2014

Using an evidence-based care bundle to improve Thai emergency nurses' knowledge of care for patients with severe traumatic brain injury

Damkliangmns, J

http://hdl.handle.net/10026.1/8139

10.1111/jocn.12923
International Journal of Evidence-Based Healthcare
Wiley

JCN Journal of Clinical Nursing

Journal of Clinical Nursing

ORIGINAL ARTICLE

Using an evidence-based care bundle to improve initial emergency nursing management of patients with severe traumatic brain injury

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Aims and objectives. To test the feasibility of an evidence-based care bundle in a Thai emergency department. The specific objective of this study was to examine the impact of the implementation of the care bundle on the initial emergency nursing management of patients with severe traumatic brain injury.

Background. A care bundle approach is one strategy used to improve the consistency, quality and safety of emergency care for different patients groups, however, has not been tested in patients with severe traumatic brain injury.

Design. A pretest/post-test design was used. The study intervention was an evidence-based care bundle for initial emergency nursing management of patients with severe traumatic brain injury.

Methods. Nonparticipant observations were conducted between October 2012–June 2013 at an emergency department of a 640 bed regional hospital in Southern Thailand. The initial emergency nursing care was observed in 45 patients with severe traumatic brain injury: 20 patients in the pretest period and 25 patients in the post-test period.

Results. There were significant improvements in clinical care of patients with severe traumatic brain injury after implementation of the care bundle: (1) use of end-tidal carbon dioxide monitoring, (2) frequency of respiratory rate assessment, (3) frequency of pulse rate and blood pressure assessment, and (4) patient positioning.

Conclusion. This study demonstrated that implementation of an evidence-based care bundle improved specific elements of emergency nurses' clinical management of patients with severe traumatic brain injury.

Relevance to clinical practice. The study suggests that a care bundle approach can be used as a strategy to improve emergency nursing care of patients with severe traumatic brain injury.

What does this paper contribute to the wider global clinical community?

- Study findings demonstrate that use of the care bundle improved specific elements of clinical care of patients with severe traumatic brain injury in low resource environments.
- It is suggested that care bundles are an appropriate and feasible strategy to assist emergency nurses deliver optimal care to patients with severe TBI.
- The next logical progression is to develop and test care bundles to compliment the care bundle used in the emergency department and that address other elements of the patient journey for patients with severe TBI, such as care on the trauma ward or intensive care unit.

Key words: brain injury, care bundle, emergency nursing, evidence-based practice, neurotrauma, Thailand, trauma

Accepted for publication: 17 May 2015

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Introduction

Emergency nurses play a vital role in the initial care of patients with severe Traumatic Brain Injury (TBI) and frequently make independent decisions regarding the emergency care of these patients. Emergency nursing decisions include patient positioning, cervical collar application, and type and frequency of physiological monitoring (Price *et al.* 2003, Mittal *et al.* 2009). Emergency nurses' decisions directly impact on patient outcomes and can either increase or decrease the risk of secondary brain injury (Wong 2000, Gemma *et al.* 2002, Price *et al.* 2003, Mittal *et al.* 2009). Nursing practice centred on evidence-based standards requires nurses to be knowledgeable about research findings supporting their areas of expertise (McNett *et al.* 2010).

Care bundles are one strategy to increase integration of research evidence into clinical practice and facilitate healthcare providers to deliver optimal patient care (Resar *et al.* 2012). Although care bundles have been implemented initially in intensive care units (Morris *et al.* 2011, Sedwick *et al.* 2012), care bundles are also being applied in emergency care (Weeraratne *et al.* 2010, Nguyen *et al.* 2011, McCreanor *et al.* 2012, McCarthy *et al.* 2013). Use of care bundles in emergency care has been shown to improve clinical outcomes (Weeraratne *et al.* 2010, McCarthy *et al.* 2013). However, to date, little is known about care bundle use in emergency care, particularly in low-income and middle-income countries where backgrounds, facilities, staffing and resources are different from Western countries.

Background

Severe TBI is a global problem (Helps *et al.* 2008, Crowe *et al.* 2010, Faul *et al.* 2010) and is a major and increasing problem in Thailand [Ratanalert *et al.* 2007, Bureau of Policy and Strategy (BOPS), Ministry of Public Health, Thailand 2011]. In Thailand, the incidence of hospitalisation from TBI is rising (BOPS 2011), mostly due to the severity and impact of road traffic accidents (Bureau of Epidemiology, Ministry of Public Health, Thailand 2007). Thus, large numbers of persons suffering TBI, and specifically severe TBI, mean that the management of patients with severe TBI is a continuing challenge for Thai healthcare providers. Specific challenges also face emergency nurses who play a major role in the delivery of emergency nursing care to patients with severe TBI, as they are responsible for important patient care decisions, and are with the patient for the entirety of their Emergency Department (ED) episode of care.

Evidence to guide initial emergency nursing care of patients with severe TBI in Thailand is currently available in a format with limited clinical utility. Guidelines for the management of patients with severe TBI have been established in most Western countries (BTF 2007a,b, NICE 2007, NZGG 2007, SIGN 2009, Reed 2011), however, there are several problems with implementation of these guidelines in the Thai ED context. First, these guidelines are targeted at countries where the patients with severe TBI are managed within well-developed trauma care systems and emergency care facilities (Gerber *et al.* 2013, Talving *et al.* 2013). The settings in which these guidelines were developed and implemented are very different to those found in the EDs of low to middle-income countries. Second, the majority of the guidelines for the management of patients with severe TBI focus on physician care (BTF 2007a,b, NICE 2007, NZGG 2007, SIGN 2009, Reed 2011), so evidence-based guidance for Thai emergency nurses is lacking. Finally, currently available guidelines are lengthy and too complex for use in the busy clinical environment of an ED in low to middle-income countries (BTF 2007a,b, NICE 2007, NZGG 2007).

Research has shown variation in Thai emergency nurses' knowledge and care practices for patients with severe TBI (Damkliang *et al.* 2013). Some elements of variation are placing patients at risk of harm, particularly increased intracranial pressure (ICP) and risk of secondary brain injury (Damkliang *et al.* 2013). Secondary brain injury occurs in 60–80% of severe TBI (Jeremitsky *et al.* 2003) and lack of clear evidence for the initial emergency nursing management may lead to an increased risk of morbidity and mortality following the primary brain injury (O'Phelan 2011). Further, currently available evidence cannot be directly implemented into the Thai ED context, due to the different contexts outlined previously. As a result, an evidence-based care bundle for initial emergency nursing management of patients with severe TBI was developed based on the Thai ED context, facilities, and resources and implemented in one Thai ED (Damkliang *et al.* 2014).

Aim

The major aim of this study was to test the feasibility of an evidence-based care bundle in a Thai ED. The specific objective of this study was to examine the impact of the implementation of the care bundle on the initial emergency nursing management of patients with severe TBI. For the purposes of the study, 'severe TBI' was defined as a Glasgow Coma Scale (GCS) score of 8 or less, and 'initial' emergency nursing management was defined as nursing care delivered to the patients with severe TBI from arrival to the ED until the patient was transferred to another department, typically medical imaging, trauma ward or intensive care unit.

Methods

Design

A pretest/post-test design with observational study was used. The study intervention was an evidence-based care bundle for initial emergency nursing management of patients with severe TBI.

Participants

Patients eligible for inclusion in the study were patients:

- Aged ≥18 years,
- Presenting to ED with severe TBI, defined by a GCS score of 8 or less on ED arrival, and
- Present in the ED during periods of data collection.

Setting

The study was conducted at the ED of a 640 bed regional hospital in Southern Thailand. The ED at the study site uses a three category triage scale; emergent, urgent and nonurgent. 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 (noninvasive). Each resuscitation bay has one ParaPac® (Smiths Medical, UK) transport ventilator and there is one end-tidal carbon dioxide ($ETCO_2$) monitor available for the whole ED.

Study intervention

The study intervention was an evidence-based care bundle for the initial emergency nursing management of patients with severe TBI. The care bundle was developed by the researchers, focusing on four major elements of emergency care and using a primary survey approach: (1) airway management and cervical spine protection, (2) oxygenation and ventilation management, (3) circulation and fluid balance, and (4) disability and ICP management. Details of the care bundle development process have been published elsewhere (Damkliang *et al.* 2014).

Observational tool development

A structured observation tool, developed by the researchers, was used in pretest and post-test of the study to examine eight major areas of clinical management for 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), 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 electrocardiogram (ECG) monitoring, blood pressure monitoring.
5. Disability (1): nursing assessment of GCS score and pupil size and reactivity.
6. Disability (2): maintenance of cerebral venous outflow through patient positioning.
7. Management of pain, agitation, and irritability: use of sedation, splinting of fractures, urinary catheterisation, use of analgesics, monitoring for signs of agitation.
8. Computed Tomography of the head and ED discharge: results, patient's condition immediately before transfer, personnel involved in transfer.

In the absence of pre-existing published tools, the observation tool was developed initially by one researcher (JD). The observation tool was developed based on the literature review and related to the key elements of the care bundle for management of patients with severe TBI. Content and face validity of the observation tool were established by another researcher (JC), who is an expert in emergency nursing care. The tool was pilot tested prior to being used in the study. All observation data were collected by a single researcher (JD). To minimise bias during observations, the data collected were quantitative data pertaining to specific and objective nursing activities and the physiological status of the patient.

Data collection

Pretest data were collected between 29th October 2012–1st January 2013. The care bundle was implemented between 25th February 2013–29th March 2013, and a period of one month (April 2013) was allowed for normalisation of practice. Post-test data were collected between 5th May 2013–8th June 2013. The data were collected using nonparticipant observation where the researcher simply observed the situation without intentionally influencing the activities and behaviours under study (Waltz *et al.*

2010). Nonparticipant observation was chosen as the researcher wanted to observe but not influence clinical care.

The observation commenced when the patient arrived in the ED and continued through phases of resuscitation, observation/monitoring, and treatment until the patient was transferred to another department. Each observation took between 30 minutes–five hours, depending on patient's condition and ED length of stay. The researcher undertook a purely observational role during this phase of the study and did not participate in any patient care activities. The researcher stood behind the nurses' counter in the area of the resuscitation zone which enabled clear vision of the activities occurring in the resuscitation area. The researcher did not engage in any interactions with the emergency nurses during their nursing care delivered to the patient with severe TBI.

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. Permission from the head nurse of the ED and verbal consent from the ED nurses were obtained before commencing the observation. Patient consent was waived by HREC.

Data analysis

Data analysis was performed using the computer software SPSS version 22.0 for Windows® (IBM Inc., Chicago, IL, USA). Demographic data and clinical characteristics of the patients with severe TBI in the pretest and post-test periods were compared using Chi-Square Test for independence to establish equivalence of the groups (Gravetter & Wallnau 2011). Chi-Square Test for independence was also used to compare specific elements of emergency nurses' clinical management that occurred in pretest and post-test of the study (Gravetter & Wallnau 2011).

Results

Patient characteristics

Forty-five patients with severe TBI were included in this study; 20 patients were in the pretest period and 25 patients were in the post-test period. There were no significant differences in gender, age, mechanism of injury, and the referring system of patients with severe TBI in the pretest and post-test periods (Table 1).

Table 1 Demographic data of patients with severe TBI ($N = 45$)

Demographic data	Pretest ($n = 20$) n (%)	Post-test ($n = 25$) n (%)	χ^2	df	p
Gender					
Female	2 (10·0)	5 (20·0)	0·26	1	0·61
Male	18 (90·0)	20 (80·0)			
Age (years)					
18–31	13 (65·0)	11 (44·0)	5·47	3	0·14
32–45	1 (5·0)	8 (32·0)			
46–59	3 (15·0)	4 (16·0)			
>60	3 (15·0)	2 (8·0)			
Mechanism of injury					
2 wheels vehicle	19 (95·0)	19 (76·0)	3·83	3	0·28
4 wheels vehicle	1 (5·0)	2 (8·0)			
Fall	0 (0)	2 (8·0)			
Assault	0 (0)	2 (8·0)			
Referred to ED by					
Community hospitals	12 (60·0)	14 (56·0)	1·76	3	0·62
Provincial hospitals	3 (15·0)	4 (16·0)			
EMS	5 (25·0)	5 (20·0)			
Bystanders/relatives	0 (0)	2 (8·0)			

EMS, emergency medical service; ED, emergency department; TBI, traumatic brain injury.

There were statistically significant differences in clinical characteristics of patients with severe TBI between the pretest and the post-test period in terms of minimum systolic blood pressure with more hypotensive patients in the pretest group ($p = 0·03$) (Table 2). There were two deaths in the pretest group compared with no deaths in the post-test group and more patients from the post-test group were transferred from ED to ICU ($p = 0·05$) (Table 2).

Effect of care bundle implementation on emergency nurses' clinical management of patients with severe TBI

There were significant positive changes in clinical care of patients with severe TBI in four major areas: (1) use of $ETCO_2$ monitoring (0% vs. 56·0%, $p < 0·001$), (2) frequency of respiratory rate assessment (25·0% vs. 72·0%, $p = 0·01$), (3) frequency of pulse rate and blood pressure assessment (55·0% vs. 88·0%, $p = 0·03$) and (4) patient positioning with head of bed elevation to 30 degrees (6·3% vs. 75·0%, $p < 0·001$) (Table 3). There were also a number of other improvements in care after implementation of the care bundle that did not reach statistical significance but are core elements of initial emergency nursing management of patients with severe TBI. There were increases in application of appropriately sized cervical collars, splinting of limb fractures and observation for signs of agitation. The care bundle did not change the frequency of application of

Table 2 Clinical characteristics of patients with severe TBI ($N = 45$)

Clinical characteristics	Pretest ($n = 20$) n (%)	Post-test ($n = 25$) n (%)	χ^2	df	p
ISS					
25–35	13 (65·0)	19 (76·0)	1·59	2	0·45
36–45	6 (30·0)	6 (24·0)			
46–55	1 (5·0)	0 (0)			
GCS score on ED arrival					
3	4 (20·0)	3 (12·0)	1·10	3	0·78
4–5	4 (20·0)	5 (20·0)			
6–7	8 (40·0)	9 (36·0)			
8	4 (20·0)	8 (32·0)			
GCS score on ED discharge					
3	6 (30·0)	4 (16·0)	2·89	4	0·58
4–5	4 (20·0)	7 (28·0)			
6–7	7 (35·0)	10 (40·0)			
7–8	2 (10·0)	4 (16·0)			
>8	1 (5·0)	0 (0)			
O_2 saturation (%) (min)					
≤90	3 (15·0)	3 (12·0)	0·12	2	0·94
91–95	1 (5·0)	1 (4·0)			
96–100	16 (80·0)	21 (84·0)			
O_2 saturation (%) (max)					
≤90	2 (10·0)	0 (0)	3·34	2	0·19
91–95	0 (0)	1 (4·0)			
96–100	18 (90·0)	24 (96·0)			
Systolic BP (mmHg) (min)					
<90	5 (25·0)	0 (0)	10·72	4	0·03
90–100	0 (0)	4 (16·0)			
101–110	2 (10·0)	6 (24·0)			
111–120	5 (25·0)	6 (24·0)			
>120	8 (40·0)	9 (36·0)			
Systolic BP (mmHg) (max)					
<90	2 (10·0)	0 (0)	5·84	3	0·12
101–110	3 (15·0)	1 (4·0)			
111–120	0 (0)	2 (8·0)			
>120	15 (75·0)	22 (88·0)			
Time in ED (minutes)					
<60	1 (5·0)	7 (28·0)	6·69	4	0·15
60–90	9 (45·0)	9 (36·0)			
91–120	3 (15·0)	6 (24·0)			
121–150	4 (20·0)	2 (8·0)			
>150	3 (15·0)	1 (4·0)			
Transfer to					
ICU	1 (5·0)	9 (36·0)	7·99	3	0·05
Trauma ward	12 (60·0)	11 (44·0)			
OR	5 (25·0)	5 (20·0)			
Death	2 (10·0)	0 (0)			

ISS, injury severity score; min, minimum; max, maximum; ED, emergency department; GCS, Glasgow Coma Scale; TBI, traumatic brain injury.
ISS ranges from 1–75, if ISS >15 indicates the major trauma (Baker *et al.* 1974).

jaw thrust, use of oropharyngeal airways, confirmation of ETT using auscultation, use of continuous SpO_2 monitoring, nursing assessment of GCS and pupil size and frequency of urinary catheterisation (Table 3). All of these elements of nursing management had 100% compliance in both the pretest and post-test observations. There was a decrease in the proportion of patients who received continuous heart rate monitoring, continuous EGC monitoring and administration of sedation prior to intubation in the post-test group. No patient received analgesics during care in the ED in either the pretest or post-test period (Table 3).

Discussion

The study showed significant improvements in clinical care for patients with severe TBI following implementation of the care bundle. The results of the study are consistent with other studies indicating that implementation of care bundles in emergency care improve clinical outcomes in different groups of patients (Weeraratne *et al.* 2010, Nguyen *et al.* 2011, McCreanor *et al.* 2012, McCarthy *et al.* 2013). The discussion to follow will focus on the importance of improvements in four major areas of clinical practice for ED patients with severe TBI.

First, use of capnography significantly improved after implementation of the care bundle. These improvements included preparing capnography before ETT, confirming ETT placement using capnography and continuous $ETCO_2$ monitoring. This finding is important as $ETCO_2$ monitoring is clearly recommended in all intubated patients (BTF 2007b) to ensure correct tube placement and enable ongoing monitoring $ETCO_2$ levels. Capnography is an important element of care for patients with severe TBI (BTF 2007b) as patients should be maintained in a state of normocapnia ($ETCO_2$ of 35–40 mmHg). Hyperventilation ($ETCO_2$ <35 mmHg) should be avoided (BTF 2007b) as it causes vasoconstriction leading to cerebral ischaemia (Price *et al.* 2003, Mittal *et al.* 2009). Detection of the development of hypercapnia ($ETCO_2$ >40 mmHg) is also important as this is known to cause cerebral vasodilation, increase ICP, decrease cerebral perfusion pressure (CPP) and place the patient at risk of secondary brain injury (Winter *et al.* 2005, Mittal *et al.* 2009, Sande & West 2010).

There are a number of possible reasons for increased use of capnography after care bundle implementation. First, in the pretest observation, it was observed that capnography (standalone) was located in one of the corners in the ED and was not observed to be used in any patient who was

Table 3 Observed elements of initial nursing management of patients with severe traumatic brain injury ($N = 45$)

	Pretest ($n = 20$)			Post-test ($n = 25$)				
Areas of initial nursing management	n	f	(%)	n	f	(%)	χ^2	p
Airway management								
Jaw thrust	7	7	(100)	9	9	(100)	–	–
Oropharyngeal airway	20	20	(100)	25	25	(100)	–	–
Prepare capnography	20	0	0	25	14	(56)	13·75	0·00
Confirm endotracheal tube (ETT) placement – auscultation	20	20	(100)	25	25	(100)	–	–
Confirm ETT placement – $ETCO_2$	20	0	0	25	14	(56)	13·75	0·00
Cervical spine protection								
Manual in-line stabilisation during intubation	7	7	(100)	9	9	(100)	–	–
Appropriate size cervical collar	20	19	(95)	25	25	(100)	0·01	0·44
Cervical collar correctly fitted	20	17	(85)	25	25	(100)	1·97	0·08
Oxygenation and ventilation								
Continuous SpO_2 monitoring	20	20	(100)	25	25	(100)	–	–
Continuous $ETCO_2$ monitoring	20	0	0	25	14	(56)	13·75	0·00
Regular observation of respiratory rate	20	5	(25)	25	18	(72)	8·03	0·01
Circulation and fluid balance								
Continuous heart rate monitoring	20	9	(45)	25	9	(36)	0·09	0·76
Continuous ECG monitoring	20	9	(45)	25	9	(36)	0·09	0·76
Blood pressure monitoring at least every 15 minutes	20	11	(55)	25	22	(88)	4·62	0·03
Disability and management of intracranial pressure								
Nursing assessment of Glasgow Coma Scale and pupil size	20	20	(100)	25	25	(100)	–	–
Maintain head in neutral alignment	20	17	(85)	25	25	(100)	1·97	0·08
Head of bed elevated 30 degrees	16	1	(6·3)	24	18	(75)	15·54	0·00
Administration of sedation prior to intubation	5	5	(100)	9	7	(77·8)	0·12	0·50
Limb fractures splinted	1	0	0	1	1	(100)	–	–
Urinary catheterisation	20	20	(100)	25	25	(100)	–	–
Analgesics administered	20	0	0	25	0	0	–	–
Observation for signs of agitation/coughing	9	8	(88·9)	5	5	(100)	0·00	1·00

intubated. The choice to store the capnography away from the resuscitation bay may be the result of the limited area around adult resuscitation bay. During care bundle implementation, the monitors located in adult resuscitation bays were checked for availability of $ETCO_2$ monitoring, and found that the two monitors had $ETCO_2$ monitoring capacity. The $ETCO_2$ detector from the standalone unit was then taken off and connected to one of the adult monitors located in adult resuscitation bay and education sessions were provided regarding this change. Second, education sessions during care bundle implementation improved nurses' understanding of the importance of normocapnia in severe TBI and how to use the capnography. During implementation, it was found that nurses did not know how to connect capnography to the ETT so a picture demonstrating how to connect the detector of capnography to the ETT was provided at the area of the adult resuscitation bay as a visual prompt.

Second, there were statistically significant improvements in the observed frequency of nursing assessment of vital signs including respiratory rates. In the pretest period, 60% of respiratory rates were recorded as 'ET', indicating that the patient was intubated with an ETT *in situ*, but not providing any information regarding the respiratory rate frequency setting on the ventilator or whether the patient was taking spontaneous breaths in addition to ventilator delivered breaths. Adequacy of ventilation is important information in patients with severe TBI as hypoventilation causes hypercapnia that increases cerebral vasodilation and ICP (Price *et al.* 2003, Mittal *et al.* 2009).

There was also an increase in the frequency of blood pressure monitoring after implementation of the care bundle (55·0% vs. 88·0%, $p = 0.03$). In the pretest period, the frequency of blood pressure monitoring ranged from five minutes to two hours. Intervals of two hours between assessment of blood pressure is concerning given the direct relationship between blood pressure, ICP and CPP (Sande & West 2010). Increased ICP or decreased systolic blood pressure reduces CPP, and when ICP approaches or exceeds the mean arterial blood pressure, ischaemia and necrosis of cerebral tissue may occur (McQuillan & Thurman 2009). After implementation of the care bundle, it was observed that the frequency of blood pressure monitoring was in a range of 5–30 minutes.

Consistency of assessment of vital signs is very important as it helps to detect any deterioration or concerns about the patient's condition. Nursing assessment of vital signs and neurological status should be recorded as it is necessary to observe trends and for other staff to understand the patient's condition and to review progress of care (Scottish Intercollegiate Guidelines Network (SIGN) 2009). A number of guidelines for care of patients with head injury (BTF 2007a, NICE 2007) recommend assessment of vital signs, GCS and pupils half-hourly. However, in this care bundle, the frequency of respiratory rate assessment and blood pressure monitoring is recommended to be assessed at least every 15 minutes. It may be proposed that the frequency of nursing assessment of vital signs improved as a result of educational sessions for nurses that focused on the importance of adequate oxygenation and ventilation of patients with severe TBI, and the importance of blood pressure monitoring and assessment of respiratory rates.

Third, there was a statistically significant improvement in patient positioning with head of bed elevation to 30 degrees after care bundle implementation. 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 ICP by facilitating cerebral venous outflow (Price *et al.* 2003, Reed 2011, Mittal *et al.* 2009). For every 10 degrees of head elevation, it is reported that the mean ICP drops by 1 mmHg (Wong 2000). It is therefore recommended that patients with severe TBI should be nursed in an approximately 30 degrees head-up position, if other injuries allow (Price *et al.* 2003, Reed 2011, Mittal *et al.* 2009).

In the pretest period, only one patient with severe TBI was observed to have the head of the bed elevated to 30 degrees. There are number of possible explanations for this finding. First, it is availability of the equipment in the ED. The patient trolleys used in the ED at the study site are such that to elevate the head of the bed, the trolley pole needs to be placed into one of four different notches that result in the head of the bed being elevated at fixed points between completely flat and 90 degrees. It is possible that the ED nursing staff were not aware of which notch is up to 30 degrees. Another possible explanation 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. As part of the educational sessions held during care bundle implementation there was a focus on positioning of patients with severe TBI and instructions, and specifically which notch of the patient trolley was equivalent to raising the head of the bed to approximately 30 degrees.

Finally, there were positive improvements in the use of appropriately sized and applied cervical collars following care bundle implementation. Although these differences did not reach statistical significance, cervical spine immobilisation in trauma patients is a core emergency nursing responsibility, so it may be argued that it has high clinical significance. Use of appropriate size cervical collars and appropriate application (correctly fitted) of cervical collars are important for patients with severe TBI. Head rotation, neck flexion or extension, or compression due to loose or too tight application of a cervical collar may obstruct cerebral venous outflow, resulting in increased cerebral vascular volume and further increasing ICP (Price *et al.* 2003, McQuillan & Thurman 2009).

In the pretest observation period, the application of cervical collars was observed in all patients with severe TBI, however, there were three patients in whom the cervical collar were not properly applied (collar too small, loose application, and collar applied back-to-front). Head rotation of all three patients with severe TBI was observed due to inappropriate application of cervical collars. Education sessions focusing on the importance of use of appropriate size cervical collars and appropriate application of cervical collars, particularly in patients with severe TBI, were provided to emergency nurses. Then, a 100% compliance was seen in clinical care regarding use of appropriate size cervical collars and appropriate application of cervical collars after care bundle implementation. In addition to the education sessions, increased availability adult cervical collars in the ED was also a factor in improving clinical care regarding use of appropriate size and application of cervical collars.

Limitations

There are limitations that need to be acknowledged when interpreting the study findings. First, the study was conducted at a single site with a limited sample so the generalisability of the findings to other EDs is limited. However, the conduct of this single site study was necessary to establish if introduction of the care bundle to guide emergency nursing care of critically ill patients with severe TBI was feasible for use in the Thai context. Second, it is acknowledged that emergency care of patients with severe TBI also involved emergency medical service personnel and medical staff. Although, deliberately, the primary focus of this study was the emergency nursing management of patients with severe TBI, there were elements of the care bundle that may have influenced emergency medical practice. However, the effects of the care bundle on medical management of patients with severe TBI were beyond the scope of this study. Finally, although measurement of sustained knowledge over time was beyond the scope of this study, strategies were put in place to sustain use of the care bundle at the study site beyond the period of the study. First, use of the care bundle was recognised as one of the strategies for nursing quality improvement of trauma care at this study site. Second, audits were planned to monitor changes in the compliance with elements of the care bundle. Finally, further studies are planned at the study site to examine initial nursing management of patients with severe TBI over time.

Conclusion

The care bundle approach is one method of promoting consistent, evidence-based emergency nursing care of patients with severe TBI, decreasing unnecessary variations in nursing care and reducing the risk of secondary brain injury from suboptimal care. Importantly, strategies to support implementation of the care bundle must take into account local structure, staffing, processes and resources for maximum uptake in a busy clinical environment. The focus of this study was on the initial emergency nursing management of patients with severe TBI, however, the findings from this research can be applied to a range of low resource contexts and clinical conditions. The care bundle approach appears to be a promising methodology to increase the use of research evidence in low resource environments. Further, care bundles, if developed specific to the clinical context and patient population, can better equip nurses to deliver evidence-based care and optimise clinical care.

Relevance to clinical practice

The study suggests that a care bundle approach can be used as a strategy to improve emergency nursing care of patients with severe TBI. Future research should now focus on testing the care bundle approach in other specific clinical conditions or populations in the EDs of low to middle-income countries to determine if contextually developed and implemented care bundles can increase the use of research evidence in emergency care, increase clinician knowledge, improve clinical care, and ultimately improve patient outcomes in EDs with limited resources.

Contributions

Study design: JD, JC, BK; Data collection and analysis: JD, JC; Manuscript preparation: JD, JC, BK, MS.

Funding

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

Conflict of interest

No conflict of interest has been declared by the authors.

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