

Effects and Clinical Characteristics of Intracranial Pressure Monitoring–Targeted Management for Subsets of Traumatic Brain Injury: An Observational Multicenter Study

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Learning Objectives

To evaluate the efficacy of traumatic brain injury management guided by intracranial pressure monitoring and to explore the specific subgroups for which intracranial pressure monitoring might be significantly associated with improved outcomes based on a classification of the various traumatic brain injury pathophysiologies using the clinical features and CT scans.

Introduction

It became increasingly necessary to rethink the value and clinical application of TBI management guided by ICP monitoring.

TABLE 1. The Differences Between Intracranial Pressure Monitoring and No-Intracranial Pressure Monitoring

Variable	No-ICP Monitoring (%)	ICP Monitoring (%)	<i>p</i>
Total	605	838	Not available
Age (yr) (mean ± sd)	48.04 ± 17.71	47.76 ± 16.03	0.763
Sex			
Male	486 (80.3)	647 (77.2)	0.154
Female	119 (19.7)	191 (22.8)	
Mechanism of injury			
Motor vehicle accident	320 (62.9)	504 (60.1)	0.009
Fall	134 (22.1)	148 (17.7)	
Stumble	87 (14.4)	115 (13.7)	
Blow to head	40 (6.6)	31 (3.7)	
Others	24 (4.0)	40 (4.8)	
GCS score at admission	7.69 ± 2.70	7.20 ± 2.60	< 0.001
9–12	178 (29.4)	188 (22.4)	0.004
6–8	283 (46.8)	402 (48.0)	
3–5	144 (23.8)	248 (29.6)	
GCS score of 9–12 at admission that dropped to 3–8 within 24 hr after injury	24 (4.0)	63 (7.5)	0.005
Pupillary reactions			
Both reacting	422 (69.8)	551 (65.8)	0.165
One reacting	64 (10.6)	114 (13.6)	
None reacting	119 (19.7)	173 (20.6)	
Hypertension present on day 1	49 (8.1)	103 (12.3)	0.010
Hypotension present on day 1	97 (16.0)	128 (15.3)	0.695
Marshall classification on initial CT			
Marshall CT I–II	163 (26.9)	146 (17.4)	< 0.001
Marshall CT III–IV	168 (27.8)	301 (35.9)	
Marshall CT V–VI	274 (45.3)	391 (46.7)	
CT signs of intracerebral hypertension			
Yes	432 (71.4)	678 (80.9)	< 0.001
No	173 (28.6)	160 (19.1)	
Major extracranial injury	171 (28.3)	287 (34.2)	0.016
Intracranial lesion, <i>n</i> (%)			
Epidural hematoma	164 (27.1)	225 (26.8)	0.913
Subdural hematoma	206 (34.0)	463 (55.3)	< 0.001
Traumatic subarachnoid hemorrhage	307 (50.6)	535 (63.9)	0.486
Intraparenchymal lesion	407 (67.2)	708 (84.5)	< 0.001
Trauma center level			
I	510 (84.3)	659 (78.6)	0.007
II	95 (15.7)	179 (21.4)	
Teaching status			
University	455 (75.2)	603 (72.0)	0.168
Nonteaching	150 (24.8)	235 (28.0)	
ICP monitoring utilization			
≥ 50%	262 (43.3)	697 (83.2)	< 0.001
< 50%	343 (56.7)	141 (16.8)	

ICP = intracranial pressure, GCS = Glasgow Coma Scale.

Methods

A retrospective observational multicenter study was conducted. Data was collected on adult moderate or severe TBI patients treated from January 2012 to December 2013 in 22 hospitals (16 level I trauma centers and 6 level II trauma centers) of nine Chinese provinces. All data were collected by physicians from medical records. The 6-month mortality and favorable outcome were assessed with the Glasgow Outcome Scale Extended score.

TABLE 3. The Differences Between Intracranial Pressure Monitoring and No-Intracranial Pressure Monitoring on Interventions and Outcomes

Variable	No-ICP Monitoring	ICP Monitoring	<i>p</i>
<i>n</i>	605	838	
Length of stay			
ICU (d)	6 (2–13)	10 (5–16)	< 0.001
Hospital (d)	16 (9–26)	22 (13–36)	< 0.001
Mechanical ventilation			
Duration (d)	3 (1–7)	3 (1–7)	0.637
Osmotherapy	408 (67.4)	681 (81.3)	< 0.001
Cerebrospinal fluid drainage	17 (2.0)	401 (66.3)	< 0.001
Type of ICP monitoring			
Intraventricular monitoring	–	425 (50.7)	–
Parenchymal monitoring	–	248 (29.6)	–
Subdural monitoring	–	149 (17.8)	–
Epidural monitoring	–	16 (1.9)	–
Duration of ICP monitoring (mean ± sd)		4.44 ± 3.65	
1–3 d	–	207 (24.7)	–
4–7 d	–	456 (54.4)	–
8–14 d	–	165 (19.7)	–
> 14 d	–	10 (1.2)	–
ICP ≥ 20 at any point, <i>n</i> (%)	–	574 (68.5)	–
Neurosurgical procedures			
No	151 (25.0)	185 (22.1)	0.201
Craniotomy	133 (22.0)	118 (14.1)	< 0.001
Decompressive craniectomy	321 (53.1)	535 (63.9)	< 0.001
New loss of pupil reactivity	72 (11.9)	79 (9.4)	0.190
Decrease in the Glasgow Coma Scale score ≥ 2	111 (18.3)	122 (14.6)	0.054
6 Mo outcome			
Dead	124 (20.5)	142 (16.9)	0.086
Alive	481 (79.5)	696 (83.1)	
Unfavorable outcome	277 (45.8)	414 (49.4)	0.175
Favorable outcome	328 (54.2)	424 (50.6)	
Predicted outcome			
Probability of death at 6 mo (mean ± sd)	0.35 ± 0.24	0.37 ± 0.24	0.045
< 0.2	218 (36.2)	262 (30.2)	0.132
0.2–0.4	170 (28.1)	246 (29.4)	
0.4–0.6	120 (19.8)	164 (19.6)	
> 0.6	102 (16.9)	175 (20.8)	
Unfavorable outcome probability at 6 mo (mean ± sd)	0.49 ± 0.27	0.51 ± 0.27	0.103
< 0.2	118 (19.5)	134 (16.0)	0.082
0.2–0.4	143 (23.6)	181 (21.6)	
0.4–0.6	122 (20.2)	199 (23.7)	
> 0.6	222 (36.7)	324 (38.6)	

ICP = intracranial pressure. Unless stated otherwise, *n* (%) or median (interquartile range) is reported. Dashes indicate value not available.

Results

An intracranial pressure monitor was inserted into 838 patients (58.1%). The significant predictors of intracranial pressure monitoring included the mechanism of injury, a Glasgow Coma Scale score of 9–12 at admission (adjusted odds ratio, 0.57; 95% CI, 0.36–0.90), those who had a Glasgow Coma Scale score of 9–12 at admission (adjusted odds ratio, 0.28; 95% CI, 0.08–0.96), and those who had a probability of death at 6 months greater than 0.6 (adjusted odds ratio, 0.55; 95% CI, 0.32–0.94).

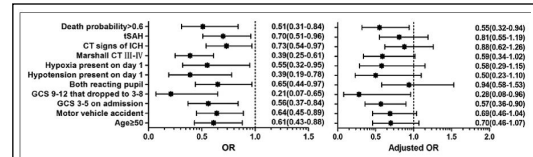


Figure 2. Forest plot of odds ratios (ORs) and adjusted odds ratios (AORs) for 6-month mortality after severe traumatic brain injury at the different subgroups of intracranial pressure (ICP) monitoring use. ORs were estimated using a univariate analysis, and AORs were estimated using a multivariate logistic regression analysis where having undergone ICP monitoring or not was entered into the model as an independent variable together with the propensity score to adjust for potential confounding by indication. GCS = Glasgow Coma Scale, ICH = intracerebral hypertension, ISAH = traumatic subarachnoid hemorrhage.

TABLE 4. Intracranial Pressure–Related Complications and System Complications Between the Two Groups

Variable	No-ICP Monitoring	ICP Monitoring	<i>p</i>
<i>n</i>	143	356	–
ICP-related complications			
ICP catheter-related infection	–	1 (0.3)	–
ICP catheter-related hemorrhage	–	3 (0.8)	–
Infections			
Pneumonia	102 (71.3)	292 (79.2)	0.055
Sepsis or septic shock	4 (2.8)	13 (3.7)	0.839
Nervous system	18 (11.2)	32 (9.0)	0.451
Hydrocephalus	8 (5.6)	9 (2.5)	0.151
Cerebrospinal fluid leakage	5 (3.5)	2 (0.6)	0.036
Gastrointestinal hemorrhage	1 (0.7)	2 (0.6)	0.857
Renal insufficiency	4 (2.8)	13 (3.7)	0.839
Acute respiratory distress syndrome	1 (0.7)	6 (1.7)	0.670
Multiple organ dysfunction syndrome	15 (10.5)	28 (7.9)	0.345

ICP = intracranial pressure.

Dashes indicate value not available.

Conclusions

There were multiple differences between the intracranial pressure monitoring and no intracranial pressure monitoring groups regarding patient characteristics, injury severity, characteristics of CT scan, and hospital type. Intracranial pressure monitoring in conjunction with intracranial pressure–targeted therapies is significantly associated with lower mortality in some special traumatic brain injury subgroups.