EVIDENCE-PRACTICE GAPS IN INITIAL NEURO-PROTECTIVE NURSING CARE: A MIXED METHODS STUDY OF THAI PATIENTS WITH MODERATE OR SEVERE TRAUMATIC BRAIN INJURY

ABSTRACT

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 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 four hours 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.

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This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as doi: 10.1111/ijn.12899
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 healthcare 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 TBI that need to be improved in the Thai trauma context, which there 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.

KEYWORDS

brain injury; evidence-based practice; neuroprotection; nursing; practice gaps; trauma; Thailand
EVIDENCE-PRACTICE GAPS IN INITIAL NEURO-PROTECTIVE NURSING CARE: A MIXED METHODS STUDY OF THAI PATIENTS WITH MODERATE OR SEVERE TRAUMATIC BRAIN INJURY

INTRODUCTION
Moderate or severe traumatic brain injury (TBI) is a leading cause of mortality, disability, and increased healthcare 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., 2016; Johannigman et al., 2015).

Evidence-based practice can reduce mortality from TBI (Gupta et al., 2016; 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 optimises 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, morbidity and improve quality of life of TBI survivors (American College of Surgeons [ACS], 2015; Carney et al., 2016; National Institute for Health and Clinical 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., 2016; 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 et al., 2013), thus is 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 & Goamalos, 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.

**METHODS**

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

Setting
The study setting was the 6-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 (SpO₂), end-tidal carbon dioxide (ETCO₂), 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 hours, then will 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 post-operative 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 four-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.
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.

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 three hours, 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 hours after admission. Data were collected during the first 4 hours 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.
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.

Ethical considerations

Ethical approval was obtained from the Human Research and Ethics Committee (HREC) at XXXX [redacted for anonymity] 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.

Data analysis

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

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.

**Table 1 here**

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 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.

**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 (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 minute ventilation (MV) measurements in 22 patients: 40 measurements (36.7%) in 15 patients (68.2%) indicated hyperventilation (MV 10.1–21.2 litres/minute). 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 ten 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 a MAP less than 80 mmHg, nine patients had tachycardia (heart rate>100 beats/minute) 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 degrees. Of 109 observations of patients’ head and neck positions; 75 instances (68.8%), the position was neutral. 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.

**Audit of clinical practice**

Most patients \((n=21)\) had SpO\(_2\) and RR recorded within 30 minutes 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 hours of care. All patients had heart rate, MAP and SBP documented within the first 30 minutes of admission and then at least hourly.

Elevating head-of-bed to 30 degrees was documented in 20 patients \((90.9\%)\).

Documentation of temperature within 30 minutes 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 hours 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 hours of care.

**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 a failure to use ABG analysis, ETCO\(_2\) monitoring, and SpO\(_2\) targets (Table 2).

**Table 2 here**
In terms of haemodynamic management, the major evidence-practice gaps were failure to use targets for MAP and SBP (Table 3).

**Table 3 here**

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).

**Table 4 here**

**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.

**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., 2016). 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 ETCO₂ monitoring in patients with moderate or severe TBI, which further influenced the failure to use ETCO₂ 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 ETCO₂ monitoring knowledge and skills (Damkliang et al., 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 realised the benefits of capnography, its use was also prioritised (Damkliang et al., 2014). Therefore, trauma ward should focus on the strategies to help nurses to improve their knowledge and skills related to ETCO₂ monitoring through education, training, and environmental redesign to make this equipment accessible.

Arterial blood gas analysis was rarely performed, despite recommendations that partial pressure of arterial carbon dioxide (PaCO₂) should be measured in patients with moderate or severe TBI (Carney et al., 2016). 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.

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 SpO₂ is higher than 95–98%, the FiO₂ should be decreased. However, FiO₂ was not reduced in most instances of SpO₂ exceeding the recommended values. The routine
practice of trauma ward nurses was to maintain SpO₂ of 95% or higher: a maximum SpO₂
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 FiO₂ when SpO₂ 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 SpO₂ targets are needed to enable trauma nurses to improve
respiratory management of patients with moderate to severe TBI.

**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 mmHg (NICE, 2014) and 100-140
mmHg (Brighenti & Joosten, 2018; Carney et al., 2016) 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. A MAP below 80 mmHg places patients at risk of
inadequate CPP (Kinoshita, 2016) and a SBP below 100 mmHg may trigger autoregulatory
vasodilatation, resulting in increased cerebral blood volume and increased ICP (Carney et al.,
2016). The most likely explanation for this finding is that there were no practice
recommendations regarding maximum MAP and SBP in trauma ward.

**Intracranial pressure management**

There was considerable variation in the degree of head-of-bed elevation from 10 to 30
degrees. Mean ICP decreases by one mmHg for every 10 degrees of head elevation (Wong,
2000) and 30 degrees head-of-bed elevation is recommended to maximise 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 degrees 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, 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 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., 2016), 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; 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., 2016; 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 hours 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 hours 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 hours 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., 2016; 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 to
improve agitation management and use of sedatives in patients with moderate or severe
TBI.

Limitations
This study was conducted at a single site with a limited sample and convenience sampling, so
findings may not be generalisable 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.
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.
REFERENCES


doi:10.1111/joim.12778


doi:10.3171/2014.3.JNS131500


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<th>TABLE 1 Patient participant characteristics (n=22)</th>
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<td><strong>Gender</strong></td>
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<tr>
<td>Female</td>
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<tr>
<td>Male</td>
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<tr>
<td>Cause of injury</td>
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<td>Road traffic crash</td>
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<td>Pedestrian</td>
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<td>Car</td>
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<td>Motorcycle with helmet</td>
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<td>Motorcycle without helmet</td>
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<td>Bicycle</td>
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<td>Fall</td>
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<td>Assault</td>
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<td>Admission GCS score</td>
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<td></td>
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<tr>
<td>Moderate TBI (GCS 9–12)</td>
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<tr>
<td>Severe TBI (GCS ≤ 8)</td>
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<td>Computed tomography diagnosis</td>
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<tr>
<td>Subdural haematoma</td>
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<td>Subarachnoid haemorrhage</td>
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<td>Intracerebral haemorrhage</td>
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<tr>
<td>Contusion</td>
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<td>Midline shift</td>
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TABLE 1 Patient participant characteristics (n=22)

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<tr>
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<tbody>
<tr>
<td>Isolated TBI</td>
<td>2</td>
<td>9.1</td>
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<tr>
<td>Multiple trauma with TBI</td>
<td>20</td>
<td>90.9</td>
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<tr>
<th></th>
<th>Median</th>
<th>Interquartile range (Q₁–Q₃)</th>
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<tbody>
<tr>
<td>Age (years)</td>
<td>45.5</td>
<td>20.8–63.3</td>
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<tr>
<td>Injury severity score</td>
<td>27</td>
<td>23.4–32.3</td>
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</tbody>
</table>

Abbreviations: TBI, Traumatic brain injury; GCS, Glasgow Coma Scale
TABLE 2. International evidence-based recommendations and current neuro-protective nursing care in trauma ward: respiratory management

<table>
<thead>
<tr>
<th>International evidence-based recommendations</th>
<th>Current neuro-protective nursing care in trauma ward</th>
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<tbody>
<tr>
<td>1. Maintain PaO$_2$ $\geq$ 97.5 mmHg (NICE, 2014) – 100 mmHg (ACS, 2015) and PaCO$_2$ 35–45 mmHg (ACS, 2015; Carney et al., 2016)</td>
<td>• Failure to use arterial blood gas analysis to monitor PaCO$_2$ and PaO$_2$.</td>
</tr>
<tr>
<td>2. Maintain SpO$_2$ $\geq$ 95% (ACS, 2015; NICE, 2014), 94–98% (Driscoll, 2017)</td>
<td>• 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.</td>
</tr>
<tr>
<td>3. Monitor end-tidal carbon dioxide (VSTS, 2014)</td>
<td>• There was one capnograph in trauma ward, but a failure to use end-tidal carbon dioxide monitoring.</td>
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</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>International evidence-based recommendations</th>
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TABLE 3. International evidence-based recommendations and current neuro-protective nursing care in trauma ward: haemodynamic management

<table>
<thead>
<tr>
<th>International evidence-based recommendations</th>
<th>Current neuro-protective nursing care in trauma ward</th>
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<tbody>
<tr>
<td>Maintain MAP≥80 mmHg by infusion of fluid and vasopressor as prescribed (NICE, 2014)</td>
<td>A MAP target was not used.</td>
</tr>
<tr>
<td>72.6% of documented MAP measurements were &lt;80 mmHg or &gt;90 mmHg.</td>
<td></td>
</tr>
<tr>
<td>Maintain SBP≥100 mmHg by infusion of fluid and vasopressor as prescribed (ACS, 2015; Carney et al., 2016)</td>
<td>SBP was kept ≥90 mmHg.</td>
</tr>
<tr>
<td>47.2% of documented SBP measurement were &lt;100 mmHg or &gt;140 mmHg.</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>International evidence-based recommendations</th>
<th>Current neuro-protective nursing care in trauma ward</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Keep 30 degrees head-of-bed elevated (ACS, 2015; Mcivoy &amp; Meyer, 2009; VSTS, 2014)</td>
<td>• Head-of-bed was elevated and documented for 86.4% of patients, but the degree of elevation varied from 10 to 30 degrees.</td>
</tr>
<tr>
<td>2. Remove cervical collars as soon as possible (Mcivoy &amp; Meyer, 2009)</td>
<td>• Half of patients who were applied cervical collars had cervical collars removed once a normal cervical spine CT scan result was confirmed.</td>
</tr>
<tr>
<td>3. Maintain normothermia (36–37.5°C) (ACS, 2015; Carney et al., 2016; Mcivoy &amp; Meyer, 2009)</td>
<td>• Temperature of 72.7% of patients was monitored and documented on admission to trauma ward, then 4-hourly.</td>
</tr>
<tr>
<td>• The trigger for nursing interventions to treat hyperthermia was temperature ≥38.5°C.</td>
<td></td>
</tr>
<tr>
<td>• Cold sponge bath was routinely used when temperature ≥38.5°C.</td>
<td></td>
</tr>
<tr>
<td>4. Pain and agitation management</td>
<td>• Pain assessment and documentation were not performed in any patients.</td>
</tr>
<tr>
<td>4.1 Pain assessment (using BPS) and pain management (continuous analgesia infusion combination with bolus doses when needed)</td>
<td>• 68.2% of patients received 3 mg 1–2 doses of intravenous morphine. One patient received a...</td>
</tr>
</tbody>
</table>
TABLE 4. International evidence-based recommendations and current neuro-protective nursing care in trauma ward: intracranial pressure management

<table>
<thead>
<tr>
<th>International evidence-based recommendations</th>
<th>Current neuro-protective nursing care in trauma ward</th>
</tr>
</thead>
<tbody>
<tr>
<td>(ACS, 2015; NICE, 2014; Schug et al., 2015)</td>
<td>continuous morphine infusion.</td>
</tr>
<tr>
<td></td>
<td>• No patients received analgesics prior to endotracheal suctioning.</td>
</tr>
<tr>
<td>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; Mcivoy &amp; Meyer, 2009; Schug et al., 2015)</td>
<td>• Depth of sedation assessment was not routine practice and was not performed in any patient who received sedatives.</td>
</tr>
<tr>
<td></td>
<td>• Sedative drugs were not routinely prescribed; the usual practice was for nurses to call physicians when patients had severe agitation.</td>
</tr>
<tr>
<td></td>
<td>• Agitation was observed in 72.7% of patients; just 25% of patients who had agitation received sedatives.</td>
</tr>
</tbody>
</table>

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

Date:
2021-12

Citation:

Persistent Link:
http://hdl.handle.net/11343/287000