Review Article

Current pre-hospital traumatic brain injury management in China

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BACKGROUND: Traumatic brain injury (TBI) is associated with most trauma-related deaths. Secondary brain injury is the leading cause of in-hospital deaths after traumatic brain injury. By early prevention and slowing of the initial pathophysiological mechanism of secondary brain injury, pre-hospital service can significantly reduce case-fatality rates of TBI. In China, the incidence of TBI is increasing and the proportion of severe TBI is much higher than that in other countries. The objective of this paper is to review the pre-hospital management of TBI in China.

DATA SOURCES: A literature search was conducted in January 2014 using the China National Knowledge Infrastructure (CNKI). Articles on the assessment and treatment of TBI in pre-hospital settings practiced by Chinese doctors were identified. The information on the assessment and treatment of hypoxemia, hypotension, and brain herniation was extracted from the identified articles.

RESULTS: Of the 471 articles identified, 65 met the selection criteria. The existing literature indicated that current practices of pre-hospital TBI management in China were sub-optimal and varied considerably across different regions.

CONCLUSION: Since pre-hospital care is the weakest part of Chinese emergency care, appropriate training programs on pre-hospital TBI management are urgently needed in China.

KEY WORDS: Traumatic brain injury; Pre-hospital; China; Emergency medicine

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INTRODUCTION

Traumatic brain injury (TBI) is a major health and socioeconomic issue around the world. It is the leading cause of trauma-related deaths and the most common cause of mortality and disability among the young people.^[1] Globally, the incidence of TBI is rising rapidly because of the increasing use of motor vehicles in low-income and middle-income countries.^[2]

In China, the incidence of TBI ranged from 55.4 to 64.1 per 100 000 population in 1986.^[3] Because of a lack of coherent systems for national registration of TBI, the incidence transition of TBI in the past decades is unknown.^[4] However, the dramatic increase in the number

of vehicles and high-rise buildings in China has increased the risk of both traffic accidents and high-level falls.^[5] The number of people who died from road traffic accidents increased from about 60 000 in 1995 to 100 000 in 2003. Among these cases, brain injuries accounted for 38.7% to 57.3% of the deaths.^[4] The population most affected by TBI death and disability was young men,^[4] which are costly to society because of the years of potential lives lost and the working years of potential lives lost. Moreover, the proportion of severe TBI in China is much higher than that in other countries (20% vs. 10%).^[4,6] This group of patients has the longest hospital stay and the highest hospital cost, and it has a high case-fatality rate.^[7] To find the reasons behind the

high proportion of severe TBI in China may shed new lights on future TBI management and prevention.

Secondary brain injury, which occurs in minutes to days following primary injury, is the main cause of TBI mortality.^[8] Post-injury events such as hypoxemia, hypotension, and intracranial hypertension can initiate the pathophysiological mechanisms of secondary brain injury.^[9] A study^[10] has revealed that there is a high incidence of these post-injury events at the occurrence of accidents. Accordingly, early prevention, identification, and correction of these events in the pre-hospital setting can lower the risk of secondary brain injury and reduce the case-fatality rate of TBI.^[2] As such, many countries have established guidelines for TBI pre-hospital management over the past 15 years.^[11–15]

Since pre-hospital care is the weakest part of Chinese emergency care,^[16] suboptimal practices in TBI management may exist in pre-hospital settings. In this article, we reviewed the current practices of pre-hospital TBI management in China, while describing the current situation and analyzing the existing problem of pre-hospital TBI management in China.

METHODS

Chinese language research papers about pre-hospital TBI management in China published from 1 January 1998 to 31 December 2013 were retrieved using the China National Knowledge Infrastructure (CNKI), which is the largest comprehensive Chinese-based information database. The types of resources in CNKI include journal articles, newspaper articles, theses, conference papers, and books.^[17] All the research papers with the Chinese characters “颅脑外伤(head injury)”, “颅脑创伤(head trauma)”, “颅脑损伤(head damage)”, “脑外伤(brain injury)”, “脑创伤(brain trauma)”, “脑损伤(brain damage)”, and “院前急救(pre-hospital emergency treatment)” in the titles or as key words were included in the initial search.

TBI is defined as an alteration in brain function, or other evidence of brain pathology, caused by an external force.^[18] Therefore, any cerebral condition caused by non-trauma mechanisms is not considered as TBI. Since there are no paramedics in China, the staff members in the pre-hospital care system are doctors, nurses, patient-carriers, and drivers.^[16] Of this group, doctors play a crucial role in the pre-hospital management.^[19] Therefore, the criteria for the literature search included articles concerning (i) brain injury conditions caused by trauma, (ii) emergency care in the pre-hospital settings, and (iii) assessment and treatment practised by pre-hospital doctors. Articles about pediatric

patients or practices of nursing care were excluded. The references of the identified articles were examined to make sure that all relevant articles were included.

The information about the assessment of oxygenation, blood pressure, and clinical signs of brain herniation in addition to the treatment of hypoxemia, hypotension, and brain herniation was extracted from the identified articles. The information about the key practices of pre-hospital TBI management is discussed in the *Guidelines for Pre-hospital Management of Traumatic Brain Injury, Second Edition* (Brain Trauma Foundation, BTF).^[12]

RESULTS

The initial search identified 471 articles. According to the selection criteria, 65 articles were included in the review at last (Figure 1). All the identified articles were peer-reviewed. Thirty-nine were original research articles, and the remaining articles were correspondence pieces without abstracts. Among these 65 research papers, 44 were cross-sectional studies reporting local practices of TBI management in pre-hospital settings. Twenty-one articles were case-control studies attempting to assess the important role of pre-hospital care in TBI management. In our review, 17 of the identified research papers discussed the management of all TBI patients and 48 concentrated only on severe TBI patients. An increasing trend in a number of reports during the time period reflects an increasing recognition of this problem (Figure 2).

Assessment of oxygenation and treatment for hypoxemia

In the 65 articles, 39 (60%) reported that the pre-

Figure 1. Flow chart of the literature screening process.

hospital doctors assessed oxygenation for TBI patients in pre-hospital settings. Thirty-four (52%) assessed oxygenation by observing patients' breathing, whereas only 9 (14%) articles documented the measurement of patients' blood oxygen saturation.

Almost all papers reported the pre-hospital doctors implemented airway management for TBI patients. In China, the most prevalent basic airway management was

manual clearing, which was reported in 57 (88%) articles (Table 1). These practices included manual removal of vomit and regurgitation from the patient's oral cavity, nasal cavity, and pharynx. Even though 54 (83%) articles mentioned endotracheal intubation, only half of them stated clearly under what circumstance they intubated their patients, with indications varying in different regions (Table 2). Nineteen of the remaining articles described the intubation indication

Figure 2. Number of publications in different years.

Table 1. Assessment of oxygenation and treatment for hypoxemia for TBI patients in Chinese pre-hospital settings

Intervention	Number of papers	Proportion (%)	Reference
Assessment of oxygenation			
Clinical observation	34	52.3	20–53
Pulse oximetry	9	13.8	34,38,46,48,54–58
Overall	39	60.0	20–58
Airway management			
Basic			
Manual clearing	57	87.7	20–36,38–46,48,49,51–53,55–80
Suction	15	23.1	25,26,33,38,40,46–48,52,58,63,67,70,79,81
Airway manoeuvres (head tilt chin lift; jaw thrust; cervical collar)	19	29.2	23,26,28,29,31,38,39,41,46,51,54,57,61,62,64,66,67,69,77
Airway adjuncts (oropharyngeal airway, nasopharyngeal airway)	26	40.0	26,28,29,33,35,38,40,42,46–48,52,57,58,60,61,73,74,76–83
Turning patient's head to one side	27	41.5	21,24–31,33,36,41–43,45–47,52,53,57,60,61,65,76,77,79,80
Pulling out tongue with tongue forceps	14	21.5	25,33,36,38,40,43,48,52,53,57,58,67,75,78
Advanced			
Endotracheal intubation	54	83.1	20–22,25–32,34–36,38–42,44–54,56,58,60–65,67–71,73–80,82–84
Cricothyrotomy (needle, surgical)	9	13.8	45–48,52,58,65,73,84
Tracheotomy	3	4.6	47,62,84
Overall	64	98.4	20–36,38–84
Ventilation			
Bag valve mask (BVM)	17	26.2	26,28,29,32,33,40,44,52,60,63,64,66,70,73,74,79,83
Mechanical resuscitator	6	9.2	38,50,52,53,55,67
Capnography	0	0	–
Overall	22	33.8	26,28,29,32,33,38,40,44,50,52,53,55,60,63,64,66,67,70,73,74,79,83
Medication			
Respiratory stimulant	11	16.9	26,27,30,31,33,44,50,52,53,64,69

Table 2. Intubation indications for TBI patients in Chinese pre-hospital settings

Intervention	Number of papers	Proportion (%)	Reference
Non-objective indications (when necessary; if conditions permitted)	19	29.2	20–22,26,30,31,36,39,45,46,49,51–54,61,65,69,76,80,83
Hypoventilation	11	16.9	29,32,34,35,52,60,62,67,73,79,82
Respiratory rate < 10/minute	1	1.5	26
Respiratory arrest	4	6.2	29,42,52,60
Severe airway obstruction	8	12.3	28,38,40,48,58,63,70,78
Vomiting	5	7.7	34,40,63,70,79
Coma	5	7.7	25,34,40,63,70
Cardiac arrest	6	9.2	41,52,56,68,71,75
Chest injury	1	1.5	62
Overall	46	70.8	20–22,25,26,28–32,34–36,38–42,45,46,48,49,51–54,56,58,60–63,65,67–71,73,75,76,78–80,82,83

as "intubate TBI patients when necessary". The remaining 8 articles mentioned intubation only, but did not give any indications. As a result, the intubation rate in China varied considerably (3.8%–83.3%) across regions (Table 3).

Table 3. Intubation rate in TBI patients in Chinese pre-hospital settings

Intubation rate (%)	Sample size	Reference
For all TBI patients ^a		
29.5	105	27
7.1	437	30
3.8	418	46
Overall ^a	960	–
For severe TBI patients ^b		
83.3	30	82
47.9	194	64
18.7	316	39
18.0	89	38
17.2	1 268	73
13.5	385	32
5.9	202	68
Overall ^b	2 484	–

^a: Data come from papers talking about pre-hospital management for all TBI patients; ^b: Data come from papers talking about pre-hospital management for severe TBI patients.

Twenty-two (34%) articles reported that the pre-hospital doctors implemented artificial ventilation for TBI patients, and that most of them used bag valve mask devices. None of the identified papers claimed that the doctors had monitored end tidal carbon dioxide (ETCO₂) levels during ventilation. Eleven (17%) research papers documented the use of respiratory stimulants for TBI patients in pre-hospital settings (Table 1).

Assessment of blood pressure and treatment for hypotension

Assessment of TBI patients' blood pressure in pre-hospital settings was reported in 36 (55%) identified papers. Almost all papers stressed the correction of hypotension. The most common interventions reported were hemostasis (mostly through applying direct pressure) (83%) and fluid resuscitation (63%) (Table 4). Twenty-seven (42%) identified papers documented the type of resuscitation fluid used for TBI patients. The resuscitation

Table 4. Assessment and treatment for hypotension for TBI patients in Chinese pre-hospital settings

Interventions	Number of papers	Proportion (%)	References
Assessment of blood pressure			
Blood pressure monitoring	36	55.4	20–24,26,28,29,31–36,38–43,45,47,49–53,55,63,64,66–68,72,75,82
Treatment for hypotension			
Hemostasis	54	83.1	20–26,28,29,32,34–36,39–43,45,47–73,75,78–84
Fluid resuscitation	41	63.1	23,24,26–31,33,35–38,40,41,44,47,48,51–53,55–58,60–69,74,75,79,82–84
Dextran	15	23.1	24,26,29,39,44,49,51,52,64,68,69,71,72,75,84
Balanced salt solution (BSS)	14	21.5	23,29,35,41,44,47,52,53,64,66–69,84
Hypertonic solutions (7.5% NaCl)	8	12.3	26,47,56,60,72–74,79
Hydroxyethyl starch	5	7.7	24,26,41,53,67
Normal saline	2	3.1	49,51
Freeze-dried plasma	1	1.5	44
Overall	27	41.5	23,24,26,29,35,39,41,44,47,49,51–53,56,60,64,66–69,71–75,79,84
Vasopressors (e.g. epinephrine, dopamine)	8	12.3	29,40,52,53,64,66,67,69
Elevation of lower limbs	2	3.1	26,61
Anticholinergic (anisodamine hydrochloride)	3	4.6	26,53,64
Overall	62	95.4	20–45,47–75,78–84

Table 5. Intracranial pressure management for TBI patients in Chinese pre-hospital settings

Interventions	Number of papers	Proportion	References
Assessment of brain herniation			
Observation of pupils	34	52.3	21,23–32,34,36,37,39–46,49–55,64,66,69,70,77
Observation of consciousness	33	50.8	20,21,23,25–34,36,37,39–41,44,45,47,49–53,55,64,66,69,70,74,77
Assessment of GCS score	8	12.3	20,21,28,32,35,38,45,46
Overall	40	61.5	20,21,23–47,49–55,64,66,69,70,74,77
Methods to control intracranial pressure			
Interventions implemented only for patients with clinical signs of brain herniation			
Mannitol	32	49.2	20–22,24,27,29–31,38,40–42,45,47,48,50,53,56–60,65,66,76,78–84
Furosemide	17	26.2	24,29,37,38,40,41,47,48,50,52,53,58,65,66,76,78,83
Corticosteroids	14	21.5	22,24,29,37,38,40–42,47,50,52,53,56,65
50% glucose solution	3	4.6	20,21,45
Albumin	2	3.1	24,84
Glycerol and fructose	1	1.5	84
Hyperventilation	1	1.5	45
Overall	33	50.8	20–22,24,27,29–31,38,40–42,45,47,48,50,52,53,56–60,65,66,76,78–84
Interventions implemented for all patients			
Mannitol	28	43.1	23,25,26,32–34,37,39,43,44,46,49,51,52,54,55,61–64,67–72,74,75
Furosemide	9	13.8	25,26,32–34,43,46,55,74
Corticosteroids	8	12.3	25,26,33,43,55,63,70,83
10% glucose solution	4	6.2	33,39,71,75
Overall	29	44.6	23,25,26,32–34,37,39,43,44,46,49,51,52,54,55,61–64,67–72,74,75,83
Overall	60	92.3	20–27,29–34,37–72,74–76,78–84,20–27,29–34,37–52,54–72,74–76,78–84

Table 6. Other interventions for TBI patients in Chinese pre-hospital settings

Interventions	Number of papers	Proportion (%)	References
Medications			
Sedatives	14	21.5	22,24,25,29,32,35,38,39,42–44,61,64,79
Analgesia	6	9.2	24,29,30,39,44,64
Naloxone	4	6.2	24,64,74,82,84
Vasodilator	3	4.6	25,43,77
Muscle relaxants	2	3.1	22,35
Antibiotics	2	3.1	82,84
Sodium bicarbonate	1	1.5	84
Operations			
Prevention of the reflux of cerebrospinal fluid leak	23	35.4	23,25,28,29,36–38,40,41,44,45,50,52–55,57,61,63–65,67,69
Lifting head 15°–30°	12	18.5	20,21,23,25,26,29,33,43,45,52,61,77
Ice cap	3	4.6	38,43,66

Table 7. Case-fatality rate of TBI during pre-hospital phases in China

Case-fatality rate during pre-hospital period (%)	Sample size	Reference
For all TBI patients ^a		
10.8	437	30
8.1	360	25
5.3	418	46
4.4	45	61
2.4	1 146	47
3.6	504	29
3.2	597	26
3.1	478	23
0	30	54
Overall ^a	4 015	–
For severe TBI patients ^b		
24.2	120	69
21.6	194	64
18.8	85	31
16.1	316	39
15.8	202	68
15.7	483	35
14.7	68	65
13.1	107	63
10.7	28	44
8.0	87	70
6.7	134	36
6.3	126	21
5.7	265	34
5.7	985	40
4.3	94	20
4.2	24	37
2.5	160	74
2.2	89	38
2.1	97	62
Overall ^b	3 664	–

^a: Data come from papers talking about pre-hospital management for all TBI patients; ^b: Data come from papers talking about pre-hospital management for severe TBI patients.

fluid used for TBI patients varied in Chinese pre-hospital settings. Among them, dextran (23%) and balanced salt solution (22%) were most prevalent (Table 4).

Assessment of neurologic status and treatment for brain herniation

Forty (62%) papers claimed that their pre-hospital doctors assessed TBI patients' neurologic status in pre-hospital settings. Most of the papers showed clinical signs of brain herniation by observing the patients' pupils

and levels of consciousness, but only 8 (12%) papers documented the measurement of the patients' GCS scores.

Interventions to control elevated intracranial pressure (ICP) were documented by 60 (92%) identified papers. Twenty-nine (45%) papers documented that agents had been administered to control ICP for all TBI patients without providing evidence that they had checked for the clinical signs of brain herniation in advance. The most common medications used to control ICP in Chinese pre-hospital settings were mannitol, furosemide, and corticosteroids (Table 5).

Other interventions

Other interventions discussed by the identified papers included some medications and operations (Table 6). Most research papers stated that they prevented intracranial infection in patients with open skull fractures by preventing reflux of cerebrospinal fluid leaks and administering antibiotics. The reflux of cerebrospinal fluid leaks was prevented by raising patients' heads for those with cerebrospinal rhinorrhoea, or by turning patients' heads to the leaking side for those with cerebrospinal otorrhea.

The proportion of TBI patients who died during the pre-hospital phases varied in the research papers. For all TBI patients, the overall case-fatality rate of TBI during pre-hospital phases was 4.48%, and ranged from 0% to 10.8% in different areas. For severe TBI patients, the overall rate was 10.4%, and rates ranged from 2.1% to 24.2% (Table 7).

DISCUSSION

Existing evidence has shown that China has a higher proportion of severe TBI compared to other countries, suggesting that the country could have sub-optimal management of TBI in pre-hospital settings.

This literature review presented the current situation of pre-hospital management of TBI in China, including problems in the management of oxygenation, blood pressure, and ICP in TBI patients.

Oxygenation, airways, and ventilation

Hypoxemia is independently associated with significant increases in morbidity and mortality in cases of severe TBI.^[85] Evidence-based guidelines published by BTF suggested the continuous measurement of oxygen saturation in pre-hospital settings.^[12] However, only 9 papers documented the measurement of oxygen saturation for TBI patients (Table 2). As a result, hypoxemia cannot be promptly identified and the efficiency of airway management cannot be evaluated in many Chinese pre-hospital settings.

Many papers provided options for airway management (Table 2). Among them, practices such as turning the patient's head to one side if the patients were vomiting and pulling out the patient's tongue with tongue forceps were prevalent in Chinese pre-hospital settings. However, these practices were not commonly mentioned in the literature from other countries. In addition, most of the reviewed papers did not offer clear and appropriate indications for their airway management practices. For example, only 27 identified papers provided detailed objective indications for TBI intubation, and most of which were not aggressive enough when compared with the guidelines.^[14] As a result, the overall intubation rate among severe TBI patients in China was 19.1%, which was far less than that of the US (43.0%).^[86] Unclear and improper indications may lead to suboptimal practice in pre-hospital settings. According to one study in Hebei Province, China, 87 (51.6%) of severe TBI patients were suffering from airway obstruction on arrival, and 69.0% of them could not get enough oxygen because of airway obstruction or inadequate pre-hospital oxygen supplements.

Some researchers pointed out that failed or inappropriate intubation without the use of sedatives and muscle relaxants during intubation may worsen TBI outcomes.^[88,89] Therefore, rapid sequence intubation (RSI), which is defined as an administration of an induction agent followed by neuromuscular blocking agents (NMBA) to induce unconsciousness and motor paralysis for tracheal intubation,^[90] is recommended for pre-hospital TBI management.^[11,12] However, none of these 65 research papers mentioned administration of NMBAs during intubation.

Suboptimal ventilation, especially hypocapnia caused by hyperventilation, is common in pre-hospital settings.^[91] Intubated TBI patients who present with severe hyperventilation have significantly higher mortality rates than those without hyperventilation.^[92] Therefore, monitoring ET CO_2 continuously to avoid suboptimal ventilation during pre-hospital phases is recommended.^[12,14] Only 22 (34%) papers reported ventilation for TBI patients and none of them monitored ET CO_2 in pre-hospital settings (Table 2). Only one article stated in the discussion section that routine hyperventilation should be avoided in TBI patients.^[35]

Hypotension and fluid resuscitation

Patients with hypotension not corrected in the field had a worse outcome than those whose hypotension was corrected by the time of arrival at the emergency department.^[85] BTF suggests that patients with suspected TBI should be monitored in pre-hospital settings for hypotension.^[12] However, less than half of the Chinese papers documented the measurement of blood pressure for TBI patients in pre-hospital settings (Table 5).

For the treatment of hypotension, BTF suggests that every hypotensive patient should be treated with isotonic fluids.^[12] Current reviews suggested that only 60% of the identified papers reported they had used resuscitation fluid for their TBI patients. Among those papers which did not document the use of resuscitation fluid, 46% (11 of 24 papers) said they administered mannitol or furosemide to their TBI patients.^[25,32,34,39,43,46,49,54,70-72] This situation may indicate a trend of overtreatment of brain herniation, and in turn, the ignorance of the adverse effect of hypotension on TBI patients in some Chinese pre-hospital settings.

Evidence showed that hypertonic saline is more effective in correcting hypovolemia when compared with hypertonic saline/dextran (HSD) and Ringer's lactate.^[93] Moreover, hypertonic saline can also decrease ICP in TBI patients.^[94] Hypertonic saline (7.5%) resuscitation is recommended by the guidelines.^[11,12] In China, the use of hypertonic saline is not widespread. Only 8 (12%) papers reported the use of hypertonic saline in pre-hospital settings (Table 6).

Brain herniation

Since brain herniation can dramatically elevate the mortality in TBI, patients' clinical signs of brain herniation should be assessed frequently in pre-hospital phases.^[12] In particular, the Glasgow Coma Scale (GCS)

is a significant and reliable indicator of the severity of TBI, and it can help to identify improvement or deterioration in neurological status through repeated measurements.^[12] Even though 40 (62%) Chinese papers stated that they assessed the signs of brain herniation for TBI patients, only 8 (12%) documented the measurement of GCS scores for TBI patients in pre-hospital settings (Table 7). A lack of GCS assessment may reduce awareness of the change of neurologic status in TBI patients and relevant interventions may be delayed.

Hyperventilation is the main therapy recommended to control elevated ICP.^[12] In China, practice of hyperventilation was only reported by one of the identified papers.^[45] Although mannitol has long been proven as an effective tool for reducing ICP, there is no evidence to support its use in pre-hospital settings.^[12] In addition, the osmotic diuresis that accompanies mannitol administration may lead to hypotension, especially in hypovolemic patients, and may worsen secondary brain injury in TBI patients.^[95] However, this review found that 60 (92%) identified papers used mannitol to control ICP in pre-hospital settings. Twenty-eight (43%) papers even reported that they administered mannitol to all of their TBI patients (Table 7).

Even though the use of corticosteroids in pre-hospital settings has been proven harmful for TBI patients,^[96] 22 (34%) papers reported the use of corticosteroids (Table 7). Similarly, albumin was associated with higher mortality rates than normal saline (RR=1.63) in TBI,^[97] but it is popular in Chinese pre-hospital settings.

Other interventions

Guidelines indicated that adequate sedation and analgesia were essential in TBI patients, especially if they were ventilated.^[14] In China, sedation and analgesia were only reported by 14 (22%) and 6 (9%) identified papers respectively.

Hypertension in TBI patients is usually caused by inadequate sedation and analgesia, and vasodilating agents should be avoided in TBI patients since these may cause fatal hypotension.^[14] Three of the identified papers reported the use of vasodilating agents for TBI patients. The agents used were sodium nitroprusside, nifedipine, and reserpine.^[25,43,77] These agents may worsen secondary brain injury and lead to a poor prognosis for TBI patients.

Other medications such as naloxone and sodium bicarbonate, and practices such as the prevention of reflux of cerebrospinal fluid leak and ice cap were

not commonly recommended in the pre-hospital TBI guidelines from other countries. More research needs to be done to determine if these practices are appropriate in pre-hospital TBI management.

In summary, we found problems in the current practices of pre-hospital TBI management in China. This suboptimal pre-hospital emergency management may contribute to the high proportion of poor outcomes in TBI in China.

LIMITATIONS

Several limitations of this review should be acknowledged. First, this is a literature review and most likely does not represent the true state of TBI care in the pre-hospital settings in China. Second, this review mainly focused on pre-hospital care of TBI in China, which limits generalizing our findings to other countries. Last, the studies we identified in this review used different approaches to quantify pre-hospital practice across China, and therefore it is not appropriate to quantitatively combine the results.

In conclusion, current practices of pre-hospital TBI management in China are sub-optimal and vary considerably, which may lead to a higher proportion of TBI patients with poor outcomes. Hence, appropriate training programs are urgently needed in China.

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Correction

We apologize for an error in the article *Life-threatening complications of ascariasis in trauma patients: a review of the literature* by Quan-yue Li et al (*World J Emerg Med*, 2014, Vol 5, No 3, 165–170), the phrase "in 2 cases after operation" should have been removed.