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ORIGINAL RESEARCH

Knowledge, Attitude, and Practice of Anesthetists in Managing Severe Craniocerebral Trauma in China: A Cross-Sectional Study

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Objective: The study explored the knowledge, attitude, and practice (KAP) toward severe craniocerebral trauma perioperative management among anesthetists in China.

Methods: This cross-sectional study recruited anesthetists from 15 provinces in China between October 17, 2022, and November 09, 2022. Pearson's correlation was used to assess the relationships between KAP dimension scores, and multivariable linear regression was performed to identify factors associated with higher KAP scores.

Results: The study included 200 anesthetists (122 females). The mean knowledge, attitude, and practice scores were 50.41±7.36 (possible range, 0–84), 20.23±2.72 (possible range, 0–24), and 11.85±4.54 (possible range, 2–28), respectively. The knowledge scores were positively correlated with the attitude scores (r=0.522, P<0.001), but the practice scores were not significantly correlated with the knowledge or attitude scores. Anesthetists with experience in 100–300 craniocerebral trauma surgeries (B = 3.728, 95% confidence interval [CI]: 0.271–7.186, P = 0.035) or more than 300 surgeries (B = 7.680, 95% CI: 2.684–12.675, P = 0.003) were significantly more likely to achieve higher overall KAP scores compared to those with experience in fewer than 100 surgeries.

Conclusion: Anesthetists in China exhibit moderate knowledge, a positive attitude, and inadequate practice regarding perioperative management of severe craniocerebral trauma. Greater clinical experience in managing craniocerebral trauma perioperatively is associated with higher KAP scores. The results highlight the need for targeted training and experience-based education to improve perioperative outcomes, which could translate into better clinical outcomes for the patients. Policymakers should be aware of those gaps and include additional training as necessary.

Keywords: craniocerebral trauma, anesthetist, surveys and questionnaires, knowledge, attitudes, practice

Introduction

Trauma is among the leading causes of disability and death in people <35 years old and the sixth mortality reason worldwide.[1] Most severe traumatic injuries are related to motor vehicle accidents (drivers, passengers, and pedestrians), falls, and direct blows to the body.[1] The common causes of traumatic brain injury (TBI) include blunt, penetrating, and acceleration/deceleration injuries. Severe craniocerebral injury most often presents as altered consciousness accompanied by other neurological and neuropsychological issues.[2] Managing craniocerebral injury includes surgery, reducing intracranial pressure through dehydration, nutritional support, infection and epilepsy prevention, and maintaining water, electrolyte, and acid-base balance. Despite treatment, TBI is associated with 20–30% mortality and high morbidity, especially severe craniocerebral trauma.[3]

The perioperative management of craniocerebral trauma aims to manage the primary injury while preventing secondary damage.[4] A multidisciplinary approach is crucial in the management of patients with craniocerebral trauma.

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Besides anesthetists, severe cases require the participation of other specialists during acute management or during progressive resolution.[5] Guidelines for the management of craniocerebral trauma are available,[6] and adherence to these guidelines reduces mortality and improves outcomes.[7,8] The therapeutic goals of perioperative management of TBI include cerebral decompression, the provision of appropriate anesthesia, maintaining sufficient cerebral perfusion, and preventing secondary injury.[9] The current management strategies for craniocerebral trauma involve the monitoring and maintenance of cerebral perfusion pressure (CPP), intracranial pressure (ICP), mean arterial blood pressure (MAP), oxygenation, normoglycemia, and normothermia.[9] Anesthetists are central in managing craniocerebral injuries during the perioperative period, including resuscitation and stabilization of the patient in the emergency department, airway management and ventilation, provision of anesthesia for surgical intervention and analgesia, and providing care in the intensive care unit.[9,10] However, published data are limited regarding anesthetists' knowledge and implementation of perioperative strategies for managing patients with severe craniocerebral trauma.

Knowledge, attitude, and practice (KAP) studies provide insights regarding the knowledge gaps, improper attitudes, inexact beliefs, misconceptions, and behaviors of medical professionals toward a health-related topic.[11] Moreover, KAP surveys can help develop and implement educational and training programs to improve the performance of the topic.[11] Therefore, this study aimed to evaluate the KAP toward severe craniocerebral trauma perioperative management among anesthetists in China.

Materials and Methods

Study Design and Participants

This cross-sectional study recruited anesthetists from 15 Chinese provinces between October 17, 2022, and November 09, 2022. The inclusion criteria were as follows: 1) certified practicing doctor (ie, graduates from domestic regular medical schools); 2) employed as an anesthetist (ie, majoring in clinical medicine or Anesthesiology); and 3) volunteered to participate in this study. Informed consent was obtained from all the participants. Doctors mentioned in the Law of China on Licensed Doctors refer to healthcare providers who obtained the qualification of licensed doctors or licensed assistant doctors and were registered to practice in medical, prevention, and healthcare institutions, including clinical physicians, dentists, public health physicians, and traditional Chinese medicine physicians.

Questionnaire Design and Distribution

The first version of the questionnaire was designed based on the current guidelines about the management of TBI[6] and previous studies.[11,12] The questionnaire was revised according to the insights from two associate chief or higher physicians. A pilot evaluation of the questionnaire was performed with 35 physicians, resulting in a Cronbach's α coefficient of 0.79, suggesting good internal consistency (ie, good reliability).

The study version of the questionnaire was in Chinese language. It included 44 questions across four dimensions: demographic information, knowledge, attitude, and practice (Supplementary Materials). Eight questions collected the demographic information: age, sex, educational level, type of hospital, location of the hospital, professional title, years of experience, and previous experience in participating in operations for severe craniocerebral trauma. Knowledge was evaluated using 21 items (K1-K21). Items K1-K16 were scored using a 5-point Likert scale (0–4 points) according to the positivity/negativity of the response selected, which ranged from "very familiar" to "very unfamiliar" for items K1–K3, K5, K8, K9 and K16 and from "strongly agree" to "strongly disagree" for items K4, K6, K7 and K10–K15. Items K17–K21 were scored 4 or 0 points for correct or incorrect answers, respectively. The possible range of scores for the knowledge dimension was 0–84 points. Six questions evaluated attitudes (A1-A6), each of which was scored using a 5-point Likert scale (0–4 points) according to the positivity/negativity of the response chosen, which ranged from "strongly agree" to "strongly disagree". The possible range of scores for the attitude dimension was 0–24 points. The practice dimension comprised nine items (P1-P9). Items P1 and P2 collected information about learning methods and frequency, and these data were analyzed using descriptive statistics and were not included in the overall score for the practice dimension. Items P3 and P4 were scored from 1 point to 4 points depending on the response given. Items P5–P9 were scored using a 5-point Likert scale (0–4 points) according to the positivity/negativity of the response chosen, which ranged from "always" to "never". P1 and P2 are not assigned. The possible range of scores for the practice dimension was 2–28 points.

The professional online questionnaire platform Wenjuanxin (Changsha Ranxing Information Technology, Changsha, China) was used to design the online questionnaire. A link to the questionnaire was created and distributed via WeChat groups. In order to ensure result quality and completeness, a given IP address could only be used to complete a single questionnaire (access would be blocked if the questionnaire is accessed again using the same IP address). In addition, a response to each item was mandatory for submission. The results were exported from the questionnaire platform on an Excel spreadsheet. Each questionnaire was checked for completeness, consistency, and validity by the research team.

Statistical Analysis

Statistical analysis was performed using SPSS 26.0 (IBM Corp., Armonk, N.Y., USA). The continuous data were tested for normality using the Kolmogorov–Smirnov test. Normally distributed continuous data were expressed as means ± standard deviations (SD) and analyzed using Student's *t*-test (two levels) or ANOVA (more than two levels). Continuous data with skewed distribution were presented as medians (ranges) and analyzed using the Mann–Whitney *U*-test (two levels) or the Kruskal–Wallis test (more than two levels). Categorical variables are expressed as n (%). The correlations between KAP dimension scores were assessed using Pearson correlation analysis. Univariable and multivariable linear regression analyses were used to identify the variables associated with the KAP scores. Variables with $P < 0.05$ in the univariable analysis were entered into the multivariable analysis. Unstandardized beta values (*B*) and 95% confidence intervals (95% CIs) were calculated. Two-sided $P < 0.05$ was considered statistically significant.

Results

Demographic Characteristics of the Study Participants

Two hundred anesthetists (122 females, 61.10%) participated in the study. More than half of the respondents (114/200, 57.0%) were aged ≤30 years old, and just under half of the participants (94/200, 47.00%) had a master's degree or higher. The majority of anesthetists worked in a tertiary public hospital (181/200, 90.50%), and half of the respondents had a junior-grade professional title (100/200, 50.00%). Over one-third of the respondents (77/200, 38.50%) had less than 3 years of professional experience, and the majority of the anesthetists had participated in less than 100 operations for craniocerebral trauma (Table 1).

Table 1 Knowledge, Attitude, and Practice Scores Stratified According to the Baseline Characteristics of the Study Participants

Characteristic		Knowledge Score		Attitude Score		Practice Score	
		Mean ± SD	*P*	Mean ± SD	*P*	Mean ± SD	*P*
All participants	200 (100.00%)	50.41 ± 7.358		20.23 ± 2.715		11.85 ± 4.541	
Sex			0.425		0.439		0.595
Male	78 (39.00%)	49.85 ± 8.771		20.04 ± 3.013		12.06 ± 5.056	
Female	112 (61.00%)	50.76 ± 6.305		20.34 ± 2.512		11.71 ± 4.195	
Age			0.001		0.006		0.047
≤30 years-old	114 (57.00%)	48.93 ± 7.397		19.77 ± 2.939		12.40 ± 4.748	
>30 years-old	86 (43.00%)	52.36 ± 6.872		20.83 ± 2.266		11.12 ± 4.165	
Education			0.258		0.077		0.923
Junior college/Bachelor's degree	106 (53.00%)	49.85 ± 7.103		19.91 ± 2.685		11.82 ± 4.635	
Master's degree or higher	94 (47.00%)	51.03 ± 7.625		20.59 ± 2.718		11.88 ± 4.457	
Type of institution			0.332		0.464		0.392
Tertiary public hospital	181 (90.50%)	50.57 ± 7.467		20.27 ± 2.687		11.94 ± 4.606	
Non-tertiary public hospital	19 (9.50%)	48.84 ± 6.176		19.79 ± 3.011		11.00 ± 3.873	
Professional title			0.001		0.001		0.041
None	33 (16.50%)	46.36 ± 9.219		18.82 ± 3.245		13.67 ± 4.121	
Junior grade	100 (50.00%)	50.06 ± 6.080		20.21 ± 2.442		11.54 ± 4.576	
Intermediate grade or higher	67 (33.50%)	52.91 ± 7.202		20.94 ± 2.581		11.42 ± 4.533	

(*Continued*)

Table 1 (Continued).

Characteristic		Knowledge Score		Attitude Score		Practice Score	
		Mean ± SD	*P*	Mean ± SD	*P*	Mean ± SD	*P*
Years of professional experience			<0.001		0.043		0.351
≤3 years	77 (38.50%)	47.94 ± 7.630		19.84 ± 2.866		12.57 ± 4.567	
>3 and ≤5 years	35 (17.50%)	49.23 ± 5.100		19.63 ± 2.462		11.49 ± 3.838	
>5 and ≤10 years	52 (26.00%)	51.65 ± 6.302		20.56 ± 2.718		11.50 ± 4.929	
>10 years	36 (18.00%)	55.03 ± 7.692		21.14 ± 2.392		11.17 ± 4.507	
Experience of operations for craniocerebral trauma			<0.001		0.043		0.866
<100	113 (56.50%)	48.23 ± 6.892		19.83 ± 2.881		11.73 ± 4.390	
100–300	58 (29.00%)	51.71 ± 6.440		20.55 ± 2.493		12.12 ± 5.040	
>300	29 (14.50%)	56.28 ± 7.216		21.10 ± 2.209		11.76 ± 4.189	

Knowledge Scores

The mean knowledge score was 50.41 ± 7.36 (range: 0–84). Responses to the knowledge items (K1–K21) are summarized in Figure 1. Most anesthetists (>70%) were familiar with key aspects of management, such as the major goals of perioperative care (72.00%; K1), anesthesia considerations (75.00%; K2), the use of the Glasgow Coma Scale (GCS) to assess neurologic status (81.50%; K3), and endotracheal intubation techniques, including for patients with trauma to the throat or maxillofacial injuries (72.50%; K8). Additionally, 75.50% understood the relationship between cerebral perfusion pressure (CPP), mean arterial pressure (MAP), and intracranial pressure (ICP), and 72.50% recognized that hypertension is often due to the Cushing reflex and does not require immediate correction (K9). In terms of severe traumatic brain injury (TBI) management, most respondents agreed on critical practices, such as establishing an artificial airway for patients with a GCS score <8 (89.00%; K4), avoiding excessive inhalation anesthesia doses (82.50%; K6), using total intravenous anesthesia (TIVA) for better neurologic assessment (85.00%; K7), and recommending intraoperative glucocorticoids (77.00%; K10) and mannitol infusion (76.50%; K11). Awareness of safe hyperventilation practices was high: 86.00% recognized that PaCO2 <25 mmHg could worsen focal ischemia (K12), and 94.00% understood the safety and efficacy of transient hyperventilation (PaCO2 of 30–35 mmHg) with monitoring (K14).

Only 48.50% disagreed with the statement that hyperventilation should never be used (K13). Few anesthetists could calculate the GCS score for a given scenario (27.50%; K17), knew the normal ICP in a healthy adult (41.50%; K19), or were aware of the general goals of CPP management (5.50%; K21) and airway management (K18). Despite this, 89.50% correctly calculated CPP when provided MAP and ICP values (K20).

Higher knowledge was associated with older age ($P = 0.001$), more senior professional title ($P = 0.001$), longer duration of professional experience ($P < 0.001$), and greater experience participating in operations for craniocerebral trauma ($P < 0.001$) (Table 1).

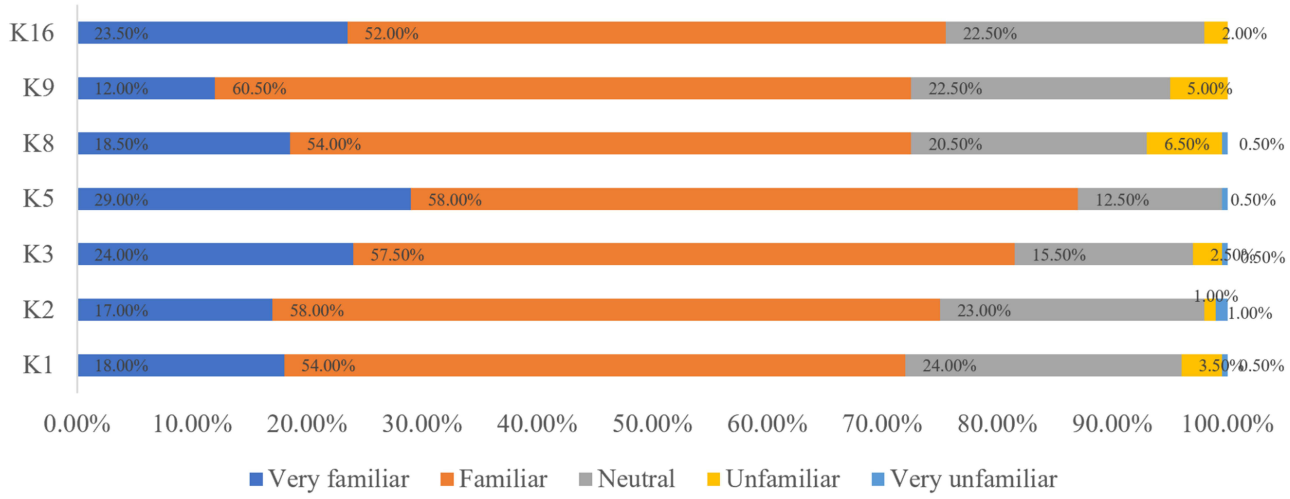
Attitude Scores

The mean attitude score was 20.23 ± 2.72 (possible range, 0–24), suggesting the participants had a positive attitude toward the perioperative management of patients with craniocerebral trauma. The A1-A6 items are presented in Supplement Table 1. The majority of participants strongly agreed or agreed that management of airway pressure is an important part of perioperative management (97.50%; item A1), that improving cerebral perfusion and blood flow and control of ICP are important (97.50%; item A2), that airway pressure is correlated with ICP and CPP (89.50%; item A3), that monitoring of neurologic function is important (95.00%; item A4), and that it is important to regularly update their knowledge regarding the perioperative management of craniocerebral trauma (97.00%; item A6). However, it was notable that only 69.00% of the anesthetists were confident in providing the correct perioperative management to patients undergoing surgery for severe craniocerebral trauma (item A5).

Older age (P = 0.006), more senior professional title (P = 0.001), longer duration of professional experience (P = 0.043), and greater experience participating in operations for craniocerebral trauma (P = 0.043) were associated with significantly higher attitude scores (Table 1).

Practice Scores

The most common learning methods used to acquire knowledge about the perioperative management of severe craniocerebral trauma (item P1; Figure 2A) were department-based study sessions (185/200, 92.50%), reading of guidelines and published papers (166/200, 83.00%), attending relevant lectures (139/200, 69.50%) and participating in relevant training (97/200, 48.50%). Furthermore, the frequency of learning (item P2; Figure 2B) was at least once per month for the majority of anesthetists (165/200, 82.50%). The practice score for the participants (calculated from the responses to items P3–P9) averaged 11.85 ± 4.54 (possible range, 2–28), suggesting that there was substantial room for improvement in the practices of the anesthetists. Few anesthetists (8.00%) stated that they often monitored the intraoperative neurologic function of patients with TBI (item P4), and 35.00% of the respondents indicated that they often utilized intraoperative transient hyperventilation to reduce an elevated ICP (item P3). Additionally, routine



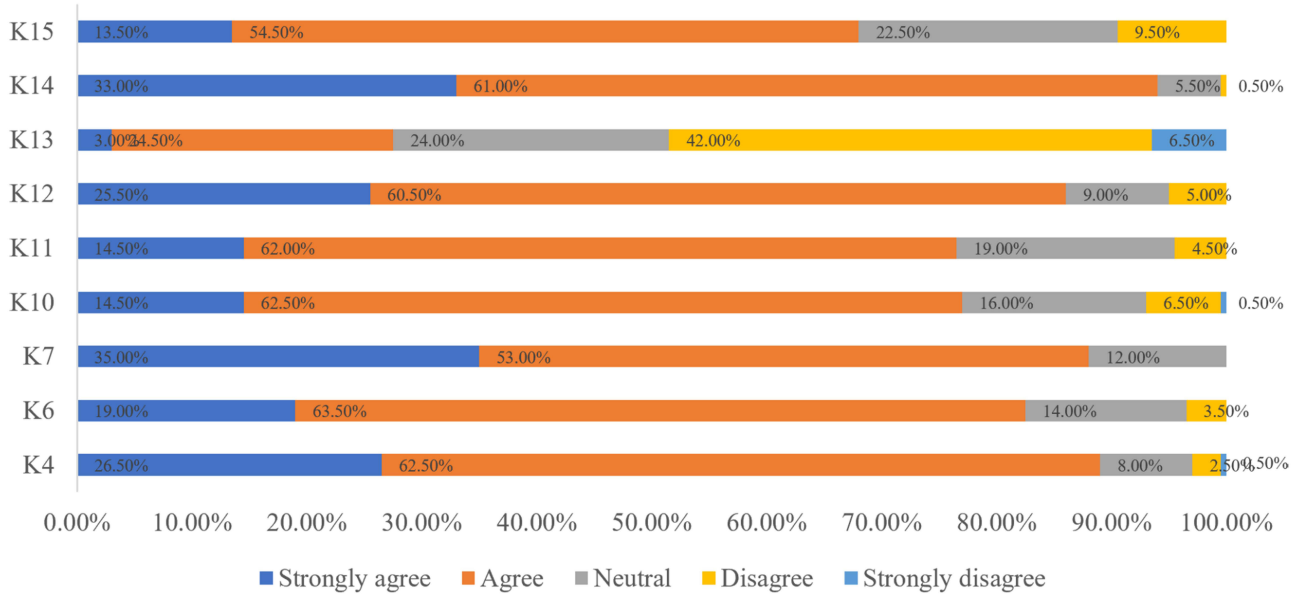


Figure 1 Continued.

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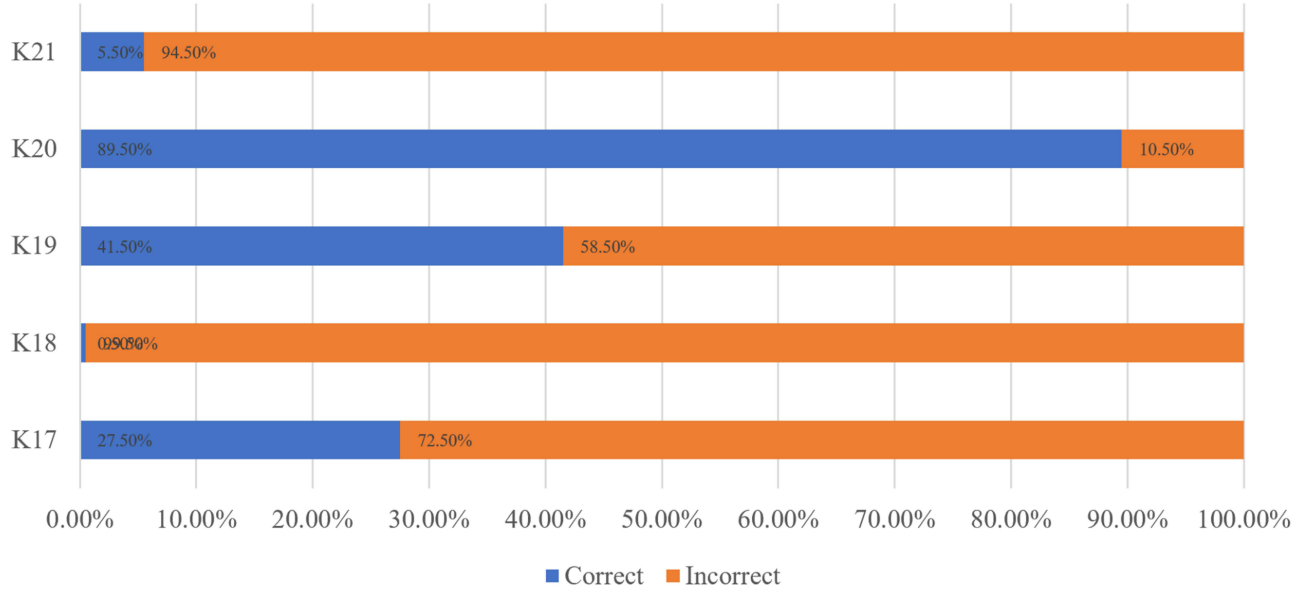

Figure 1 Responses to the questions in the knowledge dimension according to the level of understanding. K1: The major goals of the perioperative management of patients with craniocerebral trauma are to improve cerebral perfusion and cerebral blood flow, control intracranial pressure (ICP), and prevent secondary brain damage. K2: The key points of anesthesia management in patients with craniocerebral trauma are to make rapid and comprehensive assessments, implement timely and effective perioperative management, maintain cerebral perfusion pressure (CPP) and oxygen supply, prevent and alleviate secondary neuronal injury, provide satisfactory surgical conditions for neurosurgeons, and improve the prognosis. K3: The Glasgow coma scale (GCS) score can be used to assess the neurologic status of patients with craniocerebral trauma, based on eye opening, speech and motor responses, and the degree of consciousness impairment is reflected by the sum of the three indicators, with lower scores indicating a higher severity of consciousness disorder, brain death or extremely poor prognosis. K4: For patients with severe craniocerebral trauma and a GCS score <8, mechanical ventilation via an artificial airway (eg, endotracheal intubation) should be implemented immediately, as this can effectively control the airway and ICP. K5: All patients with craniocerebral trauma should be considered to have a "full stomach". Once the patient has been provided with adequate oxygen, the esophagus should be closed using the Sellick maneuver (the patient's chin is lifted upwards without moving the cervical spine, and the cricoid cartilage is pushed backward). Ventilation between anesthesia induction and endotracheal intubation must be avoided to minimize the risk of reflux aspiration caused by the flow of air into the patient's stomach induced by positive pressure ventilation. K6: Inhalation anesthesia is not the preferred method of anesthesia for patients with craniocerebral trauma, but if this method is selected, the recommended dose of halogenated agent for inhalation anesthesia should be less than 1 minimum alveolar concentration (MAC). K7: Total intravenous anesthesia (propofol + remifentanil) is beneficial for the perioperative management and neurologic assessment of patients with traumatic brain injury (especially by reducing electrophysiological interference). K8: Endotracheal intubation by fiberoptic bronchoscopy or Lightwand is recommended for patients with maxillofacial fracture or when glottis exposure is difficult due to severe soft tissue edema, whereas tracheotomy is required for patients with severe maxillofacial trauma or throat trauma. K9: A relatively high blood pressure in a patient with craniocerebral trauma is generally caused by the Cushing's reflex and does not require correction. However, antihypertensive drugs can be used in elderly people with hypertension if necessary. K10: Intraoperative use of glucocorticoids is recommended in patients with severe craniocerebral trauma. K11: Continuous infusion of mannitol is recommended, and the loading dose is 0.25–1 g/kg. K12: Hyperventilation partial pressure of carbon dioxide ($PaCO_2$) <25 mmHg) can worsen the degree of focal cerebral ischemia. K13: Hyperventilation is not recommended in any patient with craniocerebral trauma. K14: Acute transient hyperventilation ($PaCO_2$ 30–35 mmHg within 12 hours) is relatively safe and effective for patients with an elevated ICP but monitoring of cerebral blood flow and cerebral perfusion must be performed simultaneously. K15: Mechanical ventilation with a positive end-expiratory pressure to improve the oxygenation is safe for most patients with severe craniocerebral trauma. K16: Are you familiar with the relationship between CPP, mean arterial pressure (MAP) and ICP? K17: What is the GCS score for a patient with craniocerebral trauma who opens their eyes to pain, has slurred and unclear speech, and hyperextension of the limbs? K18: What are the general goals of airway management? K19: What is the intracranial pressure of a healthy adult in the supine position? K20: What is the CPP in a patient with a MAP of 120 mmHg and an ICP of 80 mmHg? K21: What are the goals for CPP management?.

("always" or "often") perioperative monitoring of ICP (item 5), cerebral oxygen level (item 6), cerebral blood flow (item 7), cerebral electrophysiology (item 8) and brain temperature (item 9) were performed by only 23.50%, 15.00%, 12.00%, 31.00% and 12.00% of the anesthetists, respectively (Figure 3).

Younger age ($P = 0.047$) and more junior professional titles ($P = 0.041$) were associated with higher practice scores (Table 1).

Correlations

The knowledge scores were positively correlated with the attitude scores ($r = 0.522$, $P < 0.001$). However, the practice scores were not significantly correlated with the knowledge or attitude scores (Supplement Table 2).

Factors Associated with the Total KAP Score

The multivariable analysis demonstrated that having participated in 100–300 operations for craniocerebral trauma ($B = 3.728$, 95% CI = 0.271–7.186, $P = 0.035$ vs <100 operations) and having participated in >300 operations for

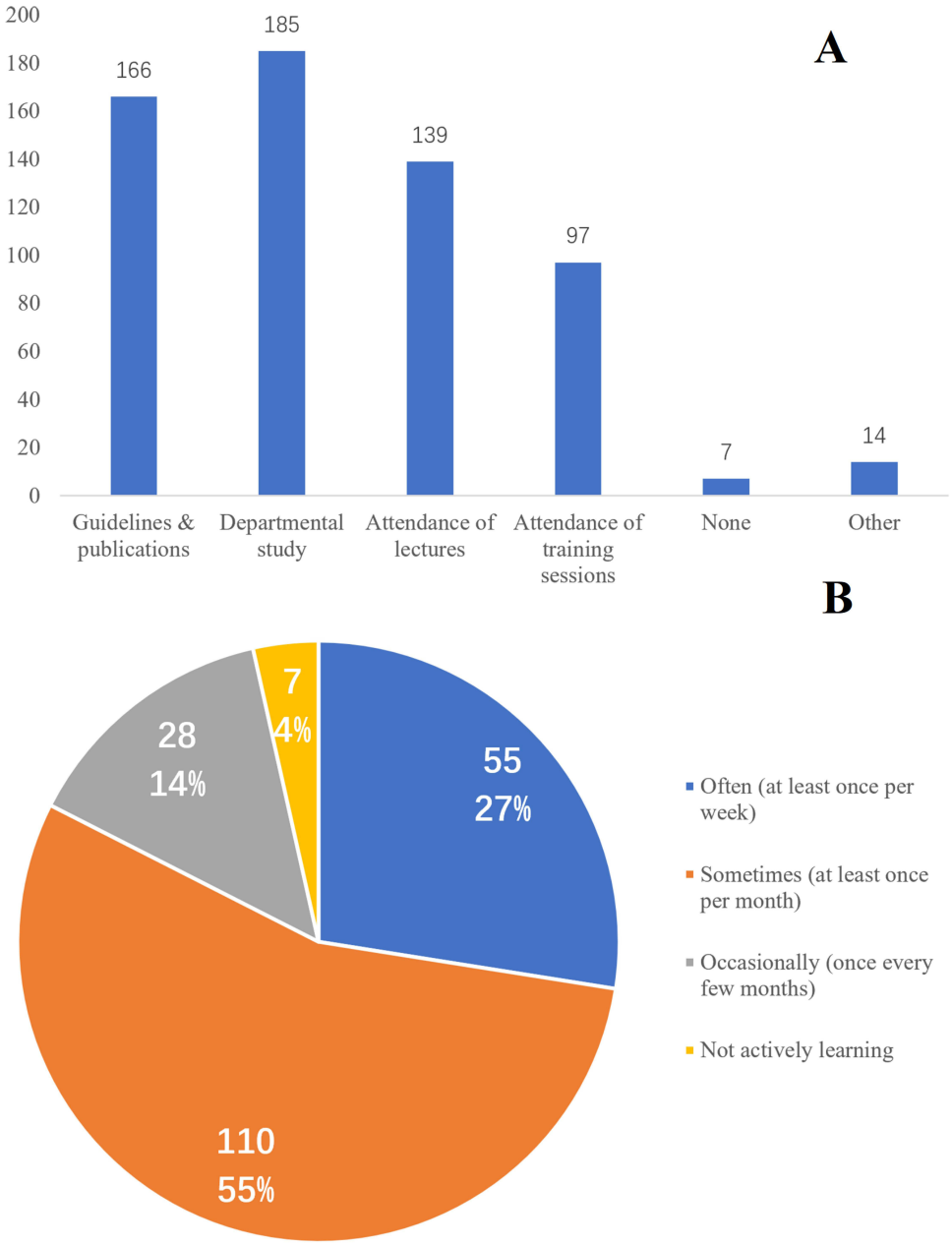

Figure 2 Learning methods regarding craniocerebral injury (numbers of patients) (**A**) and learning frequency (**B**).

craniocerebral trauma (B = 7.680, 95% CI = 2.684–12.675, P = 0.003 vs <100 operations) were the only factors independently associated with a higher total KAP score (Table 2).

Discussion

This study suggested that anesthetists had moderately correct knowledge but good attitudes toward severe craniocerebral injury perioperative management. However, deficiencies in some of the practices of the respondents were identified. The multivariable analysis identified greater experience participating in operations for craniocerebral trauma as the only factor independently associated with the total KAP score.

Current management of craniocerebral trauma focuses on the treatment of the primary damage and prevention of secondary damage, and the key aspects of treatment include early resuscitation, optimization of hemodynamics, surgical removal of mass lesions, ICP control, maintenance of CPP and optimization of the physiological milieu.[10] Previously

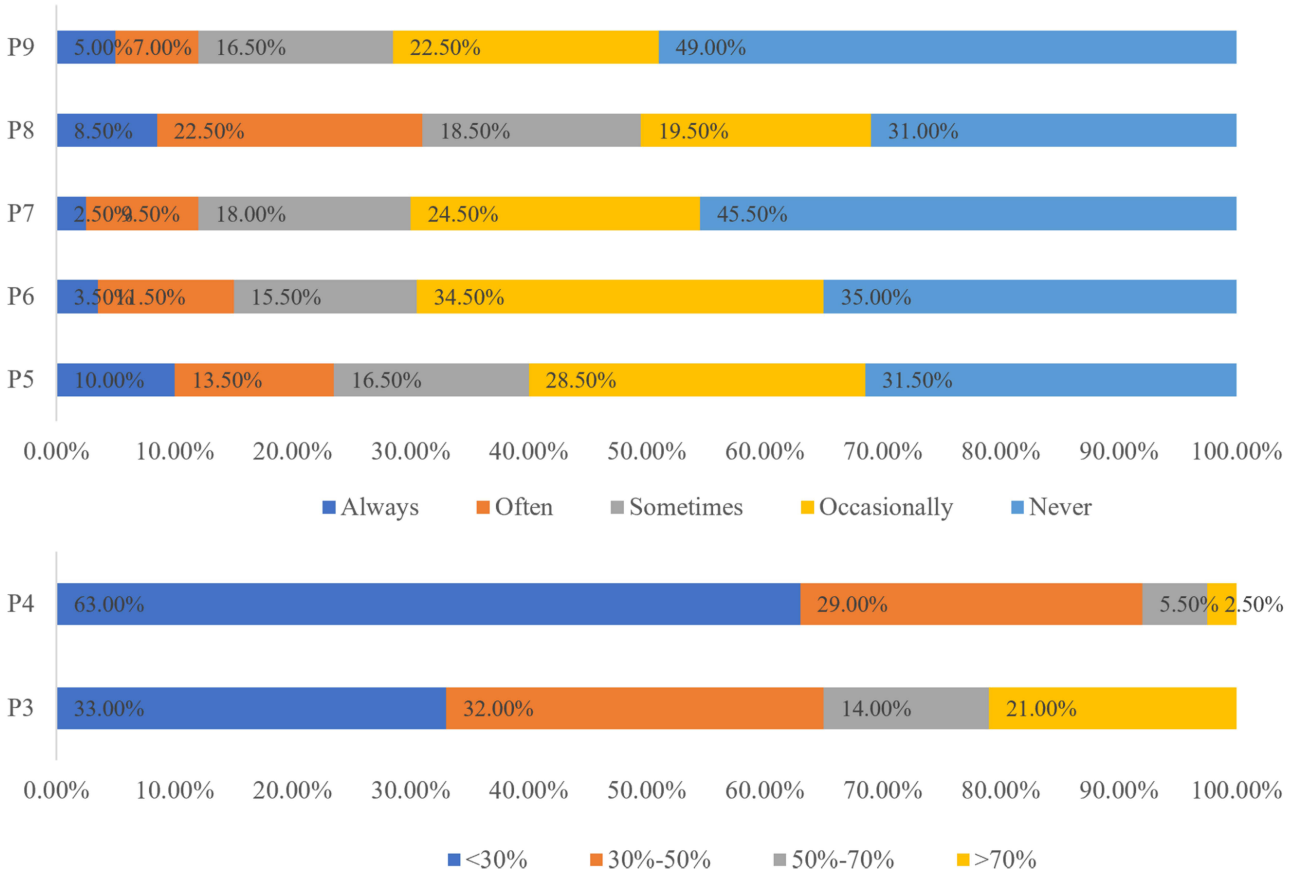

Figure 3 Responses to the questions in the practice dimension according to the level of practice. P3: How often do you use transient hyperventilation to control intracranial pressure (ICP) in clinical practice? P4: How often do you monitor the intraoperative neurologic functions of patients with traumatic brain injury in clinical practice? P5: How often do you monitor ICP in patients with severe craniocerebral trauma during the perioperative period? P6: How often do you monitor cerebral oxygen level in patients with severe craniocerebral trauma during the perioperative period? P7: How often do you monitor cerebral blood flow in patients with severe craniocerebral trauma during the perioperative period? P8: How often do you monitor cerebral electrophysiology in patients with severe craniocerebral trauma during the perioperative period? P9: How often do you monitor brain temperature in patients with severe craniocerebral trauma during the perioperative period?.

published studies have evaluated the knowledge of nurses regarding the management of severe TBI,[13] the adherence of caregivers to recommendations regarding target blood pressure in patients with TBI,[14] the implementation of guideline recommendations by neurotrauma centers,[15] doctors' knowledge and practices relating to craniocerebral injury in the prehospital setting,[16] and perceptions/knowledge of TBI among caregivers,[17] educators[18] and the general public.[19] However, KAP surveys of anesthetists regarding the perioperative management of craniocerebral trauma are lacking. Knowledge and application of the latest clinical guidelines by medical staff promote evidence-based treatment that enhances the quality of the care provided and thereby improves outcomes.[12,20,21] Therefore, evaluating the KAP of anesthetists, who play a central role in severe craniocerebral injury perioperative management, is important.

In the present study, 14 of the 21 knowledge items were correctly answered by >70% of the participants (K1–K12, K14, and K20). Additionally, 68% of the participants provided correct responses to item K15. However, notable knowledge gaps were identified in the areas covered by item K13 (whether hyperventilation should never be recommended for patients with craniocerebral trauma), item K19 (the ICP of a healthy adult in the supine position), item K17 (calculation of the GCS score for a patient with eye-opening to pain, slurred and unclear speech, and limb hyperextension), item K21 (the goals of CPP management) and item K18 (the general goals of airway management). Furthermore, the average knowledge score was 50.41 ± 7.36 out of a possible maximum of 84, indicating moderate knowledge about craniocerebral trauma perioperative management. These results are broadly in agreement with those reported previously by surveys of clinicians and nurses. A survey of medical staff (including doctors and nurses) in Tanzania found that the percentage of respondents correctly answering 20 knowledge-based questions on the management of TBI ranged from 0%–95%, with the average value being only 43.15%.[12]

Table 2 Univariable and Multivariable Analyses of Factors Associated with the KAP Score

Characteristic	Univariable Analysis		Multivariable Analysis	
	B (95% Confidence Interval)	*P*	*B* (95% Confidence Interval)	*P*
Sex				
Male	Ref.			
Female	0.871 (−2.123 to 3.865)	0.567		
Age (years)				
≤30	Ref.		Ref.	
>30 but ≤40	3.197 (0.279 to 6.115)	0.032	−1.528 (−5.815 to 2.759)	0.483
Education level				
Junior college/college	Ref.			
Master's degree or higher	1.925 (−0.992 to 4.841)	0.195		
Type of institution				
Tertiary public hospital	3.147 (−1.818 to 8.113)	0.213		
Non-tertiary public hospital	Ref.			
Professional title				
None	Ref.		Ref.	
Junior-grade	2.962 (−1.102 to 7.025)	0.152	2.861 (−1.633 to 7.355)	0.211
Intermediate-grade or higher	6.420 (2.115 to 10.725)	0.004	2.283 (−3.729 to 8.295)	0.455
Professional experience (years)				
≤3	Ref.		Ref.	
>3 and ≤5	−0.008 (−4.101 to 4.086)	0.997	−1.532 (−6.053 to 2.989)	0.505
>5 and ≤10	3.361 (−0.243 to 6.965)	0.067	1.056 (−4.125 to 6.237)	0.688
>10	6.983 (2.928 to 11.037)	0.001	3.544 (−3.520 to 10.607)	0.324
Experience of operations for craniocerebral trauma				
<100	Ref.		Ref.	
100–300	4.583 (1.418 to 7.748)	0.005	3.728 (0.271 to 7.186)	0.035
>300	9.341 (5.263 to 13.420)	<0.001	7.680 (2.684 to 12.675)	0.003

A survey of emergency service physicians in Peru determined that only 61.1% of the participants had high knowledge about TBI management.[22] Although they studied children and adolescents, Oyesanya et al reported that 41% of pediatric nurses in the USA had low evidence-based knowledge regarding providing care to patients with moderate-to-severe TBI.[23] Another study evaluating nurses' knowledge of TBI guidelines reported a mean knowledge score of 14.31 ± 3.84 points out of a maximum of 40 points, and the vast majority of nurses (93.3%) were deemed to have incorrect knowledge.[24] Additionally, a questionnaire evaluating Chinese doctors' knowledge about the prehospital management of TBI reported that the scores ranged from 0.64 (for treatment-related questions) to 0.80 (for assessment-related questions).[16] Educational interventions, such as those described previously,[12,24] may help improve the knowledge of anesthetists in China regarding the perioperative management of craniocerebral injury.

The participants had strongly positive attitudes toward the perioperative management of craniocerebral injury. The majority of the participants (≥89.50%) strongly agreed or agreed with five of the six attitude items. However, only 69.00% of the anesthetists stated that they were confident in providing appropriate perioperative management for severe craniocerebral trauma. This lack of confidence in some participants may reflect an appreciation that their level of knowledge was lacking in some areas. Indeed, a previous study reported that less than 50% of health professionals in Tanzania considered themselves to have received adequate training to assess patients with TBI or develop a treatment plan for these patients.[12] The present study also identified a significant correlation between knowledge and attitude scores. Therefore, interventions to improve knowledge of the perioperative management of severe TBI may also benefit attitudes.

On the other hand, the mean practice score indicated poor practice (ie, 42.32%), suggesting room for improvement. Few anesthetists indicated that they always/often monitored intraoperative neurologic function; only around half of the respondents stated that they always/often utilized intraoperative transient hyperventilation to control an elevated ICP.

Additionally, routine perioperative monitoring of ICP, cerebral oxygen level, cerebral blood flow, cerebral electrophysiology, and brain temperature was performed by less than one-quarter of the participants. Although the findings highlight the need for improvements in patient monitoring, it is possible that resource limitations may have affected the monitoring of some or all of these parameters in the clinical setting. Interestingly, the practice score was not correlated with the knowledge score or attitude score, implying that interventions specifically aimed at improving knowledge might not necessarily result in improvements in the practices of anesthetists treating patients with craniocerebral trauma. Prior research has identified several factors that affect adherence to evidence-based practices, including good interdisciplinary collaboration, allocation of sufficient resources, and clinicians' skepticism of the evidence base for some guideline recommendations. Thus, improving practices may require more than providing education/training targeted at specific knowledge gaps. The KAP theoretical framework stipulates that knowledge is the basis for practice and that attitudes are the force driving practice.[25,26] Although the correlations among KAP dimensions were weak or absent, improving knowledge should translate into better attitudes and practice. As highlighted above, this study identified several knowledge items that would warrant improvements, which could be achieved through training activities. They could take the form of continuing education activities, lectures, interactive websites, podcasts, or reading materials. Future studies should design and test such an intervention. In the meantime, stakeholders and policymakers should include the perioperative management of severe craniocerebral trauma in the training curriculum of anesthetists. The main points are summarized in Supplement Table S3.

Our subgroup analysis indicated that anesthetists who were older or who had a more senior professional title, longer duration of professional experience, or greater experience participating in operations for craniocerebral trauma had higher knowledge and attitude scores. Previous research has also identified older age and greater experience as factors that enhance knowledge of the management of TBI.[22–24] Other factors reported to enhance knowledge regarding TBI include previous training and higher education level.[23,24] Thus, higher knowledge levels and better attitudes appear to be related to greater professional experience. Interestingly, our subgroup analysis also found that a higher practice score was associated with younger age and more junior professional title, in contrast to the findings for knowledge and attitude, and this may have contributed to greater experience participating in operations for craniocerebral trauma being the only independent factor associated with the total KAP score in the regression analysis. The finding that younger and more junior anesthetists had higher practice scores was somewhat unexpected, and the reasons for this remain unclear. However, it is possible that older, more senior anesthetists are more likely to adhere to more established methods, while younger, more junior anesthetists are more likely to adopt newer practices recommended by the latest guidelines. Further research will be needed to establish whether this might be the case.

This study had some limitations. The sample size was small, and the analysis maybe lacked statistical power to detect real differences between groups. Second, the generalizability of the results remains to be determined, even though it was a multicenter study, particularly given the variations in TBI care between Chinese and European centers.[27] Third, the questionnaire was developed based on guidelines, and it may be limited in its ability to assess perceptions regarding severe craniocerebral injury perioperative management. Since the study included 15 Chinese provinces, some local practices could influence the results, but the questionnaire was developed according to guidelines and basic concepts that should be applied in China. Fourth, this study did not assess whether education/training programs would enhance the questionnaire scores. Fifth, the study was cross-sectional, preventing any analysis of causality. Finally, all KAP studies are at risk of the social desirability bias.[28,29] Some participants could have been tempted to answer what they knew was the right response instead of what they were actually thinking or doing.

Conclusion

Anesthetists in China exhibit moderate knowledge, a positive attitude, and inadequate practice regarding perioperative management of severe craniocerebral trauma. Greater clinical experience in managing craniocerebral trauma perioperatively is associated with higher KAP scores, highlighting the need for targeted training and experience-based education to improve perioperative outcomes.

Data Sharing Statement

All data generated or analyzed during this study are included in this published article.

Ethics Approval and Consent to Participate

The study was carried out after the protocol was approved by the Ethics Committee of Shanghai Tongren Hospital (2023-012-01). I confirm that all methods were performed in accordance with the relevant guidelines. All procedures were performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments, and informed consent was obtained from all participants.

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Disclosure

The authors declare that they have no competing interests in this work.

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