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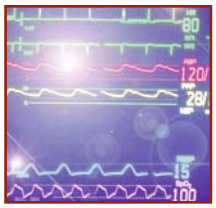

Judgments of Critical Care Nurses About Risk for Secondary Brain Injury

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Background Interdisciplinary care for patients with traumatic brain injury focuses on treating the primary brain injury and limiting further brain damage from secondary injury. Intensive care unit nurses have an integral role in preventing secondary brain injury; however, little is known about factors that influence nurses' judgments about risk for secondary brain injury.
Objective To investigate which physiological and situational variables influence judgments of intensive care unit nurses about patients' risk for secondary brain injury, management solely with nursing interventions, and management by consulting another member of the health care team.
Methods A multiple segment factorial survey design was used. Vignettes reflecting the complexity of real-life scenarios were randomly generated by using different values of each independent variable. Surveys containing the vignettes were sent to nurses at 2 level I trauma centers. Multiple regression was used to determine which variables influenced judgments about secondary brain injury.
Results Judgments about risk for secondary brain injury were influenced by a patient's oxygen saturation, intracranial pressure, cerebral perfusion pressure, mechanism of injury, and primary diagnosis, as well as by nursing shift. Judgments about interventions were influenced by a patient's oxygen saturation, intracranial pressure, and cerebral perfusion pressure and by nursing shift. The initial judgments made by nurses were the most significant variable predictive of follow-up judgments.
Conclusions Nurses need standardized, evidence-based content for management of secondary brain injury in critically ill patients with traumatic brain injury.

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Traumatic brain injury (TBI) affects more than 1.4 million persons in the United States every year and accounts for $37.8 billion in health care costs annually.[1,2] Interdisciplinary care for TBI patients centers on treating the primary brain injury and limiting further damage to surrounding brain tissue from secondary brain injury. Secondary brain injury is a cascade of interrelated events that include cellular changes at the primary injury site, brain tissue ischemia, and cerebral edema.[3,4] These events occur in 60% to 90% of TBI patients in the hours and days after the primary injury.[5,6] During this time, fluctuations in physiological values, such as blood pressure, oxygen saturation, body temperature, intracranial pressure (ICP), and cerebral perfusion pressure (CPP), exacerbate secondary brain injury and result in higher mortality rates, additional cognitive and physical impairments, and longer stays.[5,7-10]

Intensive care unit (ICU) nurses are responsible for the continuous monitoring and maintenance of physiological values associated with secondary brain injury and therefore are the members of the health care team best positioned to detect and prevent secondary brain injury. However, nurses vary in their practice, and little is known about how ICU nurses manage secondary brain injury. Evidence-based guidelines for care of TBI patients have been established,[11] but the extent to which these guidelines influence nursing practice in the management of secondary brain injury is not known.

The purpose of this study was to investigate which physiological variables (ie, blood pressure, oxygen saturation, ICP, CPP) and situational variables (ie, a patient's primary and secondary diagnoses, age, sex, and mechanism of injury, as well as nursing shift and time of assessment) influenced ICU nurse judgments about patients' risk for secondary brain injury, management solely with nursing interventions, and management by consulting another member of the health care team.

Background

Secondary Brain Injury

TBI, defined as a blow or penetrating injury to the head that disrupts normal brain function, is a result of falls, motor vehicle accidents, being struck by an object, and assaults.[12] Damage to brain tissue is due to primary and secondary injury. Primary brain injuries occur at the time of impact and are classified as focal or diffuse.[13] In response to the primary injury, cerebral cellular changes, cerebral ischemia, and cerebral edema occur and cause damage to surrounding brain tissue, or secondary brain injury. These changes, in conjunction with fluctuations in physiological parameters, such as blood pressure, ICP, CPP, oxygen saturation, and body temperature, contribute to additional compression and damage of brain tissue.[3,4] Guidelines established by the Brain Trauma Foundation (BTF) and the American Association of Neurological Surgeons include recommended ranges for systolic blood pressure, oxygen saturation, ICP, and CPP to limit secondary brain injury.[11] Continuous monitoring of these variables by ICU nurses minimizes the occurrence of the processes associated with secondary brain injury and prevents secondary brain damage.

Evidence-based guidelines for care of patients with traumatic brain injury have been established.

Physiological Variables and Nurses' Judgments

Nursing interventions influence physiological values and can increase or decrease risk for secondary brain injury.[14-17] Routine nursing interventions can adversely affect physiological variables, leading to secondary brain damage. Endotracheal suctioning and patient repositioning in particular can increase blood pressure and ICP while decreasing oxygen saturation and CPP in critically ill TBI patients.[15-24] However, little evidence is available on nursing interventions to prevent secondary brain injury when physiological fluctuations occur.[25] Importantly,

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no investigators have examined how ICU nurses interpret these physiological values, make judgments about a patient's risk for secondary brain injury, and determine if a situation is best managed solely with nursing interventions or through consultation with other members of the health care team.

Situational Variables and Nurses' Judgments

Situational variables consist of patient variables (eg, primary and secondary diagnosis, age, sex, mechanism of injury) that influence mortality and hospitalization rates in TBI patients[12,26-29] and contextual variables (eg, nursing shift, type/time of assessment), which can influence ICU nurses' judgments.[30-40] The types of judgments typically made by nurses can vary, depending on the shift worked and whether or not a nurse is performing an initial assessment on a patient or has provided care for that patient before.[30-32]

Theoretical Framework

Social judgment theory provided the framework for the study. In this theory, every judgment is due to interactions between variables in the environment and the individual who makes the judgment.[41] The theory has 3 constructs: the ecology or the situation present in the environment, the cues presented as a result of the situation, and the judgment of the individual. Within social judgment theory, the ecology, or the situation that exists within the environment, elicits a particular set of cues, which serve as a lens through which the individual interprets the situation. The individual assigns weights to each cue, determining how heavily each cue influences the judgment made by the individual.[41]

Oxygen saturation, intracranial pressure, and cerebral perfusion pressure levels predicted nurses' judgments about risk for secondary brain injury.

In health care research in which social judgment theory is used, a patient's status often represents the ecological component of the lens model.[42-46] In our study, characteristics of the patient and of the care environment (ie, situational variables) made up the ecological aspect of the model. These variables, either in isolation or combination with one another, influence the cues (ie, physiological variables) that are then interpreted by the individual making the judgment.

Methods

The study was reviewed and approved by the institutional review boards at each study site and by Kent State University, Kent, Ohio.

Design

A multiple segment factorial survey design was used: vignettes or fictional case studies in conjunction with sample survey methods. The factorial survey design has been used extensively in the social sciences and in medical and nursing research to simultaneously investigate independent variables that may be difficult or unethical to control, such as abnormal physiological values.[42-48] Consistent with this method, vignettes reflecting real-life clinical contexts were randomly generated by using different values, or levels, of each physiological and situational variable (Tables 1 and 2). An example of the vignette template is provided in the Figure. Each study participant received a different set of 5 vignettes to judge, allowing the factors that affect judgments to be causally tested by using regression techniques.[47,48]

After each segment of the vignettes, nurses used a 10-point Likert scale to indicate the likelihood of making 3 separate judgments about the situation presented (see Figure). These judgments were the dependent variables of the study and included judgments about the likelihood of patients' risk for secondary brain injury, managing the situation solely with nursing interventions, and managing the situation by consulting another member of the health care team.

Procedures

A survey containing the vignettes was completed by a convenience sample of ICU registered nurses from 3 ICUs at 2 level I trauma centers: MetroHealth Medical Center in Cleveland, Ohio, and Summa Akron City Hospital in Akron, Ohio. Nurses were recruited during routine unit report sessions and nursing staff meetings on all shifts. Nurses who met the eligibility criteria and were interested in participating were given a letter explaining the study and a study survey. Nurses were instructed to complete the survey and return it anonymously to the principal investigator (M.M.) directly or via US mail. Preaddressed, stamped envelopes were provided to the nurses who wished to return surveys in the mail. In order to ensure that all nurses had an opportunity to participate in the study, additional surveys with a letter explaining the study were placed in unit mailboxes of all registered nurses on staff.

Data Analysis

Data were analyzed by using methods consistent with factorial survey methods.[48] Descriptive statistics were first calculated to summarize the characteristics of the survey respondents. Correlational analyses were then conducted with dependent variables.

Table 1
Physiological vignette variables

Variable	Level	Value	Rationale
Systolic blood pressure, mm Hg	1	90-100	Hypotension occurs in 35% of TBI patients and increases mortality 50% to 150%.[49]
	2	80-89	
	3	70-79	Hypotension is especially harmful in TBI patients because of impaired cerebral autoregulation[3] and results in decreased CPP.[50]
	4	<70	
Oxygen saturation, %	1	90-95	Episodes of desaturation in TBI patients are associated with increased mortality rates and poor outcomes for patients.[49]
	2	85-89	
	3	80-84	Cerebral hypoxia is associated with increased ICP, decreased CPP, and hypocarbia.[51]
	4	<80	
Body temperature, °C	1	38-38.5	Fever occurs in 50% to 70% of TBI patients and has adverse effects on outcome.[9,52,53]
	2	38.6-39	
	3	39.1-39.5	Increases in body temperature result in increased cerebral blood flow, carbon dioxide production, oxygen consumption, and ICP.[13,54]
	4	>39.6	
ICP, mm Hg	1	15-20	Increased ICP occurs in approximately 50% of TBI patients and has adverse effects on patients' outcomes.[55-59]
	2	21-25	
	3	26-30	Increased ICP causes a decrease in cerebral perfusion.[54]
	4	>30	
CPP, mm Hg	1	60-65	Decreased CPP is associated with poor outcomes and mortality.[10,60]
	2	55-59	Cerebral vascular resistance and cerebral autoregulation are impaired as a result of the primary brain injury.
	3	50-54	
	4	<50	Low CPP values cause cerebral ischemia and additional brain damage.[57]

Abbreviations: CPP, cerebral perfusion pressure; ICP, intracranial pressure; TBI, traumatic brain injury.

Finally, data from study vignettes were analyzed by using multiple regression techniques.

Vignette variables (ie, physiological and situational variables) were used as central analysis in the regression models to determine which variables were most predictive of the judgments of ICU nurses about risk for secondary brain injury, managing the situation solely with nursing interventions, and managing the situation by consulting with other members of the health care team. These analyses were performed to identify independent variables that influenced judgments at time 1 (ie, after reading the first segment of the vignette). Each regression analysis provided information on the amount of variance explained, effect sizes, and significance of variables predictive of each of the 3 dependent variables. The influence of each independent variable and the overall power of the regression model were evaluated by using the multiple correlation squared (R^2).

In order to determine which variables were predictive of judgments at time 2 (ie, judgments made after reading the second segment of the vignette), a separate set of regression analyses was performed. A regression model was created for each follow-up judgment. For each model, a series of regression analyses was performed in which different groups of variables (ie, vignette variables at time 1, vignette variables at time 2, and judgment scores at time 1) were entered in blocks to determine which variables were predictive of time 2 judgments. SPSS, version 15.0 (SPSS Inc, Chicago, Illinois), was used for all data analyses.

Results

Demographic Data

A total of 67 nurses returned completed surveys (44% response rate). The unit of analysis in the factorial survey design is the vignette, not the respondent.[47,48] Thus, the returned surveys provided 335 vignettes for analysis, a number adequate to maintain 80% power with a medium-small effect size. Table 3 provides a summary of the characteristics of the respondents. Most respondents (64%) were 26 to 40 years old and had worked as registered nurses for less than 10 years. Although 30% of nurses had more than 10 years' critical care experience, many (75%) had only recently started working in their current ICU. A total of 58% of the respondents had a bachelor's degree in nursing, 22% had associate degrees, and 19% had nursing diplomas.

> Oxygen saturation and cerebral perfusion pressure influenced judgments to manage a situation through consultation.

At the end of the demographic survey, nurses were asked to indicate knowledge of evidence-based guidelines for TBI patients. In response to this question, only 27% (n = 18) indicated they had knowledge

Table 2
Situational vignette variables

Variable	Level		Rationale
Primary diagnosis	1	Epidural hematoma	Epidural hematoma occurs in 2% to 6% of TBI patients, subdural hematoma in 30%, and intracranial hemorrhage in 4% to 15%. Diffuse axonal injury accounts for 50% of TBIs.[4,13,54]
	2	Subdural hematoma	
	3	Intracranial hemorrhage	
	4	Diffuse axonal injury	
Secondary diagnosis	1	Extracranial injuries	Extracranial injuries occur in 95% of TBI patients.[27] Hypertension and diabetes occur in 28% to 73% and increase mortality rates.[26,28,29,61]
	2	Hypertension	
	3	Diabetes mellitus	
	4	None	
Patient's age, y	1	25	Most TBI patients are 15 to 34 years old. Age is a strong predictor of outcome in TBI patients.[12,62-66]
	2	35	
	3	45	
	4	55	
	5	65	
	6	75	
	7	85	
Patient's sex	1	Male	Males are 1.5 times more likely than females to have a TBI.[12]
	2	Female	
Mechanism of injury	1	Fall	Falls, motor vehicle accidents, being struck, and assaults are leading causes of TBI. Motor vehicle accidents are responsible for the highest number of hospitalized TBI patients.[12]
	2	Motor vehicle accident	
	3	Struck by a blunt object	
	4	Assault	
Nursing shift	1	Days	The types of decisions made by nurses vary by nursing shift.[31]
	2	Evenings	
	3	Nights	
Type/time of assessment (used only in follow-up vignette)	1	Follow-up assessment/15 minutes later	Reassessment of changes in a patient's status must be done at least every 15 minutes. Routine reassessment of intensive care unit patients in stable condition is done at least every 4 hours.[13,30]
	2	Routine shift reassessment/4 hours later	

Abbreviation: TBI, traumatic brain injury.

of existing guidelines. However, when asked to write in the name of the guidelines, no nurses referred to guidelines supplied by the BTF,[11] which are the current evidence-based standard of care for TBI patients.

Correlational Analysis of Dependent Variables

Analyses were performed to determine correlations among the 3 dependent variables: risk for secondary brain injury, management solely with nursing interventions, and management by consulting. Judgments about risk for secondary brain injury and management by consulting were moderately correlated ($R = 0.767$; $P = .001$); judgments about risk for secondary brain injury and management solely with nursing interventions had a modest negative correlation ($R = -0.775$; $P = .001$). Thus, nurses who judged patients at high risk for secondary brain injury were more likely to consult another member of the health care team and less likely to use solely nursing interventions. As expected, we also detected a modest negative correlation between judgments to use solely nursing interventions and to consult ($R = -0.758$; $P = .001$), indicating that nurses who judged that a situation would be best managed with nursing interventions would be less likely to consult another member of the health care team.

Regression Analyses of Judgments at Time 1

A regression model was first created to identify variables predictive of judgments about a patient's risk of secondary brain injury at time 1. All physiological and situational variables from the initial vignette segment were entered into the analysis. The resulting regression model was significant: $R = 0.613$; $R^2 = 0.376$; $R^2_{adj} = 0.308$; $F_{33,301} = 5.500$; $P < .001$). Specifically, physiological and situational variables had a 0.613 correlation with likelihood of secondary brain injury and accounted for more than 30% of the variance. Table 4 presents a summary of the regression coefficients predictive of judgments at time 1. The significant physiological and situational variables predictive of time 1 judgments about a patient's risk for secondary brain injury were oxygen saturation ($\beta = .305$; $P < .001$), ICP ($\beta = .197$; $P = .001$),

Template of initial vignette (segment 1):

You are performing your initial assessment when caring for a _____(age) _____(gender) patient in your surgical intensive care unit on the _____(shift). The patient has sustained a _____(primary diagnosis) from _____(mechanism of injury) and has _____(secondary diagnosis). In performing your assessment, you record the following values:

_____(Blood pressure)
_____(Oxygen saturation)
_____(Body temperature)
_____(Intracranial pressure)
_____(Cerebral perfusion pressure)

1. What is the likelihood that this situation places your patient at increased risk for additional injury to the brain?

(Not very likely) 0 1 2 3 4 5 6 7 8 9 10 (Very likely)

2. What is the likelihood that you would manage this situation *solely* with nursing interventions?

(Not very likely) 0 1 2 3 4 5 6 7 8 9 10 (Very likely)

3. What is the likelihood that you would consult another member of the health care team to assist in managing this situation?

(Not very likely) 0 1 2 3 4 5 6 7 8 9 10 (Very likely)

Template of follow-up vignette (segment 2):

You are now performing your _____(type of assessment) on this same patient. You now record the following values:

_____(Blood pressure)
_____(Oxygen saturation)
_____(Body temperature)
_____(Intracranial pressure)
_____(Cerebral perfusion pressure)

1. What is the likelihood that this situation places your patient at increased risk for additional injury to the brain?

(Not very likely) 0 1 2 3 4 5 6 7 8 9 10 (Very likely)

2. What is the likelihood that you would manage this situation *solely* with nursing interventions?

(Not very likely) 0 1 2 3 4 5 6 7 8 9 10 (Very likely)

3. What is the likelihood that you would consult another member of the health care team to assist in managing this situation?

(Not very likely) 0 1 2 3 4 5 6 7 8 9 10 (Very likely)

Figure Vignette templates.

CPP ($\beta = .461$; $P < .001$), primary diagnosis ($\beta = .112$; $P = .04$), mechanism of injury ($\beta = .143$; $P = .02$), and nursing shift ($\beta = .111$; $P = .04$).

A second regression model was created to determine how the same set of physiological and situational variables were predictive of the second dependent variable: judgments to manage a situation solely with nursing interventions. The resulting regression model was significant ($R = 0.557$; $R^2 = 0.310$; $R^2_{adj} = 0.235$; $F_{33,301} = 4.103$; $P < .001$), explaining approximately 24% of the variance in judgments. Significant predictors of judgments in this model (Table 4) were oxygen saturation ($\beta = -.331$; $P < .001$), ICP ($\beta = -.186$; $P = .003$), CPP ($\beta = -.314$; $P = .001$), and nursing shift ($\beta = .116$; $P = .04$).

A third regression model (Table 4) was then created to examine which physiological and situational variables influenced the third judgment at time 1: judgments to consult another member of the health care team to assist in managing a situation. This model was significant ($R = .500$; $R^2 = 0.250$; $R^2_{adj} = 0.168$; $F_{33,301} = 3.037$; $P < .001$) and explained more than 16% of the variance in judgments. However the only variables that were significant predictors of judgments to consult were oxygen saturation ($\beta = .327$; $P < .001$) and CPP ($\beta = .265$; $P = .01$).

Judgments at Time 2

The regression analyses described for time 1 indicate independent variables that influence initial judgments of ICU nurses. In further regression analyses, groups of variables were entered in blocks to determine which variables were predictive of ICU nurse judgments at time 2.

In order to determine how vignette variables at time 1 (ie, physiological and situational variables in the first vignette segment), vignette variables at time 2 (ie, physiological and situational variables in the

Table 3
Demographic data of nurse respondents

Characteristic	No.	%[a]
Age, y		
20-25	6	9
26-30	15	22
31-35	18	27
36-40	10	15
>40	18	27
Ethnicity[b]		
White	61	92
Other	5	8
Years as registered nurse		
0-10	41	61
≥11	26	39
Years in intensive care		
0-10	47	70
≥11	20	30
Years in current intensive care unit		
0-10 years	50	75
11 years or greater	17	25
Years caring for patients with traumatic brain injury		
0-10	50	75
≥11	17	25
Highest nursing degree		
Associate degree	15	22
Nursing diploma	13	19
Bachelor's degree	39	58
Primary nursing shift		
Days	17	25
Day/night	20	30
Day/evening	7	10
Nights	22	33
Evenings	1	1

[a] Because of rounding, not all percentages total 100.
[b] One nurse did not respond to this question.

second vignette segment), and judgments at time 1 influenced judgments about secondary brain injury at time 2, a series of regression equations were performed in which each group of variables was entered in blocks.

In order to identify variables predictive of time 2 judgments about patients' risk for secondary brain injury, physiological variables at time 1 were entered into the first block of a regression equation. These variables were significant and accounted for 12% of the variance in judgments ($R = 0.404$; $R^2 = 0.164$; $R^2_{adj} = 0.124$; $F = 4.160$; $P < .001$). Vignette variables from time 2 were then entered into the second block of the regression equation. These variables increased the variance explained in the model to 24% ($R = 0.553$; $R^2 = 0.305$; $R^2_{adj} = 0.244$; $F = 4.997$; $P < .001$). Block 3 contained the judgment scores about likelihood of secondary brain injury from time 1 (ie, judgments by nurses after reading the first segment of the vignette). Addition of these variables to the regression equation increased the variance explained to 67% ($R = 0.834$; $R^2 = 0.695$; $R^2_{adj} = 0.667$; $F = 24.902$; $P < .001$). Overall, judgment scores from time 1 explained the majority of the variance in judgments about a patient's risk for secondary brain injury at time 2. Table 5 lists the regression coefficients for the individual vignette variables that were significant predictors of judgments.

Regression analyses were then performed in which the same groups of variables were again entered in blocks to determine which variables were predictive of time 2 judgments to manage a situation solely with nursing interventions. Each block of variables produced a significant regression equation, with judgments at time 1 again accounting for the majority of the variance (60%) in judgments at time 2 ($R = 0.801$; $R^2 = 0.642$; $R^2_{adj} = 0.609$; $F = 19.597$; $P < .001$).

A final set of regression analyses was performed to determine how these variables influenced judgments to consult another member of the health care team at time 2. The same groups of variables were again entered in blocks into the regression equation. This regression model was significant, with judgments at time 1 accounting for most of the variance (53%) in judgments at time 2 ($R = 0.754$; $R^2 = 0.569$; $R^2_{adj} = 0.531$; $F = 14.985$; $P < .001$).

Discussion

The purpose of this study was to determine which physiological and situational variables influence ICU nurses' judgments about secondary brain injury in patients with TBI. We found that physiological variables explained most of the variance in nurses' initial judgments about secondary brain injury. Specifically, a patient's oxygen saturation, ICP, and CPP were significant predictors of judgments about the patient's risk for secondary brain injury and of managing a situation solely with nursing interventions. Judgments to manage a situation through consultation with other members of the health care team were influenced by oxygen saturation and CPP. As values for these physiological variables in the vignettes worsened, a corresponding increase occurred in judgment scores for a patient's risk and for consulting and a decrease in judgments to solely use nursing interventions.

These findings are consistent with the routine education ICU nurses receive on managing critically ill patients: to ensure adequate airway protection and oxygenation as a priority during resuscitation and care.[67,68] Ensuring adequate oxygen saturation levels is therefore an expected standard of care for critically ill patients, and particularly for brain-injured patients because hypoxia decreases cerebral oxygenation, leading to secondary brain injury.[49,51,54,69]

Our finding that oxygen saturation was a significant predictor of all judgments is therefore consistent with the required education and expectations of ICU nurses to ensure adequate oxygenation as a priority when caring for patients.

ICU nurses are taught to consider the "whole picture" when interpreting physiological parameters in TBI patients. Because a patient's blood pressure, ICP, and CPP values depend on one another (ie, mean arterial pressure - ICP = CPP), nurses are often instructed that fluctuations in blood pressure can usually be tolerated, provided that the patient's ICP remains within normal limits (<25 mm Hg), and, more important, that CPP values remain greater than 60 mm Hg.[13,54] Thus, our finding that oxygen saturation and CPP were significant predictors of all 3 judgments about secondary brain injury (ICP was a significant predictor of only 2 judgments, and blood pressure was not a significant predictor) is consistent with the literature on management of secondary brain injury in TBI patients.[54,70,71]

Worsening values for body temperature were not significant predictors of judgments in this study. Nationally, nurses vary in how they define elevated temperature (fever) and determine appropriate interventions.[72,73] Currently, no evidence-based standards of care for temperature management are available, particularly for TBI patients. Although fever in TBI patients has been associated with poor outcomes,[9,52,53] to what extent nurses are aware of this information when determining risk for secondary brain injury is not clear. Our finding that elevated temperature did not influence judgments about secondary brain injury suggests that nurses do not routinely associate the physiological value of body temperature with secondary brain injury. This finding is consistent with the literature that nurses vary in how they define and respond to elevated temperature when caring for TBI patients.[73]

Nursing practice is increasingly influenced by evidence-based standards, and nurses are expected to be knowledgeable about research findings and clinical guidelines affecting the nurses' area of clinical expertise. However, marked gaps still remain between best evidence and nursing practice.[72,73] In our study, only 27% of nurses were aware of evidence-based guidelines for managing physiological parameters in TBI patients. Of those nurses who responded that they were aware of guidelines, not 1 nurse was able to cite the name of guidelines established by the BTF,[11] which are the current standard of evidence-based care for TBI patients. This finding is particularly interesting, because 2 of the ICUs in the study had implemented BTF guidelines as standard practice within their units. Further, a recent survey[74] of 413 trauma centers in the United States indicated that 66% of trauma centers are compliant with BTF guidelines. The finding that nurses in our study were not aware of these guidelines therefore indicates that ICU nurses still lack knowledge of evidence-based guidelines for prevention of secondary brain injury in TBI patients. Although evidence-based guidelines

Table 4
Summary of regression coefficients predictive of judgments at time 1

Judgment	Significant variables	β	*t*	*P*
Patient at risk for secondary brain injury	Oxygen saturation	.305	5.212	<.001
	Intracranial pressure	.197	3.381	.001
	Cerebral perfusion pressure	.461	4.956	<.001
	Primary diagnosis	.112	2.011	.04
	Mechanism of injury	.143	2.393	.02
	Nursing shift	.111	0.209	.04
Manage solely with nursing interventions	Oxygen saturation	-.331	-5.373	<.001
	Intracranial pressure	-.186	-3.037	.003
	Cerebral perfusion pressure	-.314	-3.212	.001
	Shift	.116	2.031	.04
Manage by consulting member of health care team	Oxygen saturation	.327	5.133	<.001
	Cerebral perfusion pressure	.265	2.602	.01

Table 5
Summary of regression coefficients predictive of judgments at time 2

Judgment	Significant variables	β	*t*	*P*
Patient at risk for secondary brain injury	Blood pressure	.160	2.629	.009
	Oxygen saturation	.294	4.827	<.001
	Intracranial pressure	.187	3.135	.002
	Cerebral perfusion pressure	.448	4.175	<.001
	Mechanism of injury	-.142	-2.492	.01
	Nursing shift	-.170	-2.975	.02
Manage solely with nursing interventions	Blood pressure	-.135	-2.092	.04
	Oxygen saturation	-.287	-4.544	<.001
	Cerebral perfusion pressure	.183	3.057	.002
	Nursing shift	.239	4.044	<.001
Manage by consulting member of health care team	Oxygen saturation	.334	1.818	<.001
	Cerebral perfusion pressure	.342	1.635	.003
	Diagnosis	.123	1.971	.05
	Mechanism of injury	.193	2.907	.004

may be in place, ICU nurses may not be receiving adequate education about these guidelines.

We used a multiple segment factorial survey design to investigate how different groups of variables influenced ICU nurses' judgments at 2 different times. A key advantage of the factorial survey method is the high degree of internal validity.[48] The combination of experimental design and a survey method enhances internal validity by allowing the values of each independent variable to vary randomly, eliminating the multicollinear nature of the variables and enhancing the possible variance of the independent variables.[48] Content validity of the vignettes was established by using the recent-case method.[47,75] Nurses were asked to provide information about the most recent TBI patient they cared for in their ICU. Data from these questions were then used to validate the content of randomly generated vignettes. Stability between variables reported in recent cases and vignette variables established content validity.

Ensuring adequate oxygen saturation levels is an expected standard of care.

Use of the factorial survey design was valuable, because the design closely resembles real-life scenarios encountered in the ICU, where a patient's status can quickly change and nurses often make judgments based on previous situations or responses associated with that patient.[30] The regression analyses with the second segment of the vignettes (ie, judgment scores at time 2) indicated that the single best predictor of follow-up judgments was the initial judgments made by a nurse. Judgments at time 1 nearly doubled the explained variance in judgments at time 2. The resulting variance explained for all 3 judgments at time 2 was significantly increased to approximately 60%.

The primary limitation of our study is that data on judgments were gathered by using vignettes rather than by direct observation in the clinical setting. However, when several highly intercorrelated variables are examined, inferring causation between each variable and judgments is difficult. In addition, manipulating physiological variables in an observational study to determine how ICU nurses would respond would be difficult and unethical. Use of the factorial survey design allows for investigation of how fluctuations in these individual variables influence judgments. Therefore, to address this limitation and ensure that the vignettes accurately reflected clinical situations, content validity of the vignettes was first established.

No evidence-based standards for temperature management exist.

A second limitation of the study is the generalizability of the findings. Although the sample consisted of nurses from 3 ICUs at 2 different trauma centers, the sample size was not large enough to conclude that the judgments in this study reflect judgments made by all ICU nurses. Characteristics of respondents were similar to those of nonrespondents, indicating that the study sample reflected nurses working in the 3 units. However, because the sample was limited to nurses working in a single geographical location, and because education on secondary brain injury varies by nursing unit and hospital, we cannot assume that ICU nurses working in all trauma centers would respond similarly to the vignettes.

Conclusion

We examined how physiological and situational variables influenced ICU nurses' judgments about secondary brain injury in TBI patients. Together, the variables explained a significant proportion of the variance in judgments about a patient's risk for secondary brain injury, managing a situation solely with nursing interventions, and managing a situation by consulting another member of the health care team. Our findings highlight the need for standardized, evidence-based content for ICU nurses on management of secondary brain injury in TBI patients. Information from this study can be used to guide such educational initiatives and as a basis for future research on the effects of these educational interventions on the incidence of secondary brain injury and patients' outcomes.

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FINANCIAL DISCLOSURES

None reported.

SEE ALSO

For more about secondary brain injury, visit the *Critical Care Nurse* Web site, **www.ccnonline.org**, and read the article by Lemke, "Sympathetic Storming After Severe Traumatic Brain Injury" (February 2007).

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