Received: 7 November 2019 | Revised: 10 June 2020 | Accepted: 26 October 2020
DOI: 10.1111/ijn.12899

ORIGINAL RESEARCH PAPER

INTERNATIONAL JOURNAL of NURSING PRACTICE
WILEY

Evidence–practice gaps in initial neuro-protective nursing care: A mixed methods study of Thai patients with moderate or severe traumatic brain injury

Kesorn Promlek RN MNS, Lecturer[1,2] | Judy Currey RN, PhD, Professor[1] | Jintana Damkliang RN, PhD, Assistant Professor[2] | Julie Considine RN, PhD, Professor[1,3]

[1]School of Nursing and Midwifery, Centre for Quality and Patient Safety Research, Institute for Health Transformation, Deakin University Geelong, Geelong, Australia

[2]Faculty of Nursing, Prince of Songkla University, Hat Yai, Thailand

[3]Centre for Quality and Patient Safety Research-Eastern Health Partnership, Box Hill, Victoria, Australia

Correspondence
Kesorn Promlek, School of Nursing and Midwifery, Centre for Quality and Patient Safety Research, Institute for Health Transformation, Deakin University Geelong, Geelong, Australia.
Email: kesorn.p@psu.ac.th

Funding information
Deakin University, Australia: a PhD scholarship and a 2019 Deakin University Faculty of Health Publication Award; Prince of Songkla University, Thailand: a PhD scholarship

Abstract

Aims: This paper aims to identify the frequency and nature of evidence–practice gaps in the initial neuro-protective nursing care of patients with moderate or severe traumatic brain injury provided by Thai trauma nurses.

Background: Little is known about how Thai trauma nurses use evidence-based practice when providing initial neuro-protective nursing care to patients with moderate or severe traumatic brain injury.

Design: A mixed methods design was used to conduct this study.

Methods: Data were collected from January to March 2017 using observations and audits of the clinical care of 22 patients by 35 nurses during the first 4 h of admission to trauma ward. The study site was a regional hospital in Southern Thailand.

Results: The major evidence–practice gaps identified were related to oxygen and carbon dioxide monitoring and targets, mean arterial pressure and systolic blood pressure targets and management of increased intracranial pressure through patient positioning and pain and agitation management.

Conclusion: There were evidence–practice gaps in initial neuro-protective nursing care provided by Thai trauma nurses that need to be addressed to improve the safety and quality of care for Thai patients with moderate or severe traumatic brain injury.

KEYWORDS
brain injury, evidence-based practice, neuroprotection, nursing, practice gaps, Thailand, trauma

SUMMARY STATEMENT

What is already known about this topic?

- Traumatic brain injury is a global problem that is a major public health issue in low-resource settings like Thailand.
- Evidence-based practice improves patient outcomes and quality of care while reducing health-care costs, which is particularly important in low-resource environments.

What this paper adds?

- There were evidence–practice gaps in the initial neuro-protective nursing care of patients with moderate or severe traumatic brain injury provided by Thai trauma nurses that increase the risk of secondary brain injury.
- This study has identified a number of evidence–practice gaps related to oxygen and carbon dioxide monitoring and targets, mean arterial pressure and systolic blood pressure targets and management of increased intracranial pressure.

The implications of this paper for practice/policy:

- The study results provide a snapshot of the evidence–practice gaps of neuro-protective nursing care for patients with moderate or severe traumatic brain injury that need to be improved in the Thai trauma context, which is a low-resource setting.
- The evidence–practice gaps identified in this study will enable targeted interventions to improve the safety and quality of care for Thai patients with moderate or severe traumatic brain injury.

1 | INTRODUCTION

Moderate or severe traumatic brain injury (TBI) is a leading cause of mortality, disability and increased health-care costs worldwide (Massenburg et al., 2017) and is a critical issue in low-resource countries, like Thailand (Taechakamolsuk, Nittayasut, Damnakkeaw, Sangjanthip, & Tantitam, 2015). After moderate or severe TBI, patients are at high risk of secondary brain injury, which is associated with poor patient outcomes (Sanders, 2013). The major risk factors for secondary brain injury are oxygen and carbon dioxide abnormalities, hypotension and increased intracranial pressure (ICP) (Carney et al., 2016a; Johannigman et al., 2015). Evidence-based practice can reduce mortality from TBI (Carney et al., 2016b; Lee et al., 2015) and decrease costs associated with TBI care (Whitmore et al., 2012). Given that TBI is a major issue in Thailand (Taechakamolsuk et al., 2015), evidence-based TBI care is critical to cost-effective care that optimizes patient outcomes. However, little is known how Thai trauma nurses use evidence when providing initial neuro-protective nursing care for patients with moderate or severe TBI.

There are a number of guidelines for TBI care that aim to reduce mortality and morbidity and improve quality of life of TBI survivors (American College of Surgeons (ACS), 2015; Carney et al., 2016a; National Institute for Health and Care Excellence (NICE), 2014). However, the TBI guidelines to date have been developed and implemented in middle- and high-resource countries (ACS, 2015; Carney et al., 2016a; NICE, 2014). Thai nurses face many challenges in delivering evidence-based practice for patients with moderate or severe TBI. First, although there is a clinical practice guideline (CPG) for TBI care in the Thai context, it was developed by Thai neurosurgeons and general physicians (Panjaisri, Phuenpathom, & Veerasan, 2013) and is thus not specific for nursing management of patients with moderate or severe TBI. Furthermore, little is known about the use or uptake of this CPG in Thailand or its impact on clinical care. Second, implementing evidence from high-resource settings with well-developed trauma care systems is not feasible in the Thai trauma context due to resource limitations, differences in workforce, workflow and care delivery systems and cultural considerations. Therefore, there is a concern that lack of evidence-based guidelines for nursing care of patients with moderate or severe TBI in critical care settings causes variability in nursing practice, increasing the risk of secondary brain injury (McNett, Doheny, Sedlak, & Ludwick, 2010).

There is a need to critically determine the current state of initial neuro-protective nursing care of patients with moderate or severe TBI by Thai trauma nurses and determine whether evidence–practice gaps exist and, if so, what are the major issues, specific to Thai trauma care.

2 | METHODS

2.1 | Aims

The aims of this study were to (i) establish the current state of initial neuro-protective nursing care delivered to patients with moderate or severe TBI during the first 4 h of trauma ward admission and (ii) compare current initial neuro-protective nursing care delivered to trauma ward patients with international evidence-based recommendations for TBI care in order to establish the frequency and nature of evidence–practice gaps in the Thai trauma care context.

2.2 | Design

A mixed methods design was used. Study data were collected by observations and audits of clinical practice during the first 4 h of trauma ward admission.

2.3 | Setting

The study setting was the six-bed trauma unit located in a 37-bed trauma ward at a regional hospital in Southern Thailand. Each of the six trauma unit beds has a mechanical ventilator, bedside monitor and wall suction units. The bedside monitors are capable of monitoring oxygen saturation (SpO_2), end-tidal carbon dioxide ($ETCO_2$), heart rate and cardiac rhythm and non-invasive and invasive blood pressure. Criteria for the trauma unit admission are critically injured patients with multiple traumatic injuries, including TBI, from the emergency department (ED). All patients with moderate or severe TBI are cared for in this trauma unit for approximately 48 h and will then be transferred to another department, such as the neurosurgical intensive care unit (ICU) or neurosurgical ward. It is common for patients needing surgery and who require postoperative critical care nursing to be returned to trauma unit because of the limited neurosurgical ICU beds.

Trauma ward has 22 registered nurses (RNs) who completed a 4-year Bachelor of Nursing degree and 13 nursing assistants (NAs) who work as assistants to RNs. All trauma ward staff can be allocated to care for patients in trauma unit. The six trauma unit patients are cared for by two RNs and one or two NAs per shift. Patients with TBI are medically managed by neurosurgeons, general surgeons and other specialists depending on their other injuries.

2.4 | Participants

The participants were trauma ward RNs and NAs and trauma unit patients with moderate or severe TBI. Convenience sampling was used to invite all 22 RNs and 13 NAs to participate in the study through face-to-face monthly nursing staff meetings. Purposive sampling was used to select adult patients with moderate or severe TBI who were intubated for mechanical ventilation. Patients with cervical spine injury were excluded from the study.

2.5 | Data collection

The researcher undertook a purely observational role. The researcher stood at the nurses' counter to enable a clear view of trauma unit care activities. The researcher went to the patients' bedside half-hourly in the first hour, then hourly for the next 3 h, coinciding with nursing assessments. Data were collected and documented using a structured observation instrument as detailed in the following section. Observations took place from 11 January to 6 March 2017 and over various times of the day and day of the week. The observations commenced when patients arrived in trauma unit and continued for the first 4 h after admission. Data were collected during the first 4 h of care as this is a high-risk period for respiratory, haemodynamic and ICP alterations (Holmes, Peng, & Bair, 2012; Johannigman et al., 2015).

Audits of clinical practice were focused on nursing observation charts of patient participants and were performed after the researcher completed observations of clinical practice for each patient. Audits were conducted once nurses completed their documentation and when the charts were available at the nurses' counter to avoid interruptions to nurses' work.

2.6 | Instruments

There were no suitable existing instruments that could be used to address the study aim. The researchers therefore developed instruments based on the literature review related to respiratory, haemodynamic and ICP management to support the structured observation and audit of clinical practice. The patient demographic data collected included age, gender, cause of injury, Glasgow Coma Scale (GCS) score at ED arrival, date and time of trauma unit admission, injury severity score, extracranial injuries and physiological data. The instruments were pilot tested on two patients with moderate or severe TBI who admitted to trauma unit.

2.7 | Ethical considerations

Ethical approval was obtained from the Human Research and Ethics Committee (HREC) at Deakin University and the Ethics Committee at the study site. All RNs and NAs gave written informed consent and their verbal consent was confirmed before commencing the observations. Patient consent was waived by HREC.

2.8 | Data analysis

Data analysis was conducted using SPSS version 23.0 for Windows® (IBM Inc., Chicago, IL, USA). Descriptive statistics were used to summarize nurses' demographic data, patient characteristics and compliance with specific elements of neuro-protective nursing care.

3 | RESULTS

Twenty-two patients with moderate or severe TBI were observed. Median age was 45.5 years and most patients (77.3%) were males. Nearly all injuries (91%) were caused by road traffic crashes and many occurred in motorcycle riders without helmets (68.2%). The majority of patients had subdural haematoma (45.5%), followed by subarachnoid haemorrhage (40.9%). Patient characteristics are presented in Table 1.

All 22 RNs and 13 NAs working in trauma ward were involved in caring for patients with moderate or severe TBI in the trauma unit during the data collection period. All trauma ward nursing staff were willing to be observed for their neuro-protective nursing care of patients with moderate or severe TBI, and 18 RNs and 10 NAs participated in the observations of clinical practice.

3.1 | Observation of clinical practice

Oxygen saturation was continuously monitored in all patients (n = 22). Of 107 SpO_2 measurements, five measurements in one patient indicated hypoxia (SpO_2 < 80%), when the fraction of inspired oxygen

TABLE 1 Patient participant characteristics (n = 22)

	n	%
Gender		
Female	5	22.7
Male	17	77.3
Cause of injury		
Road traffic crash	20	91
Pedestrian	0	0
Car	4	18.2
Motorcycle with helmet	0	1
Motorcycle without helmet	15	68.2
Bicycle	1	4.5
Fall	1	4.5
Assault	1	4.5
Admission GCS score		
Moderate TBI (GCS 9–12)	1	4.5
Severe TBI (GCS ≤ 8)	21	95.5
Computed tomography diagnosis		
Subdural haematoma	10	45.5
Subarachnoid haemorrhage	9	40.9
Intracerebral haemorrhage	2	9
Contusion	1	4.5
Midline shift	5	22.7
Isolated TBI	2	9.1
Multiple trauma with TBI	20	90.9
	Median	Interquartile range (Q_1–Q_3)
Age (years)	45.5	20.8–63.3
Injury severity score	27	23.4–32.3

Abbreviations: GCS, Glasgow Coma Scale; TBI, traumatic brain injury.

(FiO_2) was 1.0. There were 12 SpO_2 measurements (11.2%) of 97%–100% in patients receiving FiO_2 of 0.5 to 1.0 and 76 measurements (71%) of 99%–100% in patients receiving FiO_2 of 0.4, which placed the patient at risk of hyperoxia. There was one instance where SpO_2 of 96% was noted in a patient receiving FiO_2 of 0.4; however, FiO_2 was then increased to 0.5 in response to this SpO_2.

No patients had $ETCO_2$ monitoring. There were 109-min ventilation (MV) measurements in 22 patients: 40 measurements (36.7%) in 15 patients (68.2%) indicated hyperventilation (MV 10.1–21.2 L/min). Of 109 respiratory rate (RR) measurements, 47 (43.1%) in 15 patients indicated tachypnoea (RR 21–40/min). Only one patient had one arterial blood gas (ABG) that showed hypocapnia ($PaCO_2$ of 24.7 mmHg).

Of 106 systolic blood pressure (SBP) measurements in 22 patients, 32 (30.2%) indicated hypertension (SBP > 140 mmHg) in 10 patients and 18 (17.0%) indicated hypotension (SBP < 100 mmHg) in five patients. Of 106 mean arterial pressure (MAP) measurements in 22 patients, 33 (31.1%) were less than 80 mmHg in 11 patients and 44 were (41.5%) greater than 90 mmHg in 16 patients. Of the 11 patients with an MAP less than 80 mmHg, nine patients had tachycardia (heart rate > 100 beats/min) and four patients had hypotension.

The head of bed was elevated for 19 patients (86.4%), but the degree of elevation varied from 10 to 30°. Of 109 observations of patients' head and neck positions, the position was neutral in 75 instances (68.8%). Cervical collars were applied in 12 patients; appropriate sized and correctly fitted cervical collars were observed in nine patients. Twelve patients had normal cervical spine computed tomography (CT) scan, but cervical collars were removed in six of these patients (50%).

Of 37 temperature measurements in 22 patients, 25 (69.4%) in 18 patients were above 37.5°C (37.6–40.1°C). Five hyperthermic patients received cold sponge baths and fans. There was one instance where the physician was notified and paracetamol via intramuscular injection was administered.

There were 44 episodes of agitation in 16 patients (72.7%) and 19 episodes of cough in 12 patients (54.5%). Sixteen patients were physically restrained by both arms. In addition to arm, eight patients (36.4%) had bilateral leg restraints and two patients (9.1%) were also restrained at the chest. Sedation administration was observed on five occasions in four patients. Three patients received one or two bolus doses of sedatives and one patient received a continuous sedative infusion. Analgesic administration was observed on 24 occasions in 15 patients. Fourteen patients received one or two bolus doses of analgesics and one patient received a continuous analgesic infusion. No patients received analgesics prior to endotracheal suctioning.

3.2 | Audit of clinical practice

Most patients (n = 21) had SpO_2 and RR recorded within 30 min of admission and then hourly. No patient had $ETCO_2$ documented. All patients (n = 22) had MV and tidal volume documented once in the first 4 h of care. All patients had heart rate, MAP and SBP documented within the first 30 min of admission and then at least hourly.

Elevating head of bed to 30° was documented in 20 patients (90.9%). Documentation of temperature within 30 min of admission occurred in 16 patients (72.7%); eight patients (36.4%) had only one documentation and 14 patients (63.6%) had two documentations during the first 4 h of care. No patients had pain and agitation assessment documented. All patients had GCS, pupil size and reaction to light and limb movement and motor tone documented hourly during the first 4 h of care.

3.3 | Evidence–practice gaps

Monitoring of jugular venous saturation, cerebral perfusion pressure (CPP) and ICP did not occur in trauma ward because of limited resources. Several evidence–practice gaps were identified from observations and audits of clinical practice. In terms of respiratory management, evidence–practice gaps were failure to use ABG analysis, $ETCO_2$ monitoring and SpO_2 targets (Table 2).

TABLE 2 International evidence-based recommendations and current neuro-protective nursing care in trauma ward: Respiratory management

International evidence-based recommendations	Current neuro-protective nursing care in trauma ward
1. Maintain PaO_2 ≥ 97.5 mmHg (NICE, 2014) –100 mmHg (ACS, 2015) and $PaCO_2$ 35–45 mmHg (ACS, 2015; Carney et al., 2016a)	•Failure to use arterial blood gas analysis to monitor $PaCO_2$ and PaO_2.
2. Maintain SpO_2 ≥ 95 (ACS, 2015; NICE, 2014), 94–98% (Driscoll, 2017)	•SpO_2 was continuously monitored and documented half-hourly in the first hour, then hourly; this practice occurred in 95.5% of patients. •Failure to use a maximum SpO_2 target of 98% to prevent hyperoxia.
3. Monitor end-tidal carbon dioxide (VSTS, 2014)	•There was one capnograph in trauma ward, but a failure to use end-tidal carbon dioxide monitoring.

Abbreviations: ACS, American College of Surgeons; NICE, National Institute for Health and Clinical Excellence; $PaCO_2$, partial pressure of arterial carbon dioxide; PaO_2, partial pressure of oxygen in arterial blood; SpO_2, oxygen saturation measured by pulse oximetry; VSTS, Victorian State Trauma System.

In terms of haemodynamic management, the major evidence–practice gaps were failure to use targets for MAP and SBP (Table 3).

Finally, evidence–practice gaps in ICP management were failure to maintain appropriate patient positioning, remove unnecessary cervical collars, manage hyperthermia and manage pain and agitation (Table 4).

4 | DISCUSSION

This study identified several evidence–practice gaps, which should be priority areas of improving neuro-protective nursing care of Thai patients with moderate or severe TBI. The evidence–practice gaps are discussed according to respiratory, haemodynamic and ICP management.

4.1 | Respiratory management

No patients had $ETCO_2$ monitoring. Capnography is a crucial element of care for patients with moderate or severe TBI as normocapnia ($PaCO_2$ 35–45 mmHg) should be maintained (Carney et al., 2016a). Hypocapnia causes vasoconstriction and decreases cerebral blood flow, which may result in cerebral ischaemia (Grüne, Kazmaier, Stolker, Visser, & Weyland, 2015). Hypercapnia causes cerebral vasodilation, increased ICP and decreased CPP, placing patients at risk of secondary brain injury (Bautista, 2014; Grüne et al., 2015).

One possible reason for the non-use of $ETCO_2$ monitoring is that there was only one capnograph for the whole trauma ward, so equipment availability was an issue. The capnograph was stored in a locker in the Head Nurse's office rather than at the bedside, further limiting accessibility and availability. Trauma ward nurses had limited knowledge of $ETCO_2$ monitoring in patients with moderate or severe TBI, which further influenced the failure to use $ETCO_2$ monitoring (Promlek, Currey, Damkliang, & Considine, 2020). The issue of failure to use capnography also occurred in a Thai study of emergency care because emergency nurses had limited $ETCO_2$ monitoring knowledge and skills (Damkliang, Considine, Kent, & Street, 2014). Consequent training to improve nurses' knowledge and skills in the use of capnography increased use of this equipment in TBI patients, and as nurses realized the benefits of capnography, its use was also prioritized (Damkliang et al., 2014). Therefore, trauma ward should focus on the strategies to help nurses to improve their knowledge and skills related to $ETCO_2$ monitoring through education, training and environmental redesign to make this equipment accessible.

ABG analysis was rarely performed, despite recommendations that partial pressure of arterial carbon dioxide ($PaCO_2$) should be measured in patients with moderate or severe TBI (Carney et al., 2016a). A possible explanation for this finding is that in the Thai context, a physician prescription for ABG analysis is needed and obtaining ABG samples is beyond the scope of nursing practice for Thai RNs (Nityangoon, 2008). Cost and feasibility given low RN:patient ratios in trauma unit also influence the low use of ABG analysis.

TABLE 3 International evidence-based recommendations and current neuro-protective nursing care in trauma ward: Haemodynamic management

International evidence-based recommendations	Current neuro-protective nursing care in trauma ward
1. Maintain MAP≥80 mmHg by infusion of fluid and vasopressor as prescribed (NICE, 2014)	•An MAP target was not used. •72.6% of documented MAP measurements were <80 mmHg or >90 mmHg.
2. Maintain SBP ≥ 100 mmHg by infusion of fluid and vasopressor as prescribed (ACS, 2015; Carney et al., 2016a)	•SBP was kept ≥90 mmHg. •47.2% of documented SBP measurement were <100 or >140 mmHg.

Abbreviations: ACS, American College of Surgeons; MAP, mean arterial pressure; NICE, National Institute for Health and Clinical Excellence; SBP, systolic blood pressure.

TABLE 4 International evidence-based recommendations and current neuro-protective nursing care in trauma ward: Intracranial pressure management

International evidence-based recommendations	Current neuro-protective nursing care in trauma ward
1. Keep 30° head of bed elevated (ACS, 2015; Mcilvoy & Meyer, 2009; VSTS, 2014)	•Head of bed was elevated and documented for 86.4% of patients, but the degree of elevation varied from 10 to 30°.
2. Remove cervical collars as soon as possible (Mcilvoy & Meyer, 2009)	•Half of patients who were applied cervical collars had cervical collars removed once a normal cervical spine CT scan result was confirmed.
3. Maintain normothermia (36–37.5°C) (ACS, 2015; Carney et al., 2016a; Mcilvoy & Meyer, 2009)	•Temperature of 72.7% of patients was monitored and documented on admission to trauma ward then 4-hourly. •The trigger for nursing interventions to treat hyperthermia was temperature ≥38.5°C. •Cold sponge bath was routinely used when temperature ≥38.5°C.
4. Pain and agitation management	
4.1 Pain assessment (using BPS) and pain management (continuous analgesia infusion combination with bolus doses when needed) (ACS, 2015; NICE, 2014; Schug, Palmer, Scott, Halliwell, & Trinca, 2015)	•Pain assessment and documentation were not performed in any patients. •68.2% of patients received 3 mg one to two doses of intravenous morphine. One patient received a continuous morphine infusion. •No patients received analgesics prior to endotracheal suctioning.
4.2 Monitoring depth of sedation using RASS, keep light levels of sedation and continuous titrated sedation (propofol or midazolam) infusion combined with bolus doses when needed (ACS, 2015, Barr et al., 2014; Mcilvoy & Meyer, 2009; Schug, Palmer, Scott, Halliwell, & Trinca, 2015)	•Depth of sedation assessment was not routine practice and was not performed in any patient who received sedatives. •Sedative drugs were not routinely prescribed; the usual practice was for nurses to call physicians when patients had severe agitation. •Agitation was observed in 72.7% of patients; just 25% of patients who had agitation received sedatives.

Abbreviations: ACS, American College of Surgeons; BPS, Pain Behaviour Scale; CT, computed tomography; NICE, National Institute for Health and Clinical Excellence; RASS, Richmond Agitation Sedation Scale; VSTS, Victoria State Trauma System.

Nurses did not routinely protect patients from hyperoxia. Hyperoxia causes cerebral vasoconstriction and decreased cerebral blood flow, resulting in secondary brain injury and is associated with worse outcomes in TBI patients (Depreitere et al., 2014; Peeters et al., 2015). When SpO_2 is higher than 95%–98%, the FiO_2 should be decreased. However, FiO_2 was not reduced in most instances of SpO_2 exceeding the recommended values. The routine practice of trauma ward nurses was to maintain SpO_2 of 95% or higher: a maximum SpO_2 target of 98% was not used. Therefore, patients were at risk of hyperoxia. This traditional practice is likely to be a major reason for nurses not reducing FiO_2 when SpO_2 is higher than 95%–98%. Further, it is possible that nurses were not aware of the potentially deleterious effects of hyperoxia but more concerned about hypoxia. Education related to oxygenation management and the use of SpO_2 targets is needed to enable trauma nurses to improve respiratory management of patients with moderate to severe TBI.

4.2 | Haemodynamic management

There was a failure to use recommended MAP and SBP targets. Seventy-seven MAP measurements (72.6%) and 50 SBP measurements (47.2%) were lower or higher than international evidence-based recommendations of 80–90 (NICE, 2014) and 100–140 mmHg (Brighenti & Joosten, 2018; Carney et al., 2016a), respectively. The current practice in trauma ward is to maintain MAP higher than 65 mmHg and SBP higher than 90 mmHg, which is inconsistent with recommendations. An MAP below 80 mmHg places patients at risk of inadequate CPP (Kinoshita, 2016) and an SBP below 100 mmHg may trigger autoregulatory vasodilatation, resulting in increased cerebral blood volume and increased ICP (Carney et al., 2016a). The most likely explanation for this finding is that there were no practice recommendations regarding maximum MAP and SBP in trauma ward.

4.3 | ICP management

There was considerable variation in the degree of head of bed elevation from 10° to 30°. Mean ICP decreases by 1 mmHg for every 10° of head elevation (Wong, 2000) and 30° head of bed elevation is recommended to maximize jugular venous drainage and prevent increased ICP (ACS, 2015; Mcilvoy & Meyer, 2009). Trauma unit beds did not have angle indicators, possibly resulting in nurses' overestimation of the angle of head of bed elevation. Patient agitation is another issue when trying to maintain 30° head of bed elevation as these patients often migrate down the bed when the head of bed is elevated. Restoring the patient position requires manual lifting with at least four staff, so to perform this procedure frequently is challenging in a context where two RNs and one or two NAs are responsible for six patients.

Cervical collars remained in situ for 50% of patients (n = 6) in whom cervical spine CT scan was normal, which may place those patients at unnecessary risk of increased ICP (Patel et al., 2015) as cervical collars can impede cerebral venous outflow (Maissan et al., 2017). There are two possible explanations for this finding: (i) a lack of local guidelines to guide nurses' decisions in removing cervical collars and (ii) the high nursing workloads. Hence, removing cervical collars might not be considered a priority if there were other competing issues.

Hyperthermia was common in this study. Only 27.8% (n = 5) of hyperthermic patients received temperature reduction interventions, and the interventions provided (cold sponge baths and fans) were not evidence-based and were in fact harmful. Hyperthermia can cause increased ICP and secondary brain injury as a result of increased blood–brain permeability, leading to cerebral oedema (Meier & Lee, 2017). Cold sponge baths were routine practice for hyperthermia in trauma ward. Nurses may believe that cold sponge baths reduce temperature quickly and made patients feel comfortable as the climate in Southern Thailand where the study site located is hot all year round, with average annual temperature ranging from 24°C to 31°C (Thai Meteorological Department). In TBI patients, cold sponge baths and fanning are ineffective, decreasing temperature by only 0.42–1.25°C, and cause shivering in 50% of patients (Oddo et al., 2010; Tha-on, 1996). Shivering increases metabolism and oxygen demand, placing patients at risk of increased ICP and secondary brain injury (Zink & Kozub, 2013).

A possible explanation for the low percentage of patients who received evidence-based hyperthermia management may be a lack of guidelines for hyperthermia management in trauma ward. Nurses who used guidelines to inform their decisions were more likely to initiate treatment for hyperthermia at lower temperatures (37.7°C) than nurses who made decisions based on individual clinical judgement (38.2°C) (Rockett, Blissitt, & Thompson, 2015). International evidence-based guidelines recommend normothermia (ACS, 2015; Carney et al., 2016a), using antipyretic medications and cooling blankets (Meier & Lee, 2017; Zink & Kozub, 2013). Cooling blankets were not available in trauma ward; consequently, this practice did not occur. Another possible explanation for the rare use of antipyretic medications is that in Thailand, nurses cannot give antipyretic medication without a physician's prescription and antipyretics are not routinely prescribed, which is the case in most low-resource settings. Data from 20 countries across Europe and Israel showed that TBI patients in neuro-trauma centres in high-resource settings received paracetamol more often than patients in centres in low-resource settings (Huijben et al., 2018). Neuro-specific evidence-based protocols for hyperthermia management should be established as protocols of trauma ward to support nurses to maintain normothermia in patients with moderate or severe TBI.

Finally, patients did not receive effective assessment and management of their pain and agitation. Most patients (n = 20, 90%) had multiple injuries in addition to their moderate or severe TBI and therefore would be expected to have significant pain. Pain is a noxious stimulus that causes increased ICP and secondary brain injury in patients with moderate or severe TBI (Carney et al., 2016a; NICE, 2014). Patient advocacy is a crucial role for trauma nurses and should include routinely assessing pain and discussing the patients' pain status with physicians to ensure effective pain management to protect patients from increased ICP. However, pain assessments did not occur in any patients studied. Pain assessment tools feasible for use in patients with moderate or severe TBI who are unable to report their pain due to a decreased level of consciousness are unavailable in trauma ward, which contributed to ineffective pain assessment and management. The use of an evidence-based pain assessment tool that is feasible for use in trauma ward and applicable to patients with moderate or severe TBI should be explored to enable nurses to improve pain assessment and management.

Use of analgesics and limiting painful procedures are critical to prevent increased ICP and secondary brain injury in patients with moderate or severe TBI (Schug, Palmer, Scott, Halliwell, & Trinca, 2015). In the trauma unit, intravenous morphine 3 mg every 3 or 4 h as needed was prescribed for almost all patients. Although nurses had opportunities to administer analgesics, 31.8% of patients (n = 7) did not receive analgesic. A possible explanation for low analgesic use could be that nurses may believe that analgesics eliminate the ability to perform neurological assessment or induce haemodynamic compromise. Analgesics were also not provided in any patient before endotracheal suctioning, which is a painful procedure, but some patients received analgesics after endotracheal suctioning as they had agitation, most likely exacerbated by pain. This practice suggests that trauma nurses had a treatment rather than prevention approach to pain management. Oddo et al. (2016) recommended a continuous opioid infusion titrated to the patient's clinical state to protect the injured brain in the first 24–48 h after moderate or severe TBI. However, only one patient studied received a continuous opioid infusion. The standard practice of prescribing morphine 3 mg every 3 or 4 h as needed is inadequate to manage pain in patients, especially those with multiple injuries, and even if nurses administer it frequently, this practice should be called into question.

Seventy-five per cent (n = 12) of agitated patients did not receive sedatives. Use of sedation in ventilated patients with moderate or severe TBI is recommended by international evidence-based guidelines to prevent agitation, decrease cerebral metabolic demand, facilitate effective ventilation and further reduce ICP (Carney et al., 2016a; Oddo et al., 2016). Thai nurses cannot give sedatives without a physician's prescription, but unlike analgesics, sedatives are not prescribed routinely in trauma unit patients. Nurses are required to call the physician when patients have severe agitation to obtain a prescription for sedation. Again, advocacy is an important element of the trauma nursing role, particularly in patients with moderate or severe TBI who cannot advocate for themselves. Untreated agitation places patients at risk of secondary brain injury, so there is an urgent need to improve agitation management and use of sedatives in patients with moderate or severe TBI.

4.4 | Limitations

This study was conducted at a single site with a limited sample and convenience sampling, so findings may not be generalizable to other trauma wards. In addition, the presence of the researcher during observations of clinical practice may affect behaviours of RNs and NAs and may result in them altering their normal practice. However, significant evidence–practice gaps were observed, so this suggests that participants were practicing in normal manner.

5 | CONCLUSION

This study of initial neuro-protective nursing care of patients with moderate or severe TBI provided by Thai trauma nurses showed clear evidence–practice gaps that place patients at risk of harm. These evidence–practice gaps need to be addressed to improve the safety and quality of care for Thai patients with moderate or severe TBI; however, solutions need to take into account the context and the nature of nursing care in a low-resource setting.

ACKNOWLEDGEMENTS

Ms Promlek is supported by a PhD scholarship from Deakin University, Australia, and Faculty of Nursing, Prince of Songkla University, Thailand, and a 2019 Deakin University Faculty of Health Publication Award.

CONFLICT OF INTEREST

No conflict of interest has been declared by the authors.

AUTHORSHIP STATEMENT

We confirm that all listed authors meet the authorship criteria and that all authors are in agreement with the content of the manuscript. KP, JCo, JCu and JD conceived the study concept and study design. KP was responsible for data collection. All authors were responsible for analysis and interpretation of data and drafting and revising the manuscript and approved the final version for submission.

ORCID

Kesorn Promlek https://orcid.org/0000-0002-1838-5522

REFERENCES

American College of Surgeons. (2015). Best practices in the management of traumatic brain injury. Retrieved from https://www.facs.org/-/media/files/quality-programs/trauma/tqip/tbi_guidelines.ashx?la=en

Bautista, C. (2014). Disorders of brain function. In S. Grossman, & C. Porth (Eds.), *Porth's pathophysiology: Concepts of altered health states* (pp. 489–524). Philadelphia Wolters Kluwer Health/Lippincott Williams & Wilkins Health.

Brighenti, S., & Joosten, S. A. (2018). Friends and foes of tuberculosis: Modulation of protective immunity. *Journal of Internal Medicine*, *284*, 125–144. https://doi.org/10.1111/joim.12778

Carney, N., Totten, A. M., O'Reilly, C., Ullman, J. S., Hawryluk, G. W. J., Bell, M. J., …, Ghajar, J. (2016a). Guidelines for the management of severe traumatic brain injury (4th ed). Retrieved from https://braintrauma.org/guidelines/guidelines-for-the-management-of-severe-tbi-4th-ed#/

Carney, N., Totten, A. M., O'Reilly, C., Ullman, J. S., Hawryluk, G. W. J., Bell, M. J., … Ghajar, J. (2016b). Guidelines for the management of severe traumatic brain injury (4th ed). Retrieved from https://braintrauma.org/guidelines/guidelines-for-the-management-of-severe-tbi-4th-ed#/

Damkliang, J., Considine, J., Kent, B., & Street, M. (2014). Initial emergency nursing management of patients with severe traumatic brain injury: Development of an evidence-based care bundle for the Thai emergency department context. *Australasian Emergency Nursing Journal*, 152–160. https://doi.org/10.1016/j.aenj.2014.05.005

Depreitere, B., Güiza, F., Van den Berghe, G., Schuhmann, M. U., Maier, G., Piper, I., & Meyfroidt, G. (2014). Pressure autoregulation monitoring and cerebral perfusion pressure target recommendation in patients with severe traumatic brain injury based on minute-by-minute monitoring data. *Journal of Neurosurgery*, *120*, 1451–1457. https://doi.org/10.3171/2014.3.JNS131500

Grüne, F., Kazmaier, S., Stolker, R. J., Visser, G. H., & Weyland, A. (2015). Carbon dioxide induced changes in cerebral blood flow and flow velocity: Role of cerebrovascular resistance and effective cerebral perfusion pressure. *Journal of Cerebral Blood Flow and Metabolism: Official Journal of the International Society of Cerebral Blood Flow and Metabolism*, *35*, 1470–1477. https://doi.org/10.1038/jcbfm.2015.63

Holmes, J., Peng, J., & Bair, A. (2012). Abnormal end-tidal carbon dioxide levels on emergency department arrival in adult and pediatric intubated patients. *Prehospital Emergency Care*, *16*, 210–216. https://doi.org/10.3109/10903127.2011.640416

Huijben, J. A., Volovici, V., Cnossen, M. C., Haitsma, I. K., Stocchetti, N., Maas, A. I. R., … van der Jagt, M. (2018). Variation in general supportive and preventive intensive care management of traumatic brain injury: A survey in 66 neurotrauma centres participating in the Collaborative European NeuroTrauma Effectiveness Research in Traumatic Brain Injury (CENTER-TBI) study. *Critical Care (London, England)*, *22*, 90–90. https://doi.org/10.1186/s13054-018-2000-6

Johannigman, J. A., Zonies, D., Dubose, J., Blakeman, T. C., Hanseman, D., & Branson, R. D. (2015). Reducing secondary insults in traumatic brain injury. *Military Medicine*, *180*, 50–55. https://doi.org/10.7205/MILMED-D-14-00381

Kinoshita, K. (2016). Traumatic brain injury: Pathophysiology for neurocritical care. *Journal of Intensive Care*, *4*, 1–10. https://doi.org/10.1186/s40560-016-0138-3

Lee, J. C., Rittenhouse, K., Bupp, K., Gross, B., Rogers, A., Rogers, F. B., … Thurmond, J. (2015). An analysis of Brain Trauma Foundation traumatic brain injury guideline compliance and patient outcome. *Injury*, *46*, 854–858. https://doi.org/10.1016/j.injury.2014.12.023

Maissan, I. M., Ketelaars, R., Vlottes, B., Hoeks, S. E., den Hartog, D., & Stolker, R. J. (2017). Increase in intracranial pressure by application of a rigid cervical collar: A pilot study in healthy volunteers. European Journal of Emergency Medicine. *Official Journal of the European Society for Emergency Medicine*. https://doi.org/10.1097/MEJ.0000000000000490

Massenburg, B. B., Veetil, D. K., Raykar, N. P., Agrawal, A., Roy, N., & Gerdin, M. (2017). A systematic review of quantitative research on traumatic brain injury in India. *Neurology India*, *65*, 305–314. https://doi.org/10.4103/neuroindia.NI_719_16

Mcilvoy, L., & Meyer, K. (2009). Nursing management of adults with severe traumatic brain injury. Retrieved from http://www.aann.org/pdf/cpg/aanntraumaticbraininjury.pdf

McNett, M., Doheny, M., Sedlak, C. A., & Ludwick, R. (2010). Judgments of critical care nurses about risk for secondary brain injury. *American Journal of Critical Care*, *19*, 250–260. https://doi.org/10.4037/ajcc2009293

Meier, K., & Lee, K. (2017). Neurogenic fever: Review of pathophysiology, evaluation, and management. *Journal of Intensive Care Medicine*, *32*, 124–129. https://doi.org/10.1177/0885066615625194

National Institute for Health and Care Excellence. (2014). Head injury, triage, assessment, investigation and early management of head injury in children, young people and adults. Retrieved from https://doi.org/10.1136/bmj.g409

Nityangoon, S. (2008). Standards for critical care nursing in Thailand. In T. Jirasinthipok, P. Jermwiwatgul, S. Nityangoon, S. Wongsuwansiri, & S. Wongjarean (Eds.), *National standard for nursing in the hospital* (pp. 187–219). Retrieved from). nursing.go.th

Oddo, M., Crippa, I. A., Mehta, S., Menon, D., Payen, J.-F., Taccone, F. S., & Citerio, G. (2016). Optimizing sedation in patients with acute brain injury. *Critical Care*, *20*, 1–11. https://doi.org/10.1186/s13054-016-1294-5

Oddo, M., Frangos, S., Maloney-Wilensky, E., Kofke, W. A., Roux, P. D. L., & Levine, J. M. (2010). Effect of shivering on brain tissue oxygenation during induced normothermia in patients with severe brain injury. *Neurocritical Care*, *12*, 10–16. https://doi.org/10.1007/s12028-009-9280-2

Panjaisri, S., Phuenpathom, N., & Veerasan, K. (2013). Clinical practice guidelines for traumatic brain injury. Retrieved from http://www.google.co.th/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwjRy57jtLPNAhVCGZQKHZbAAn8QFggfMAA&url=http%3A%2F%2Fwww.med.cmu.ac.th%2Fdept%2Fsurgery%2Fneurosurgerycmu%2F2011%2Fimages%2FDocuments%2Fclinical-practice-guidelines-for-traumatic-brain-injury.pdf&usg=AFQjCNGj2gC61-FRVQ3LKWd_mQxEKHic8Q&sig2=oEiy84SrE36YRalEtN0v3Q

Patel, M. B., Humble, S. S., Cullinane, D. C., Day, M. A., Jawa, R. S., Devin, C. J., … Como, J. J. (2015). Cervical spine collar clearance in the obtunded adult blunt trauma patient: A systematic review and practice management guideline from the Eastern Association for the Surgery of Trauma. *The Journal of Trauma and Acute Care Surgery*, *78*, 430–441. https://doi.org/10.1097/TA.0000000000000503

Peeters, W., van den Brande, R., Polinder, S., Brazinova, A., Steyerberg, E. W., Lingsma, H. F., & Maas, A. I. R. (2015). Epidemiology of traumatic brain injury in Europe. *Acta Neurochirurgica*, *157*, 1683–1696. https://doi.org/10.1007/s00701-015-2512-7

Promlek, K., Currey, J., Damkliang, J., & Considine, J. (2020). Thai trauma nurses' knowledge of neuro-protective nursing care of traumatic brain injury patients: A survey study. *Nursing and Health Sciences*, *22*, 787–794. https://doi.org/10.1111/nhs.12730

Rockett, H., Blissitt, P. A., & Thompson, H. J. (2015). Fever management practices of neuroscience nurses: What has changed? *Journal of Neuroscience Nursing*, *47*, 66–75. https://doi.org/10.1097/JNN.0000000000000118

Sanders, K. (2013). Head injuries. In B. Dolan, & L. Holt (Eds.), *Accident & emergency: Theory into practice* (pp. 43–69). Beijing: Elsevier.

Schug, S. A., Palmer, G. m., Scott, D. A., Halliwell, R., & Trinca, J. (2015). Acute pain management: Scientific evidence. (4th ed). Retrieved from http://fpm.anzca.edu.au/documents/apmse4_2015_final

Taechakamolsuk, P., Nittayasut, N., Damnakkeaw, K., Sangjanthip, A., & Tantitam, N. (2015). Monitoring of motorcycle-related crash and injury. Retrieved from http://www.boe.moph.go.th/Annual/AESR2015/aesr2558/special2.pdf

Tha-on, S. (1996). *Effects of cold sponge and tepid sponge with fanning in head injuried patients with high fever. (Dissertation)*. Chiang Mai University. Retrieved from. http://search.lib.cmu.ac.th/search/?searchtype=.&searcharg=b1193523

Victorian State Trauma System. (2014). Traumatic brain injury guideline. Retrieved from http://trauma.reach.vic.gov.au/sites/default/files/Traumatic%20Brain%20Injury%20Guideline%20Guideline_Ver%201.0_250914_complete.pdf

Whitmore, R. G., Thawani, J. P., Grady, M. S., Levine, J. M., Sanborn, M. R., & Stein, S. C. (2012). Is aggressive treatment of traumatic brain injury cost-effective? *Journal of Neurosurgery*, *116*, 1106–1113. https://doi.org/10.3171/2012.1.jns11962

Wong, F. W. (2000). Prevention of secondary brain injury. *Critical Care Nurse*, *20*(5), 18–27.

Zink, E., & Kozub, E. (2013). Traumatic brain injury. In P. G. Morton, P. G. Morton & D. K. Fontaine (Eds.), *Critical care nursing: A holistic approach* (pp. 805–823). Philadelphia: Pa. Wolters Kluwer Health/Lippincott Williams & Wilkins.

How to cite this article: Promlek K, Currey J, Damkliang J, Considine J. Evidence–practice gaps in initial neuro-protective nursing care: A mixed methods study of Thai patients with moderate or severe traumatic brain injury. *Int J Nurs Pract*. 2020;e12899. https://doi.org/10.1111/ijn.12899