Australasian Emergency Nursing Journal (2013) 16, 127–135 Vol. 16 No. 4 November 2013

Available online at www.sciencedirect.com
ScienceDirect
journal homepage: www.elsevier.com/locate/aenj

RESEARCH PAPER

Thai emergency nurses' management of patients with severe traumatic brain injury: Comparison of knowledge and clinical management with best available evidence

Jintana Damkliang, MNS (Adult Nursing), RN [a,b,*]
Julie Considine, RN, PhD, FACN [c,d,1]
Bridie Kent, PhD, BSc (Hons), RN [e,2]

[a] *School of Nursing and Midwifery, Deakin University, Australia*
[b] *Faculty of Nursing, Prince of Songkla University, Thailand*
[c] *Eastern Health – Deakin University Nursing & Midwifery Research Centre, Australia*
[d] *Centre for Quality and Patient Safety Research, Australia*
[e] *University of Plymouth, UK*

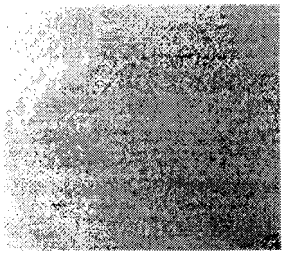
Received 11 June 2013 ; received in revised form 23 September 2013; accepted 23 September 2013

KEYWORDS
Brain injury;
Emergency nursing;
Trauma;
Neurotrauma;
Evidence-based practice;
Thailand

Summary
Background: In Thailand, the rate of TBI-related hospitalisation is increasing, however, little is known about the evidence-based management of severe TBI in the developing world. The aim of this study was to explore Thai emergency nurses' management of patients with severe TBI.
Methods: An exploratory descriptive mixed method design was used to conduct this two stage study: survey methods were used to examine emergency nurses' knowledge regarding management of patients with severe TBI (Stage 1) and observational methods were used to examine emergency nurses' clinical management of patients with severe TBI (Stage 2). The study setting was the emergency department (ED) at a regional hospital in Southern Thailand.
Results: 34 nurses participated in Stage 1 (response rate 91.9%) and the number of correct responses ranged from 33.3% to 95.2%. In Stage 2, a total of 160 points of measurement were observed in 20 patients with severe TBI over 40 h. In this study there were five major areas identified for the improvement of care of patients with severe TBI: (i) end-tidal carbon dioxide

* Corresponding author at: c/- School of Nursing and Midwifery, Deakin University, 221 Burwood Hwy, Burwood, Victoria 3125, Australia. Tel.: +61 3 9244 6127.
E-mail addresses: jdamklia@deakin.edu.au (J. Damkliang), julie.considine@deakin.edu.au (J. Considine), brigid.kent@plymouth.ac.uk (B. Kent).
[1] Address: c/- School of Nursing and Midwifery, Deakin University, 221 Burwood Hwy, Burwood, Victoria 3125, Australia.
[2] Address: School of Nursing and Midwifery, Drake Circus, Plymouth PL4 8AA, UK.

http://dx.doi.org/10.1016/j.aenj.2013.09.001



($ETCO_2$) monitoring and targets; (ii) use of analgesia and sedation; (iii) patient positioning; (iv) frequency of nursing assessment; and (v) dose of Mannitol diuretic.
Conclusions: There is variation in Thai nurses' knowledge and care practices for patients with severe TBI. To increase consistency of evidence-based TBI care in the Thai context, a knowledge translation intervention that is ecologically valid, appropriate to the Thai healthcare context and acceptable to the multidisciplinary care team is needed.

What is known

Increasing rates of severe TBI is a continuing challenge for Thai healthcare providers, particularly for emergency department clinicians. Current evidence-based guidelines for the initial management of severe TBI are predominantly from Western countries with well-developed trauma care systems and facilities.

What this paper adds

There is variation in Thai nurses' knowledge and care practices for patients with severe TBI. Some elements of variation in current practice may place patients at risk of harm. The results of this study provide a platform for targeted evidence-based interventions to improve care of patients with severe TBI in the Thai ED setting.

Introduction

Severe traumatic brain injury (TBI) is defined by a Glasgow Coma Scale (GCS) score of 8 or less.[1,2] Severe TBI is a major cause of death and disability worldwide. The incidence of severe TBI varies greatly in different parts of the world. In the United States, the annual rate of TBI-associated deaths is estimated to be 18 per 100,000 population.[3] In Europe, the average mortality rate following TBI is approximately 15 per 100,000 population.[4] In Australia, the incidence of severe TBI was 12 per 100,000 residents,[5] and the mortality rate following TBI-related hospitalisations was 4.6 per cent.[6] In Asia, the mortality rate per 100,000 population varies from 20 in India to 38 in Taiwan.[4]

In Thailand, there is little information available for nationwide TBI epidemiology, except for a few isolated studies in individual settings. In southern Thailand, a study of 1000 patients with a head injury was conducted in four hospitals, including a university hospital and three community hospitals.[7] Of these, 3.4% of head injured patients were identified as suffering from a severe TBI. Road traffic accidents (RTAs) accounted for approximately 60% of all cases of head injury, and most were motorcycle accidents. Helmets used in motorcycle related head injury were reported in 13.2%.[7] In 2007, a study of 28 Thai regional and tertiary hospitals indicated that approximately 4852 people died from RTAs, and 62,934 RTA victims were seriously injured.[8] Almost 30% of RTA cases studied sustained isolated head injuries, and approximately 17% had multiple injuries. Although the Thai government has introduced initiatives to reduce the severity and the impact of RTAs, the rate of TBI-related hospitalisation is still increasing. According to the Bureau of Policy and Strategy [BOPS] reports, the number of patients with intracranial injury rose dramatically in every region of Thailand from 70,134 cases in 2007 (110 per 100,000 population) to 82,993 cases in 2010 (130 per 100,000 population).[9] The increasing number of TBIs in Thailand means that the management of severe TBI is a continuing challenge for Thai healthcare providers, particularly for emergency department (ED) clinicians providing initial care for patients with severe TBI.

Evidence-based guidelines for the initial management of severe TBI have been established in many countries. In the US, for example, the Brain Trauma Foundation (BTF) has guidelines for severe TBI both in pre-hospital and in-hospital care.[2,10] Similar guidelines have been published in Australia, the UK and New Zealand.[11–14] The majority of the guidelines recommend immediate resuscitation of the patient and prevention of secondary insult.[2,10–14] The recommendations from these guidelines are summarised through the maintenance of airway and cervical spine protection, oxygenation and ventilation, circulation, and disability as shown in Table 1.

However, these guidelines are targeted at countries where the patients with severe TBI are managed within well-developed trauma care systems and facilities.[2,10–12,14] Little is known about the evidence-based management of severe TBI in the developing world, where facilities and resources are limited, and the incidence and management of TBI is poorly understood.

Aim

The aim of this study was to explore Thai emergency nurses' management of patients with severe traumatic brain injury. The specific research questions were:

(i) How does Thai emergency nurses' knowledge regarding management of patients with severe traumatic brain injury compare with best available evidence?
(ii) How does Thai emergency nurses' clinical management of patients with severe traumatic brain injury compare with best available evidence?

Methods

Design

An exploratory descriptive mixed method design was used to examine Thai emergency nurses' knowledge and

Table 1 Summary of evidence-based recommendations for the initial management of severe TBI.

Airway and C-spine protection[10,11,13]	• Early intubation • Maintain cervical spine stabilisation • Open and clear airway using Jaw Thrust
Oxygenation and ventilation[2,10,13]	• Monitor oxygenation continuously, keep SaO_2 > 90% • Monitor ventilation using capnography, keep $ETCO_2$ 35–40 mmHg
Circulation[2,10,13]	• Administer isotonic solution • Monitor blood pressure, keep SBP > 90 mmHg
Disability[2,10–14]	• The GCS should be measured prior to administering sedatives or paralytic agents, or after these drugs have been metabolised • Pupils should be measured after the patient has been resuscitated and stabilised • Administer a small dose of sedatives and analgesics • Keep head and neck in neutral alignment • Keep head of bed at 30° (unless contraindicated) • Ensure using appropriate size of cervical collar • Splinting of limb fractures • Urinary catheterisation • Early computerised tomography (CT) brain imaging

management of patients with severe TBI. This study was conducted in two stages. In Stage 1, survey methods were used to examine emergency nurses' knowledge regarding management of patients with severe TBI. In Stage 2, observational methods were used to examine emergency nurses' clinical management of patients with severe TBI.

Setting

The study was conducted in the ED at a regional hospital in Southern Thailand. The ED manages over 54,000 attendances per year; of these approximately 300 patients (ED statistics 2012, unpublished) have severe TBI defined as GCS of 8 or less.[1,2] Although there are guidelines for severe TBI management, as discussed, they are mostly derived from countries with well-developed trauma systems and although available in Thai ED settings, there was no evidence of guideline use at the study site at the time of this study. In addition, most recommendations in the guidelines used in Thailand focus on physician care and there are no specific nursing management recommendations for patients with severe TBI. In order to describe the context of emergency care in Thailand, a summary of emergency medical services (EMS) and initial emergency department care is provided. There are 4 levels of EMS provider training and skills in Thailand[15] and these levels are presented in Table 2.

Table 2 Summary of levels of EMS providers in Thailand.

Level of EMS provider	Training	Skills
Advanced life support (ALS)	Emergency nurse (Bachelor prepared) or emergency physician	Advanced CPR including advanced airway management (ETT), assisted ventilation, intravenous cannulation and medication administration
Intermediate life support (ILS)	110 h and trained by National Institute for Emergency Medicine	Basic CPR including applied oropharyngeal airway, bag-valve mask ventilation, chest compression, intravenous cannulation and medication administration
Basic life support (BLS)	3–5 days and trained by provincial emergency medical services unit	Basic CPR including applied oropharyngeal airway, bag-valve mask ventilation, chest compression
First responder (FR)	1–2 days and trained by provincial emergency medical services unit	First aid including bleeding control, splinting, and transferring

The ED at the study site uses a three category triage scale; emergent, urgent, and non-urgent. The majority of adult patients with severe TBI are triaged as 'emergent' and received into one of two adult resuscitation bays. The adult resuscitation bays have capacity to continuously monitor oxygen saturation, cardiac rhythm, heart rate, and blood pressure (non-invasive). Each resuscitation bay has one ParaPac® transport ventilator. One end-tidal carbon dioxide ($ETCO_2$) monitor is available for the whole ED. Within the ED, there is also a paediatric resuscitation bay, three general monitored cubicles, and nine unmonitored observation bays. Most patients with severe TBI are transferred from ED to CT and then to the intensive care unit (ICU) or trauma ward. Occasionally, patients are transferred from ED to CT and then back to ED before going to operating room or ICU but this is not the normal practice. The average length of ED stay at the study site for patients with severe TBI is approximately 2 h.

Usual staffing is nine nurses and four Emergency Physicians on both morning and evening shift, and seven nurses and three Emergency Physicians overnight. All ED nurses working in the study site are Registered Nurses who have

undertaken a four year Bachelor of Nursing degree. Nurses working in the ED have also undertaken an additional four months of postgraduate education specifically related to emergency nursing. On any given shift in the ED, there are usually one to two postgraduate prepared nurses and six to eight Registered Nurses.

Participants

All 37 emergency nurses (both Registered Nurses and postgraduate prepared nurses) were invited to participate in the study through a face-to-face invitation at nursing staff meetings. In Stage 1, emergency nurses were asked to complete the knowledge questionnaire. In Stage 2, the emergency nurse who was caring for the patient with severe TBI was asked allow nonparticipant observation of patient care, and verbal consent was obtained before commencing the observation. Participation in Stage 1 and Stage 2 was voluntary.

Tool development

Stage 1

In Stage 1, a questionnaire was used to test nurses' knowledge regarding management of severe TBI. In the absence of pre-existing published tools, the questionnaire was developed by the researchers specifically for this study. The questionnaire enabled collection of demographic data (nurses' age, highest level of nursing education, years of ED experience, specific training in trauma care) and required nurses to complete 21 multiple choice questions (MCQs). The MCQs were developed based on a literature review related to current research evidence for emergency nursing management of a patient with severe TBI. The key areas examined by the MCQs were: airway management and cervical spine protection (Q1–4), ventilation management (Q5–9), circulation management (Q10–11), patient reassessment (Q12), positioning (Q13), intracranial pressure monitoring (Q14–15), Mannitol management (Q16–18), management of pain and irritability (Q19–20) and diagnostic imaging (Q21). One point was given for each correct answer, resulting in a total possible score of 21.

Content and face validity was established by expert panel review. Three specialists in ED medicine, a neurosurgeon, an Advanced Trauma Life Support (ATLS) certified anaesthetist, and an ED physician, evaluated the items for relevance and accuracy. The alpha coefficient was employed as the index of content validity, using a 4-point rating scale, from non-relevant (1point) to very relevant (4 point).[13] The overall alpha coefficient was 0.97, indicating higher agreement between the experts.

Stage 2

A structured observation tool developed by the researchers was used in Stage 2 of the study to examine eight major areas clinical management of patients with severe TBI:

(1) Demographics and injury severity: patient age and gender, source of referral to ED, details of extra-cranial injuries, injury severity score (ISS) (ISS more than 15 indicates major trauma),[16] ED length of stay and ED discharge destination.
(2) Airway management and c-spine protection: use of jaw thrust or airway adjuncts, nursing management during endotracheal intubation (manual in-line stabilisation, medication administration), confirmation of correct endotracheal tube (ETT) placement, appropriately sized and applied cervical collar.
(3) Oxygenation and ventilation: oxygen saturation monitoring, $ETCO_2$ monitoring, respiratory rate monitoring.
(4) Circulation and fluid balance: use of intravenous fluids, heart rate and ECG monitoring, blood pressure monitoring.
(5) Disability: nursing assessment of GCS score and pupil size and reactivity.
(6) Disability: maintenance of cerebral venous outflow through positioning; maintaining head in neutral alignment and elevating head of bed 30 degrees.
(7) Management of pain, agitation, and irritability: use of sedation, splinting of fractures, urinary catheterisation, use of analgesics, monitoring for signs of agitation.
(8) CT scan and ED discharge: results, patient's condition immediately before transfer, personnel involved in transfer.

The observation tool was developed based on the literature review and related to the key elements of the management of patients with severe TBI. The tool was pilot tested prior to being used in the study. All observation data were collected by a single researcher (JD).

Data collection

Stage 1

A paper based survey was distributed to emergency nurses at regular staff meetings. Some nurses completed the survey at the meeting and others returned the survey to the researcher via a drop box or directly. The survey took approximately 15 min to complete. For the nurses who took the survey away, the researcher made it clear that they were not to use text books or other resources to assist with the MCQs.

Stage 2

The data were collected using nonparticipant observation where the researcher observed the situation without intentionally influencing the activities and behaviours under a study.[17] The observation commenced when the patient arrived in ED and continued through phases of resuscitation, observation/monitoring, and treatment until the patients were transferred to other departments. Each observation ranged from 35 min to 3 h and 15 min depending on patients' condition and ED length of stay. Observation took place over a seven week period and over various times of the day and days of the week.

Ethical considerations

The study was approved by the Human Research and Ethics Committee (HREC) at Deakin University and the Research Committee at the study site. All nurses gave written informed consent. Patient consent was waived by HREC.

Table 3 Results of knowledge scoring by 21 items ($n = 34$).

Areas of knowledge	Participants selecting the correct response	
	n	%
Airway management and cervical spine protection		
Q1: securing the airway with ETT	33	97.1
Q2: performing a jaw-thrust to open airway	27	79.4
Q3: use of auscultation and capnography to confirm ETT placement	30	88.2
Q4: apply an appropriate size and proper application of a cervical collar after intubation	21	61.8
Ventilation management		
Q5: target SpO_2/PaO_2	31	91.2
Q6: target end-tidal CO_2 ($ETCO_2$)	9	26.5
Q7: target $ETCO_2$ if hyperventilated is used as a temporising measure for cerebral herniation	17	50.0
Q8: results of hypocarbia in severe TBI	18	52.9
Q9: results of hypercarbia in severe TBI	20	58.8
Circulation management		
Q10: appropriate solution for resuscitation	32	94.1
Q11: target of blood pressure	27	79.4
Patient reassessment		
Q12: reassessment with airway, breathing, and circulation	25	73.5
Positioning		
Q13: maintain head and neck in neutral position	24	70.6
Intracranial pressure monitoring		
Q14: action if the patient developed a fixed and dilated pupil (s)	24	70.6
Q15: signs of IICP in brain stem	18	52.9
Mannitol management		
Q16: standard dose of Manitol	16	47.1
Q17: condition that should be avoided during administration of Mannitol	29	85.3
Q18: purpose of Mannitol	33	97.1
Management of pain and irritability		
Q19: nursing interventions that would be appropriate in preventing complications following a severe TBI	15	44.1
Q20: use of sedatives and analgesics in a severe TBI	9	26.5
Diagnostic imaging		
Q21: purpose of CT brain imaging	33	97.1

Data analysis

Study data were analysed using IBM SPSS 21.0. Descriptive statistics were used to summarise the study findings. When study data were not normally distributed, medians (Mdn) and interquartile ranges (IQR) are presented. In Stage 1 of the study, absent responses were coded as incorrect and scored as zero.

Results

Stage 1

Of the 37 nurses approached to participate in Stage 1 of the study, 34 nurses returned surveys giving a response rate of 91.9%. The median age of study participants was 32 years (IQR = 26–36) and 73.5% were female. The majority of participants were Bachelor prepared (88.2%, $n = 30$) and 11.8% held Master's degrees ($n = 4$). Participants had a median of 4 years of emergency nursing experience (IQR = 1–8) and 32.4% of participants ($n = 11$) had undertaken specific training in trauma care.

The number of correct responses ranged from 33.3% to 95.2% (Mdn = 71.4%, IQR = 57.1–80.9%). The areas with the highest number of correct responses were related to securing the airway with endotracheal intubation, purpose of Mannitol, and purpose of CT brain imaging. For each of these questions, 97.1% (33/34) participants had the correct response. The areas with the lowest number of correct responses were related to target end-tidal carbon dioxide (ETCO2) levels (26.5%, $n = 9$), use of sedatives and analgesics in a patient with severe TBI (26.5%, $n = 9$), and nursing interventions that would be appropriate in preventing complications following a severe TBI (44.1%, $n = 15$) (Table 3).

Stage 2

A total of 160 points of measurement were observed in 20 patients with severe TBI over 40 h. Of the 20 patients with a severe TBI observed, 18 were males and 2 were females. All

Table 4 Nursing management of patients with severe TBI ($n = 20$).

Observational areas	Yes n (%)	No n (%)	N/A
Airway management			
• Jaw thrust	7 (100%)	0	13
• Oropharyngeal airway	20 (100%)	0	0
• Prepare capnography	0	20 (100%)	
• Confirm ETT placement – auscultation	20 (100%)	0	0
• Confirm ETT placement – $ETCO_2$	0	20 (100%)	0
Cervical spine protection			
• Manual in-line stabilisation during intubation	7 (100%)	0	13
• Appropriate size cervical collar	19 (95%)	1 (5%)	0
• Cervical collar correctly fitted	17 (85%)	3 (15%)	0
Oxygenation and ventilation			
• Continuous SpO_2 monitoring	20 (100%)	0	0
• Continuous $ETCO_2$ monitoring	0	20 (100%)	0
• Regular observation of respiratory rate	5 (25%)	15 (75%)	0
Circulation and fluid balance			
• Continuous heart rate monitoring	9 (45%)	11 (55%)	0
• Continuous ECG monitoring	9 (45%)	11 (55%)	0
• Blood pressure monitoring at least every 15 min	11 (55%)	9 (45%)	0
Disability			
• Nursing assessment of GCS and pupil size	20 (100%)	0	0
• Maintain head in neutral alignment	17 (85%)	3 (15%)	0
• Head of bed elevated 30 degrees	1 (6.3%)	15 (93.7%)	4
• Administration of sedation prior to intubation	5 (100%)	0	15
• Limb fractures splinted	0	1 (100%)	19
• Urinary catheterisation	20 (100%)	0	0
• Analgesics administered	0	20 (100%)	0
• Observation for signs of agitation/coughing	8 (88.9%)	1 (11.1%)	11

patients had been involved in motorcycle accidents. Most were referred from a smaller community hospital ($n = 15$) approximately 15–100 kilometres from the study site and transferred by ambulance but five patients were brought directly from the accident site to the ED. The GCS on ED arrival ranged from 3 to 8: the median GCS was 5 and 30% of patients had GCS of 3. The median injury severity score was 32 (IQR = 26–39). An ISS score more than 15 indicates major trauma.[16]

The application of jaw thrust was observed in 100% of patients however hyperextension of patient's head was observed in three patients. Five patients were intubated in the ED and fifteen patients were already intubated at the transferring community hospital, however, two of these patients needed re-intubation in the ED. A cervical collar was applied in all patients, however there were three patients in whom the cervical collar was not properly applied (collar too small, loose application, and collar applied back-to-front). The most common method of confirming ETT placement was chest auscultation and $ETCO_2$ was not used to confirm ETT placement in any patients.

SpO_2 was continuously monitored in all patients but no patient had continuous $ETCO_2$ monitoring. The median SpO_2 was 99% (IQR = 96–100) however SpO_2 values ranged from 0% (in patients who had cardiac arrest on ED arrival) to 100%. There were three patients who had an observed episode of hypoxaemia defined as SpO_2 less than 90%. In these cases, the nursing response to hypoxaemia included reporting to the Emergency Physician ($n = 3$), checking placement of the pulse oximeter probe ($n = 3$), checking ETT cuff ($n = 1$), and ETT suction ($n = 3$). The frequency of respiratory rate monitoring was variable and ranged from 5 min to 30 min: respiratory rates were recorded as 'ET' in 60% of patients ($n = 12$) indicating that the patient was intubated with an ETT in situ.

Intravenous normal saline (0.9%) was administered to all patients however two patients received packed red cells and 25% received colloid solution (Voluven®). The median volume of intravenous fluids administered during ED care was 900 mls (IQR = 525–3675). Continuous monitoring of pulse rate occurred in all patients however only 45% of patients had continuous ECG monitoring. All patients had non-invasive blood pressure monitoring however the frequency of blood pressure monitoring ranged from 5 min to 2 h. Five patients had observed episodes of hypotension (systolic blood pressure < 90 mmHg). The nursing responses in all five patients included insertion of large bore cannulae, IV fluid administration, reporting to the ED physician, and keeping head of bed in flat position.

The GCS and pupil size were assessed every 5–10 min to every 2 h. Abnormality of GCS and pupil size and reactivity was found in all 20 patients. As discussed previously, the median GCS was 5 and 30% of patients had GCS of 3. Bilateral fixed dilated pupils were presented in 30% of patients

($n=6$), and 20% of patients ($n=4$) had unilateral dilated pupils. Patients' head and neck were maintained in neutral alignment in 17 cases, using an appropriate sized cervical collar. Only one patient had the head of bed elevated to 30 degrees, and rest of patients were in the supine position for the whole ED episode of care. Four patients were given sedatives (Diazepam 10 mg) before intubation, six patients were given sedatives for agitation, and only one patient received Profofol® before intubation and when agitated. There was one patient observed to have a wrist fracture that was not splinted. Urinary catheterisation occurred in all patients. No patient received analgesics during care in the ED. ED management is summarised in Table 4.

The median ED length of stay was 95 min (IQR = 60–140). Two patients died in the ED; they both had open skull fractures with exposed brain tissue (ISS were 53 and 40). Twelve patients were transferred from ED to the trauma ward, five patients were transferred from ED to the operating room, and only one patient was transferred to ICU.

Discussion

In this study there were five major areas identified for the improvement of care of patients with severe TBI. First, end-tidal carbon dioxide ($ETCO_2$) was not observed to be used in any patient and multiple choice questions regarding $ETCO_2$ monitoring were poorly answered. It is clearly recommended that all patients with ETT intubation should have $ETCO_2$ monitoring[10] to ensure correct tube placement and to monitor $ETCO_2$ levels. Capnography is an important element of care for patients with severe traumatic brain injury[10] as patients should be maintained in a state of normocapnia ($ETCO_2$ < 35–40 mmHg). Hyperventilation ($ETCO_2$ < 35 mmHg) should be avoided[10] as it may cause vasoconstriction leading to cerebral ischaemia.[18–20] Detection of the development of hypercapnia is also important as hypercapnia is known to cause cerebral vasodilation, increase intracranial pressure, decrease cerebral perfusion pressure and place the patient at risk of secondary brain injury.[18,21,22] One possible explanation for this finding was that there was only one capnography monitor for the whole ED (that has three resuscitation bays) so equipment availability is an issue. Further, the capnograph was stored in a corner of the resuscitation room rather than at the bed side, further limiting immediate availably. Anecdotal evidence suggests that nurses knew capnography was available but they did not know how to use the equipment in terms of how to connect it to the endotracheal tube and/or how to interpret the $ETCO_2$ value. In addition, nurses may have limited knowledge of the importance of $ETCO_2$ monitoring and using $ETCO_2$ values to guide management of patients with severe TBI.

Second, it was observed that no patient with severe TBI received any analgesics during care in the ED and multiple choice questions regarding use of analgesics and sedatives in severe TBI were poorly answered. This finding is particularly concerning given that 13 patients studied had multiple injuries in addition to their severe TBI and therefore could be expected to have significant pain. As recommended in the NICE guidelines, pain in the patients with severe TBI should be managed effectively because pain is a noxious stimulus that can increase intracranial pressure.[11] Increased intracranial pressure decreases cerebral perfusion pressure and places the patient at risk of secondary brain injury.[18] Adequate analgesia is critical in the prevention of elevated intracranial pressure in patients with severe TBI, so titrated intravenous opioids are recommended for patients with severe TBI.[11,21] Possible barriers to adequate pain management in the ED could be staff attitudes, knowledge deficits, and misconceptions about the need of effective pain management in patient with severe TBI, particularly when they are intubated so cannot verbalise pain. Some nurses may believe that giving any analgesics to patients with severe TBI may eliminate the ability to perform neurological assessment and this misconception requires further investigation. A major barrier to effective pain relief for patients with severe TBI is that in the Thai context, nurses cannot give analgesics without prescription from the physician, which is the case in most countries. However, advocacy is an important part element of the ED nursing role, and in patients with severe TBI, this is important given that they cannot communicate their pain status and untreated pain can cause further increases in intracranial pressure. There is an urgent need for further education and agreement from the multidisciplinary team regarding analgesic administration in patients with severe TBI.

Third, only one patient was observed to have the head of bed elevated to 30 degrees and nurses' responses to multiple choice questions regarding patients positioning were variable. Appropriate patient positioning is a basic nursing responsibility and for patients with severe TBI, elevation of the head of the bed to 30 degrees is recommended to decrease intracranial pressure by facilitating cerebral venous outflow.[18,19,23] For every 10 degrees of head elevation, it is reported that the mean intracranial pressure drops by 1 mmHg.[23] It is therefore recommended that patients with severe TBI should be nursed in an approximately 30 degrees head-up position, if other injuries allow.[18,19,23] Possible explanations for this finding may be that nurses did not know the importance of elevation of the head of the bed to 30 degrees in patients with severe TBI. Also, it was observed that some patients arrived in the ED on a spinal board and the board was not removed until the patient was transferred to other departments. Not only does prolonged time on a spinal board increase the risk of pressure injury,[24] it also made it impossible to elevate head of bed to 30 degrees. Another explanation for nurses not elevating the head of the bed was the presence of hypotension. In this study, five patients had observed episodes of hypotension (systolic blood pressure less than 90 mmHg), so keeping the head of bed in a flat position was reasonable in these patients.

Fourth, it was observed that the frequency of nursing assessment of vital signs and neurological status was variable. The frequency of respiratory rate monitoring ranged from 5 min to 30 min which suggest frequent measurement of respiratory rate, however, respiratory rates were recorded as 'ET' in 60% of patients so it is impossible to know the patient's adequacy of ventilation. Adequacy of ventilation is important information in patients with severe TBI as hypoventilation causes hypercapnia that increases cerebral vasodilation and intracranial pressure.[18–20] The frequency of blood pressure monitoring ranged from 5 min to 2 h as did

assessment of GCS and pupil size. Intervals of 2 h between assessment of blood pressure is concerning given the direct relationship between blood pressure, intracranial pressure and cerebral perfusion pressure[20,21] and the importance of early detection and treatment of hypotension in preventing secondary brain injury.[20] A number of guidelines for care of patients with head injury[2,11] recommend assessment of vital signs, GCS and pupils half-hourly. There are a number of possible explanations for the variability in time between nursing assessments. Staffing is challenging at the study site with only nine nurses for fifteen care areas including three resuscitation bays so nurses are always balancing competing priorities and one to one nursing care of patients with severe TBI is not always possible. Almost 80% of nurses were correct in the response to the knowledge questionnaire item related to target blood pressure but their knowledge related to regular assessment and the importance of limiting blood pressure fluctuations requires further investigation. Perceptions of injury severity and ED length of stay may also be factors in decisions related to frequency of nursing assessment. For example, there were three patients observed who were transferred from community hospitals with stable vital signs, had no sign of agitation: these patients were assessed twice, on ED arrival and before transferred to other departments.

Lastly, nurses' responses to multiple choice questions regarding the standard dose of Mannitol were poorly answered. Mannitol is recommended for increased intracranial pressure control at doses of 0.25–1 g/kg body weight[2] and is routinely used in emergency care of severe TBI at the study site. A possible explanation for this finding was that emergency nurses generally administered Mannitol to patients with severe TBI under prescription of "20% Mannitol 200 ml IV drip in 15 min", so they may not know the exact dose of Mannitol in grams per kilograms of body weight. In addition, the standard dose of the Mannitol is listed in the clinical guidelines used in the ED however the guidelines are designed for use by the neurosurgeons and emergency physicians, and not specifically designed to guide nursing care for patients with severe TBI.

There are a number of limitations that should be considered when interpreting the study findings. First, this was a single site study with a limited sample so the generalizability of the findings to other health services may be limited. Second, approximately half the nurses took the survey away and returned it to the researcher so it is possible that text books or other resources were used despite instructions to the contrary. Lastly, we acknowledge that emergency care also involves EMS personnel and medical staff, however, this study only focused on the emergency nursing management of patients with severe TBI.

Conclusion

There is variation in Thai nurses' knowledge and care practices for patients with severe TBI. Some elements of variation are placing patients at risk of harm particularly increased intracranial pressure and risk of secondary brain injury. The results of this study provide a platform for targeted education for emergency nurses and evidence-based interventions to improve care of patients with severe TBI in the Thai ED setting. In order to implement this evidence-base in the Thai context, education and a knowledge translation intervention that is ecologically valid, appropriate to the Thai healthcare context (particularly ED resources) and acceptable to the multidisciplinary care team will be major considerations.

Provenance and conflict of interest

Professor Julie Considine is a Deputy Editor of Australian Emergency Nursing Journal but has not been involved in the review process for this paper. This paper was not commissioned.

Funding

This study is an unfunded PhD study. Ms Damkliang is supported by a scholarship from Faculty of Nursing, Prince of Songkla University, Thailand.

References

1. O' Phelan K. Traumatic brain injury: definition and nomenclature. In: Zollman F, editor. *Manual of traumatic brain injury management*. New York: Demos Medical; 2011. p. 1–9.
2. Brain Trauma Foundation. *Guidelines for the management of severe traumatic brain injury*. 3rd ed; 2007. Available at: http://www.braintrauma.org/pdf/protected/Guidelines_Management_2007 [accessed 02.06.11].
3. Faul M, Xu L, Wald MM, Coronado VG. *Traumatic Brain Injury in the United States: Emergency Department Visits, Hospitalizations and Deaths 2002–2006*. Atlanta, GA: Centers for Disease Control and Prevention, National Center for Injury Prevention and Control; 2010.
4. Tagliaferri F, Compagnone C, Korsic M, Servadei F, Kraus J. A systematic review of brain injury epidemiology in Europe. *Acta Neurochir (Wien)* 2006;**148**(3):255–68.
5. Crowe LM, Anderson V, Catroppa C, Babl FE. Head injuries related to sports and recreation activities in school-age children and adolescents: data from a referral centre in Victoria, Australia. *Emerg Med Aust* 2010;**22**(1):56–61.
6. Helps Y, Henley G, Harrison JE. *Hospital separations due to traumatic brain injury, Australia 2004–05*. Adelaide: Australian Institute of Health and Welfare; 2008.
7. Ratanalert S, Kornsilp T, Chintragoolpradub N, Kongchoochouy S. The impacts and outcomes of implementing head injury guidelines: clinical experience in Thailand. *Emerg Med J* 2007;**24**(1):25–30.
8. Bureau of Epidemiology [BOE], Ministry of Public Health, Thailand. *Severe injury due to transport accidents (2007)*; 2011. Available at: http://www.boe.moph.go.th/report.php?cat=11&year=2007 [accessed 19.08.11].
9. Bureau of Policy and Strategy [BOPS], Ministry of Public Health, Thailand. *Health Status Information*; 2011. Available at: http://bps.ops.moph.go.th/webenglish/information.htm [accessed 04.08.11].
10. Brain Trauma Foundation. *Guidelines for prehospital management of traumatic brain injury*. 2nd ed; 2007. Available at https://www.braintrauma.org/pdf/prehospital_Guideline_2nd_Edition.pdf [accessed 16.07.11].
11. National Institute for Health and Care Excellence [NICE]. *Head injury: Triage, assessment, investigation and early management of head injury in infants, children and adults*;

2007. Available at: http://www.nice.org.uk/cg56 [accessed 11.06.11].
12. New Zealand Guidelines Group [NZGG]. *Traumatic brain injury: diagnosis, acute management and rehabilitation*; 2006. Available at: http://www.nzgg.org.nz [accessed 15.05.11].
13. Reed D. *Adult Trauma Clinical Practice Guidelines: Initial Management of Closed Head Injury in Adults*. 2nd ed; 2011. Available at: http://www.health.nsw.gov.au [accessed 15.01.12].
14. Scottish Intercollegiate Guidelines Network [SIGN]. *Early management of patients with a head injury: A national clinical guideline. Scottish Intercollegiate Guidelines Network*; 2009. Available at: www.sign.ac.uk [accessed 12.05.11].
15. National Institute for Emergency Medicine, Thailand. *Statistics in emergency medical services*; 2011. Available at: http://www.niems.go.th/ [accessed 12.11.11].
16. Baker S, B. O'Neill Jr W, H, Long W. The Injury Severity Score: a method for describing patients with multiple injuries and evaluating emergency care. *J Trauma (Lippincott Williams & Wilkins)* 1974;14(3):187–96.
17. Waltz C, Strickland O, Lenz E. *Measurement in nursing and health research*. New York: Spring Pub; 2010.
18. Mittal R, Vermani E, Tweedie I, Nee PA. Critical care in the emergency department: traumatic brain injury. *Emerg Med J* 2009;26(7):513–7.
19. Price AM, Collins TJ, Gallagher A. Nursing care of the acute head injury: a review of the evidence. *Nurs Crit Care* 2003;8(3):126–33.
20. Douglas B, Morarty J, Saxena M. Traumatic brain injury. In: Curtis K, Ramsden C, Lord B, editors. *Emergency and trauma care for nurses and paramedics*. Australia: Libby Houston; 2011. p. 1169–89.
21. Sande A, West C. Traumatic brain injury: a review of pathophysiology and management. *J Vet Emerg Crit Care* 2010;20(2):177–90.
22. Winter CD, Adamides AA, Lewis PM, Rosenfeld JV. A review of the current management of severe traumatic brain injury. *Surgeon (Edinburgh University Press)* 2005;3(5): 329–695.
23. Wong FWH. Prevention of secondary brain injury. *Crit Care Nurse* 2000;20(5):18–27.
24. Vickery D. The use of the spinal board after the pre-hospital phase of trauma management. *Emerg Med J* 2001;18(1): 51–4.