a 72% relative reduction of unexpected admission to Intensive Care Unit and 82% relative reduction of unexpected deaths in a general medical-surgical population. Mean daily frequency of VS documentation increased during the intervention period from 3.4 (SE 0.22) to 4.5 (SE 0.17), $p=0.001$ however, the authors cited a Hawthorne effect as contributing to the outcome. Although the GCS was not among the top-ranking predictors of early changes, head injury was not characteristic of the study population.

These studies helped to establish the prognostic value of VS in predicting evolving patient deterioration and the merits of routine surveillance. Surveillance strategies would yield improved outcomes if VS were consistently included in every patient assessment, yet there is a lack of consensus amongst experts as to the frequency of conducting VS assessment in a hospitalized population (Zeitz & McCutcheon, 2006). A multinational consensus conference on the afferent limb of Rapid Response Systems recommended the composition of a 'core set' of vital signs should include HR, BP, RR, Temperature, SpO₂ and level of consciousness (i.e. GCS) but could not agree on optimum frequency of this activity despite acknowledging that trends in VS must be well documented to justify clinical decisions concerning the course of care (DeVita et al., 2010).

Frequency of neurological assessment

Despite all the endorsements it has received, the frequency of neurological assessment using the GCS was never recommended by the originators of the scale and few studies address the frequency of assessment through the course of clinical surveillance. Given the GCS was originally described for repeated measures of the depth and duration of impaired consciousness and coma (Jennett & Teasdale, 1977), the score should be recorded at regular intervals during the course of treatment. Jennett (2002) later suggested using the GCS within the context of guidelines, where established frequency of monitoring of recently injured patients “had led to improved outcomes by reducing the frequency of avoidable secondary brain damage due to complications” (p.99). Failure to have recorded the GCS at all or with sufficient frequency or to not have acted promptly upon changes in GCS has been the basis of claims of medical negligence (Iavagnilio, 2011; Jennett, 2002) although the evidence underpinning the frequency of neurological observations has not yet been established (Mavin, 2009).

Recommendations for clinical practice guidelines developed jointly by the American Association of Neurosurgical Nurses and the Association of Rehabilitation Nurses substantiates that the frequency of assessment and monitoring following concussion has not been addressed in the literature. The report suggests occasional mention of serial or repeated assessments to track neurologic decline or progress exists but the timing or frequency of such assessments following concussion is not reported in the literature (American Association of Neuroscience Nurses & Association of Rehabilitation Nurses, 2011). Given that the literature suggests the frequency be adapted according to the patient’s condition, this insinuates that one must first assess the patient in order to determine the condition that merits a change in the assessment interval. Without a pre-determined schedule of assessment, a patient’s deteriorating condition will have opportunity to progress further without interruption until the next assessment that would prompt the nurse in abbreviating the assessment interval.

Documentation of VS and GCS

The predictive value of VS and GCS is lost without first conducting an assessment, and second documenting the activity. Recent studies have indicated gaps in the documentation of VS and or neurological assessment. In an exploratory study of cases presenting to acute care areas of the ED, Armstrong and colleagues (2008) noted in 387 eligible charts that VS were being recorded in full within 15 minutes of arrival for only 58% of cases. Repeat VS at 60 minutes after arrival were documented in only 7% of cases (Armstrong, Walthall, Clancy, Mulle, & Simpson, 2008). One can argue in favour of standard documentation forms that provide triggers for data collection, surveillance and reporting and yet, researchers noted the missing data in 457 transfers received from long-term care facilities to an Ontario ED even when a provincially-approved standardized transfer form was made available to sending facilities. A significant difference ($p < 0.001$) in information gaps was reported in cases where the form was not used, and gaps were present even when replaced with a substitute form. At least one information gap existed in 85.6% of cases and VS documentation was absent or missing in 37.6% of cases. The study also identified gaps in documentation of GCS and loss of consciousness on provincial transfer forms for 55.1% of cases where patients were transferred from nursing homes and seniors residences to an Ottawa ED for assessment of possible head injury (Cwinn et al., 2009).

The *Collège des médecins du Québec* carried out a province-wide study in 2003 and again in 2006, examining the frequency of documenting GCS and brain-stem reflexes for cases

of severe TBI. The researchers found that documentation of these clinical features was inversely proportional to the distance between a primary hospital and a neuro-trauma referral center. Overall, documentation of GCS alone in the 24 hours preceding death increased in only 40% of cases (Cloutier et al., 2006; Morin et al., 2003) thereby limiting the study's ability in establishing a true portrait of the potential for organ donation. More recently, researchers have reported GCS scores were missing in 65% of cases in a study of chart records reviewed in five geographic sites in Ontario including urban and rural hospital EDs and physician clinics (Ryu, Feinstein, Colantonio, Streiner, & Dawson, 2009). Regardless of injury severity, there are demonstrated gaps in documentation practices associated with neurological assessment that may contribute to inaccurate population estimates of head injury and present difficulty in assessing patient outcome. The reports of missing data are not restricted to regions or type of institution and include both VS and GCS.

Data retrieved between 2010 and 2011 from IntelliHEALTH Ontario, a database overseen by the MOHLTC and provided by the Sudbury and District Health Unit, indicates that there were 19,907 cases of head injury of varying degrees of severity reported in the northern Ontario. Admissions across the north accounted for 1457 cases, however only 455 of these had reported GCS scores. The GCS score was unavailable for 121 and unknown for another 881 admitted cases (King, 2013b). Head injury as a diagnosis accounted for 19,907 ED visits however in over 95% of these cases the GCS score was either unavailable (n=420) or unknown (n=18,535) (King, 2013a). An explanation for the missing data cannot be established without conducting a comprehensive chart review of the source documents to examine the relationship of this information gap.

Northern and rural health

The inverse proportions of documentation in GCS noted in the studies conducted by the *Collège des médecins du Québec* (Cloutier et al., 2006; Morin et al., 2003) suggests variations in practice between rural and urban settings. Researchers have remarked upon the impediments in rural practice associated with infrastructure such as the lack of modern equipment and education in the application of the health information technologies when these are made available (Hegney, McCarthy, Rogers-Clark, & Gorman, 2002a) so that rural nurses, without any previous training, (Hegney, 1995; Hegney, McCarthy, Rogers-Clark, & Gorman, 2002b) typically learn on the job (Kenny & Duckett, 2003) even in the ED (Sloan et al., 2006). For example, nurses in small hospitals in Ontario are less likely to receive training in Canadian Triage Acuity Scale (CTAS) and more likely to have less than 2 years of experience in emergency services (Sloan et al., 2006). This may extend to suggest rural nurses also provide TBI care without specific training.

Service provision for the treatment of TBI in rural setting is further complicated by the limited access to CT scanners. At some rural hospitals, patients requiring CT are transported 1-1.5 hours by land ambulance to another hospital for scanning thus lengthening the time in confirming a diagnosis and impacting the ability to conform to Canadian guidelines (Stiell, Lesiuk, Wells, Coyle, et al., 2001; Stiell, Lesiuk, Wells, McKnight, et al., 2001; Stiell, Wells, et al., 2001) for CT scanning which recommends CT if GCS score < 15 at 2 hours after injury. In areas where CT scanning was limited, the rate of hospital admissions for mild TBI was reported to be higher (Sultan, Boyle, Pereira, Antoun, & Maimaris, 2004). Limited access to imaging services could adversely impact on patient outcomes as CT scans provide diagnostic value to cases where TBI is suspected and may be a contributing factor to the higher rates of

hospitalization for head injury reported in northern Ontario (Compass, 2008). Surveillance of clinical events is essential for early identification of changes occurring in the course of clinical presentation and is vital in deciding whether CT is necessary. This is especially important where access to CT scanning is limited by distance, such as in some regions of northern Ontario, and where a return trip for diagnostic testing can extend the length of care necessary to conclude in medical diagnosis by several hours.

Future Research

Despite the body of knowledge presented, scholarly research is limited. Few studies have looked at the short-term outcomes of immediate care for mild TBI and none could be found to suggest on-going surveillance and assessment provided in the initial hours following presentation to hospital contributed to positive or negative outcomes. Considering the sequelae associated with moderate and severe TBI, there is still much to be learned in the study of early intervention, assessment and current care practices. Jennett (2002) noted a gap in the literature bridging the elements of assessment such as VS (i.e. pulse, BP, temperature, respirations, pulse oximetry) with injury outcomes. Albeit there is some evidence supporting an association between GCS and essential VS, the paucity in the literature remains ever present. When information is missing in the patient's record, health care professionals are unable to decipher a patient's health needs much less decode an evolving adverse event, thus impacting on patient outcome. As both GCS and VS documentation independently provide a measure of predictive value, an examination of all these baseline clinical variables for their combined effect in prediction would be warranted. The lack of documentation of GCS, VS or both in clinical records warrants further examination, with particular focus on acute care in rural areas.

A comprehensive assessment including all components related to neurological function including GCS, pupillary size and light reactivity, limb strength and VS, is paramount if the nurse is to initiate prompt action by medical personnel meant to improve survival outcomes and minimize long term sequelae. The development of clinical practice guidelines that provide direction in the frequency or timing of serial or repeated assessment for all TBI with consideration for severity of injury may contribute to improved documentation that in turn permits the evaluation of managed care and patient outcomes. Research that contributes towards establishing the parameters of frequency, timing and interval of neurological assessment is necessary. Studies that examine other clinical features to be included in a neurological assessment, such as VS, could greatly contribute in providing evidence to support surveillance activities in the care of patients following traumatic injuries that could include TBI.

Neurological assessment using a comprehensive and methodical approach remains the cornerstone to identifying evolving injury and planning care and would contribute a reliable means to predicting outcome at the earliest opportunity. A missed cue of physiological decline could impact patient outcome and the greatest challenge in the management of head injury rests in knowing with certainty which cases are most likely to result in a positive or negative outcome. This is especially important in rural communities where distance can play a factor in timely management by specialized personnel. The time between arrival and where the decision to discharge, transfer or admit can be affected by the time required to access diagnostic testing and the added delays of orchestrating transfer to tertiary care facilities. Research in this area with comparison between rural and urban practice settings would shed light on the disparities in morbidity and mortality rates associated with degrees of urbanization.

This paper is limited by availability of scholarly papers that have examined the relative contribution of traumatic injuries in contrast to rural and urban areas. The multiple facets of TBI in rural areas, and specifically in northern Ontario, have not been well documented in comparison to studies conducted in densely populated regions. The focus on large, densely populated areas to the south of the province, while providing samples sufficient for data analysis, has neglected examination of rural areas where rates of injury are consistently higher, especially when population rates are taken in account.

The availability of data associated with research of rural regions is another limitation. All too often the number of cases is too small to be reported without risking identification of vulnerable persons or to generate findings that are statistically significant. At times, the only available data is reported by agents of the MOHLTC and disseminated in the absence of a robust research design for information purposes and to create interest. Rural and northern health research in the field of TBI can contribute in the analysis of resources, provide solid evidence and enhancing the effort of those entrusted in creating health policy and developing service plans. The rates of injury reported across the north should raise concern and would warrant further analysis of trends, changes and hot spots of activity. Identifying the external causes of injury frequently associated with higher rates TBI provides an opportunity to earmark resources and develop prevention strategies aimed at specific behaviours or living conditions.

Understanding that research agendas are restricted by available funding and resources, the dissemination of results from isolated data sets provides a narrow snapshot. Repeated measures of salient findings would impart a better understanding of trends in need of attention. One of the key messages in this paper is the requirement for continued surveillance and the development of guidelines for practice that enhance immediate response with improved outcomes as the objective. The same may be true for establishing surveillance activities in research, where early variations in population trends are captured in order to identify changes in epidemiology that warrant consideration, can be acted upon and improve health outcomes.

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Appendix

Table 1.1 – Glasgow Coma Scale

Glasgow Coma Scale						
	Eyes open		Best verbal response		Best motor response	
	Spontaneously	4	Oriented	5	Obey commands	6
	To speech	3	Confused	4	Localise pain	5
	To pain	2	Inappropriate words	3	Withdrawal to pain	4
	None	1	Incomprehensible sounds	2	Flexion to pain	3
			None	1	Extension to pain	2
				None	1	
GCS = 15-13 (mild)		GCS =12-9 (moderate)		GCS= 8-3 (severe)		
Adapted from Teasdale & Jennett (1974)						