Significant Practice Pattern Variations Associated With Intracranial Pressure Monitoring

CE 2.3 ANCC Contact Hours

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ABSTRACT

Purpose: The purpose of this study was to describe nursing practice in the care of patients with intracranial pressure monitoring. Although standards for care of such patients have been established, there continue to be variations in the nursing practice. **Methods:** This was an observational study in which data were collected from 28 nurse–patient dyads at 16 different hospitals across the United States. Each dyad was observed for 2 hours; nursing actions and patient responses including intracranial pressure readings were documented. **Results:** Differences in the care of patients with intracranial pressure monitoring were prevalent. Variations in practice were prompted by healthcare provider prescriptions as well as nursing decisions. Prescriptions and interventions were often not supported by the available scientific evidence. **Video Abstract:** For more insights from the authors, see Supplemental Digital Content 1, at http://links.lww.com/JNN/A7.

Keywords: intracranial pressure, nursing, nursing interventions, nursing practice

Background

The first continuous intracranial pressure (ICP) monitoring device was reported in 1965 by Lundberg, Troupp, and Lorin (1965). Today, ICP monitoring is ubiquitous in any neurocritical care unit or intensive care unit (ICU), where patients are at higher risk for secondary brain injury because of cerebral edema, changes in cerebral blood flow, and hydrocephalus as well as secondary ischemia from hypotension, hypoxia, hypocapnia, hypercapnia, and fever (Miller, 2012; Wolfe & Torbey, 2009). Although elevated ICP is generally defined as an ICP > 20 mmHg, there is a wide variety of treatment thresholds ordered by the physician provider (Greenberg, 2010). Furthermore, there are no national guidelines that define the interventions that should be used to treat ICP at various thresholds.

A survey conducted among 28 medical centers in the United Kingdom identified significant variations in the management of ICP (Allan, 1989). Variations existed in the type of ICP monitoring devices and modes. Marked differences were found in the nursing education provided for ICP management and in the guidelines or protocols used to guide ICP management practices among the different medical centers. Several research studies have provided evidence on the impact of routine nursing interventions such as endotracheal suctioning and patient repositioning, which are associated with increased ICP (Kerr et al., 1997; March, Mitchell, Grady, & Winn, 1990; Mitchell & Mauss, 1978; Mitchell, Ozuna, & Lipe, 1981; Rising, 1993; Snyder, 1983). Although these studies provided understanding of how ICP values may relate to a discrete set of predefined interventions, they were designed to explore impact and not to describe variations in practice.

Guidelines established by the American Association of Neuroscience Nurses (AANN, 2004) identify evidence-based recommendations for the nursing management of ICP. These guidelines include clinical

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indications for ICP monitoring, types of ICP monitoring devices, nursing responsibilities when monitoring ICP, and the effects of nursing interventions on ICP. A survey of nursing practices targeting secondary brain injury prevention indicated that 67% of nurses reported knowledge of evidence-based guidelines for secondary brain injury management, yet no nurses in the study cited guidelines established by the Brain Trauma Foundation or AANN (McNett, Doheny, Sedlak, & Ludwick, 2010).

Given the wide variety of interventions, thresholds, and methods of monitoring, it is inevitable that nursing practice regarding ICP management has evolved since Dr. Lundberg first described ICP. This evolution has occurred in hundreds of ICUs across multiple continents. The theory of evolution implies that the likelihood of variation increases as a combination of factors, such as time, distance, and isolation, occur (Grenvik & Pinsky, 2009). There is little research evidence documenting practice variation associated with nursing care of the patient with ICP monitoring. Among nurses specifically, standardized evidence-based educational materials and protocols are less readily accessible to ICU nurses responsible for ICP management (Marshall, West, & Aitken, 2011). The purpose of this study is to describe practice variations for ICP management.

> This prospective, multicenter study was designed to examine potential variations in nursing practice and the management of care for patients undergoing ICP monitoring.

Methods

For this prospective multicenter observational study, data were gathered using two methods: direct observation and medical record review. The study received institutional review board approval at the coordinating center (Duke University, Durham, NC) and from the institutional review boards at each participating hospital. For this study, a dyad was defined as a patient–nurse pair. Hospitals were those who responded to an invitation via the AANN listserv and Neurocritical Care Society or were referred to the investigators by an AANN or Neurocritical Care Society member. Hospitals included teaching as well as community-based centers.

Patient-participants were considered eligible if they had any form of ICP monitoring in situ, were diagnosed with an intracranial pathology (e.g., traumatic brain injury, subarachnoid hemorrhage, brain tumor), and were aged 18 years or older. Because of the nature of their illness, patients were unable to provide informed self-consent. A member of the care team not associated with the study met with the legally authorized representative for each patient-participant and asked if they were willing to speak to the research team. If the legally authorized representative was willing to discuss participation, the study was explained and consent was requested. Nurses as participants were identified as the nurse assigned to care for the patient-participant and considered eligible so long as they were assigned to work in the ICU, a registered nurse, and had completed the orientation phase of their employment. There were no subjects approached who refused consent.

After consent, the site investigator initiated a 2-hour observational period at the beginning of the next hour (e.g., if consent was obtained at 2:34 P.M., observations started at 3:00 P.M.). Each dyad participated only once during this study. Observations were made in an open environment such that the patient, family, nursing, and medical staff were aware that they were being observed. The site investigator at each institution positioned herself or himself such that they could observe all activities and vital signs within the patient's room. Site investigator training consisted of written instructions on the use of a standardized case report form (CRF) to record the ICP, heart rate, respiratory rate, blood pressure, temperature, and those nursing actions (Table 3) previously reported in the literature as being associated with ICP change (McNett & Gianakis, 2010; Mitchell & Mauss, 1978; Mitchell et al., 1981; Olson, Bader, Dennis, Mahanes, & Reimen, 2010). Observations were recorded once each minute during the 2-hour observational period. An example of a completed CRF was provided in the site investigators' instruction packet, and any nursing intervention or action not listed in Table 3 was recorded in free text in the space provided in the CRF. All data not considered time sensitive (e.g., patient and nurse demographics) were abstracted from the chart review before or after the study period. The medical order prescribing ICP treatment threshold was transcribed verbatim as free text.

Data were recorded by the site investigators into an electronic spreadsheet, which was then sent electronically to the central coordinating center. All data were then aggregated into a single de-identified spreadsheet. Each CRF had separate sheets for patient demographics, nurse demographics, and the study period data.

Results

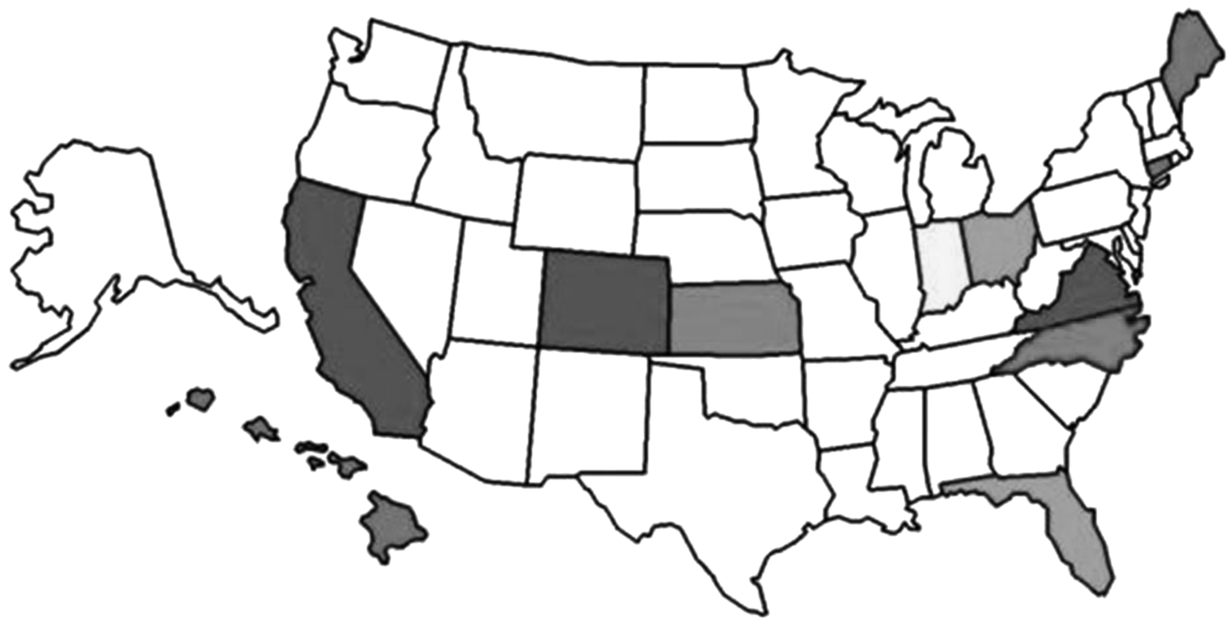
There were 3,118 minutes of direct observation made on 28 dyads enrolled at 16 hospitals across the continental United States and Hawaii between August 2009 and May 2012 (Figure 1). Table 1 provides demographics for patients and nurses. Patients within dyads were primarily men (67.9%), of non-Hispanic ethnicity (92.9%), and of Caucasian race (75%), with a mean age of 47 years. Most of the dyads were enrolled from neuroscience critical care units (22); there were two dyads from mixed-bed ICUs, and four were from surgical ICUs. Nurses enrolled in the dyads were primarily women (89.7%), non-Hispanic (86.2%), and Caucasian (79.3%). Nursing experience was a mean of 9.95 years, with a mean of 7.7 years of experience in critical care. Most nurses were baccalaureate prepared (79.3%) and had not obtained specialty certification in neuroscience nursing or critical care nursing (62.1%).

A medical order prescribing a set threshold for ICP treatment was provided for 26 of 28 (92.9%) patients and varied considerably both among and within institutions (Table 2). The direction of treatment was most frequently described as ''keep ICP less than X-value,'' ''treat ICP at X-value,'' or ''treat if ICP is greater than X-value'' (e.g., ''drain for ICP > 20''). However, there was no consistent pattern: 12 patients had orders to keep an ICP < x-value, six patients had orders to treat if ICP was > x-value; six patients had orders to treat if the ICP was equal to x-value, one patient had orders for a goal CPP but no ICP treatment threshold, and two patients did not have a specific ICP treatment order.

Treatment threshold was evaluated for the units of measure. For half of the patients (14 of 28), the ICP treatment threshold was 20; of these, three were treated at 20 cm H_20, three were treated at 20 mmHg, and the unit of measure was not included for eight participants. CSF diversion (also termed CSF drainage) to control ICP was specified for 11 of 28 (39.3%) patients. Of these, 6 of 11 were prescribed to have continuous CSF drainage with intermittent ICP monitoring and 5 of 11 were prescribed to have intermittent CSF diversion with continuous ICP monitoring. CSF diversion was not possible for patients in 7 of 28 (25%) cases where a parenchymal ICP monitor was used. The unit of measure was specified as part of a medical order for 14 of 28 (50%) patients. Half of these 14 orders indicated treatment thresholds using ''cm H_2O'' as the unit of measure, and half prescribed ''mmHg'' as the unit of measure.

Nurses performed one or more interventions during 2,760 (88.5%) of the 3,118 minutes of observation, and a total of 5,118 interventions were observed (nurses often employed more than one intervention during a single minute of observation). The ICP was recorded during 2,571 (82.5%) of the 3,118 minutes of

FIGURE 1 States That Enrolled Dyads in the SIM City Study



California, Colorado, Connecticut, Florida, Hawaii, Indiana, Kansas, Maine, North Carolina, Ohio, Virginia, Washington D.C.

TABLE 1. Demographics for Patients and Nurses

Variable	Patients, n = 28	Nurses, n = 29
Gender		
Male	19 (67.9%)	3 (10.3%)
Female	9 (32.1%)	26 (89.7%)
Ethnicity		
Hispanic	2 (7.1%)	4 (13.8%)
Non-Hispanic	26 (92.9%)	25 (86.2%)
Race		
African American	6 (21.4%)	3 (10.3%)
Asian	1 (3.6%)	2 (6.9%)
Caucasian	21 (75%)	23 (79.3%)
Native American		1 (3.4%)
ICU type		
Neuro-ICU	22 (78.6%)	23 (79.3%)
SICU	4 (14.3%)	4 (13.8%)
CCU	2 (7.1%)	2 (6.9%)
Admit diagnosis		
Ischemic stroke	2 (7.1%)	2 (6.9%)
Hydrocephalus	1 (3.6%)	1 (3.4%)
Intracerebral hemorrhage	9 (32.1%)	9 (31%)
Intraventricular hemorrhage	2 (7.1%)	2 (6.9%)
Subarachnoid hemorrhage	6 (21.4%)	6 (20.7%)
Traumatic brain injury	6 (21.4%)	7 (24.1%)
Tumor	2 (7.1%)	2 (6.9%)
Initial degree		
Associate		10 (34.5%)
Baccalaureate		19 (65.5%)
Highest degree		
Associate		5 (17.2%)
Baccalaureate		23 (79.3%)
Masters		1 (3.4%)
Specialty certification		
CCRN		7 (24.1%)
Other		4 (13.8%)
None		18 (62.1%)

Note. One dyad included 2 nurses for 1 patient. ICU = intensive care unit; SICU = surgical intensive care unit; CCU = cardiac care unit; CCRN = certified critical care registered nurse.

observation. ICP was greater than 15 mmHg during 760 minutes (24.4%), greater than 20 mmHg during 153 minutes (4.9%), and greater than 30 mmHg during 128 minutes (4.1%). Table 3 presents data on 18 different nursing interventions that are linked in literature to impact ICP; minutes of observation for each intervention are presented for various ICP thresholds. The most common interventions observed were draining CSF (n = 1,593), talking to the patient (n = 1,435; nurse = 353, other = 1,082), and limiting environmental stimulation (n = 1,250).

Discussion

The most notable finding from this study is that there are widespread practice differences at all levels of caring for patients with ICP monitoring in situ. This lack of consistency is likely multifactorial. Despite

TABLE 2. Different Combinations of Prescribed ICP Treatment

ICP Treatment Threshold[a]	Drain CSF Continuously and Monitor ICP Intermittently (*n* = 6)	Monitor ICP Continuously and Drain CSF Intermittently (*n* = 5)	CSF Diversion Frequency was not Specified (*n* = 8)	Parenchymal ICP Monitor (*n* = 6)
5 cm H_2O	1			
5 mmHg				
5 N.S.				
10 cm H_2O	1			
10 mmHg				
10 N.S.			2	
15 cm H_2O	2			
15 mmHg			2	1
15 N.S.	1			
18 cm H_2O				
18 mmHg				
18 N.S.				
20 cm H_2O			3	
20 mmHg				3
20 N.S.	1	4	1	2
25 cm H_2O				
25 mmHg				
25 N.S.		1		

Note. CSF = cerebrospinal fluid; ICP = intracranial pressure; cm H2O = centimeters pressure; mmHg = millimeters pressure.
[a]Two patients did not have specified orders.

general guidelines for care, there is a lack of national or international consensus on treatment threshold and treatment algorithms. Current literature supports a variety of approaches based on different levels of evidence for specific interventions to treat ICP and traumatic brain injury (Bratton et al., 2007b; Greenberg, 2010; McIlvoy & Meyer, 2011; McNett & Gianakis, 2010). Physicians are not provided adequate evidence to determine best practice (Andrews et al., 2008; Bratton et al., 2007a, 2007b; Mauritz, Janciak, Wilbacher, & Rusnak, 2007). Therefore, much of what is prescribed is based on individual interpretation of the evidence, ideally, with a comprehensive understanding of the principles supporting ICP monitoring and management. Finally, nursing education is largely based on learning in the clinical environment, and there remains a significant gap between scientific publication dates and integration of new data into clinical practice (Bartels, 2005; Given, 2009).

Nurses are tasked with actualizing provider-generated instructions for ICP monitoring and subsequent treatment (Olson & Graffagnino, 2005). Defining a consistent unit of measure increases both the internal and external validity and is associated with patient safety. (Leape, Berwick, & Bates, 2002) Yet, in this sample, even the manner in which treatment was prescribed varied significantly. There was no specific prescription for two dyads, and the unit of measure was not specified for 12 dyads. In the 26 dyads with treatment orders, providers prescribed treatment at 10 different thresholds (ranging from 5 to 25), using two different units of measure and two different CSF drainage strategies. Further inconsistency was noted when trying to determine if the treatment threshold was greater than, less than, or equal to a set value of ICP. The often incomplete, ambiguous, or nonspecific medical orders tasked nurses with intuiting the meaning behind any given prescription—a task which was likely performed differently by nurses at different institutions and nurses with different levels of expertise (Benner, 1984; McNett et al., 2010).

Planned and unplanned interventions described in the nursing literature as having the potential to impact ICP occurred frequently throughout the 2-hour observation periods (Olson et al., 2010; Olson & Graffagnino, 2005; Wolfe & Torbey, 2009). Nurses initiated, maintained, and regulated a variety of nursing interventions, medical–pharmaceutical interventions, and patient–family interactions. Furthermore, interventions associated with reducing ICP were performed

TABLE 3. Nursing Interventions and ICP Values

Action		Any ICP (2,571 min)	ICP > 15 (760 min)	ICP > 20 (153 min)	ICP > 30 (128 min)
May increase ICP	Turn/reposition patient	230	82	12	6
	Test/lab/x-ray	107	29	2	2
	Suction	54	17	10	10
	Reposition ET tube	17	13	13	13
	Reposition c-collar	3	1	0	0
Inconsistent impact on ICP	Facilitating patient-visitor communication	1,082	314	36	23
	RN talking to patient	353	65	10	2
	Chest percussion	67	44	11	11
	Administer BP medication	9	6	5	5
May decrease ICP	Drain CSF	1,593	274	25	15
	Limit stimulation	1,250	269	70	56
	Raise HOB	372	68	3	1
	Sedation				
	iv -push	8	3	0	0
	iv -drip	132	66	0	0
	Analgesic				
	iv -push	21	3	0	0
	iv -drip	8	3	0	0
	Anxiolytic	11	0	0	0
	ICP med	2	1	1	1
Observations for each ICP level		5,319	1,258	198	145

Note. Cells in each column are not mutually exclusive. ICP = intracranial pressure; BP = blood pressure; CSF = cerebrospinal fluid; RN = registered nurse; ET = endotracheal; HOB = head of bed; iv = intravenous.

across all levels of ICP, not simply when the ICP was elevated. It is generally accepted that ICP values of <15 mmHg are considered within the normal range (Hickey & Olson, 2009). In 1,250 events of limiting stimulation, only 269 (21.5%) were associated with an ICP > 15 mmHg. In 353 events of the nurse talking to the patient, only 65 (18.4%) involved a patient with an ICP greater than 15 and only two of those events (< 1%) were associated with an ICP > 30 mmHg. Although the head of the bed (HOB) is generally elevated, there were 372 incidents when the nurse was observed to further elevate the head, and in only 68 of 372 (18.3%) of these events was the ICP > 15 mmHg. However, the site investigators did not document the HOB elevation at baseline nor the subsequent HOB level, hence this maneuver may simply represent standard nursing care and not care aimed directly at ICP reduction.

A priority nursing intervention for patients with ICP monitoring may be CSF drainage. The most frequently supported threshold for ICP treatment is 20 mmHg. (Bratton et al., 2007b; Greenberg, 2010; McIlvoy & Meyer, 2011). CSF drainage was recorded during 1,593 of 3,118 (51.1%) minutes of the study. Noteworthy is the fact that at least six patients were prescribed with continuous CSF drainage for the 120 minutes observed and could account for up to 720 of the 1,593 minutes (45.2%) of CSF drainage. However, only 274 (17.2%) minutes of CSF diversion were associated with an ICP > 15 mmHg, and only 25 (1.6%) minutes were associated with an ICP > 20 mmHg. These data suggest that CSF diversion occurs frequently and without regard to any single ICP treatment threshold.

The fact that interventions to reduce ICP are performed even when ICP is not elevated suggests that nurses may not rely entirely on the ICP value as a cue to initiate an intervention. This finding is supported in the literature, as ICU nurses often rely on additional physiological parameters such as oxygen saturation, brain oxygenation, and cerebral perfusion pressure when making decisions about interventions to prevent secondary brain injury (McNett et al., 2010; Palmer et al., 2001). Furthermore, the fact that interventions, which may increase ICP, are performed when ICP is elevated suggests that nurses may initiate these interventions out of necessity rather than opportunity. These data indicate a need to more clearly define the context in which nursing interventions are performed that result in an increase or decrease in ICP.

Conclusion

In general, there is a lack of consistency throughout the United States in how physicians and nurses monitor and manage ICP. The scope and number of interventions that nurses coordinate across multiple levels of ICP values introduce significant concerns for previous research in which ICP is listed as a dependent or independent variable. This practice variation limits the external validity of studies in which ICP is a variable. Until researchers are provided with the data to control for the impact of nursing care interventions on ICP, it is impossible to obtain a comprehensive understanding of how ICP acts as an independent variable or how any one intervention influences ICP as a dependent variable. The findings of this study fail to support the assumption of treatment similarity required for comparing the effectiveness of different ICP treatments when nursing care interventions are not included in the model.

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