

## **Resource-Limited ENLS Traumatic Brain Injury**

*Epidemiology:* While the true global burden of traumatic brain injury (TBI) is unknown due to underdeveloped reporting systems in many low- and middle-income countries (LMICs), available data suggest that up 64-74 million new cases of TBI present to emergency departments each year worldwide, and that 80-90% of this disease burden falls on LMICs where resource gaps limit capacity to manage the complex needs of this patient population<sup>1</sup>. High-income countries (HICs) have seen a slight decline in TBI incidence over the past 30 years, whereas LMICs have seen a significant increase<sup>2</sup>. This shifting disease burden has been driven predominantly by urbanization and increased access to motor vehicles in LMICs and aging of the global population leading to a growing burden of fall-related injuries.

<u>Pre-hospital care and patient transport:</u> Infrastructures for pre-hospital care are under-developed or non-existent in many LMICs, giving rise to critical gaps in early patient stabilization and timely transport to a referral center equipped to manage the complex needs of patients with TBI. All patients should be evaluated in the field by emergency medical personnel if available. In accordance with ENLS and Brain Trauma Foundation (BTF) guidelines<sup>3</sup>, immediate priority should be given to stabilizing the patient's circulation, breathing, and spine, and determination of the Glasgow Coma Scale (GCS) score to characterize the severity of injury. In most resource-limited contexts, however, emergency medical services will be unavailable to stabilize the patient in the field, and the responsibilities for early stabilization and patient transport will fall on bystanders or family members. In this scenario, the patient should be transported to the nearest health facility equipped to stabilize the patient's circulation, airway, and breathing, immobilize the patient's spine, and coordinate transfer to the highest feasible level of care.

The need for transport to a higher level of care must be determined by the treating clinician, accounting for clinical severity, mechanism of injury, and local resource availability including access to CT, neurosurgical expertise, and travel distance to the nearest high-level center. Patients with mild TBI (GCS 13-15) without focal neurologic deficits or evidence of neurologic deterioration on serial examination over several hours may be closely monitored at a peripheral health care facility at the clinician's discretion, with a contingency plan to transport to a high-level center in the event of clinical deterioration. The ideal setting for patients with moderate to severe TBI (GCS <13) is a referral hospital staffed by neurosurgeons, trauma surgeons, intensivists, and neurologists and equipped with a CT scanner and an intensive care unit (ICU) capable of providing mechanical ventilation.

During transport, all feasible efforts should be made to maintain stability of the patient's airway, respiratory status, hemodynamics, and spine. Oxygen saturation should be continuously monitored and supplemental oxygen provided as needed and available. IV access should be maintained and the transporting vehicle should be equipped with a blood pressure cuff and isotonic fluids to maintain systolic blood pressure above 100mmHg (for patients age 50-69) or 110mmHg (for patients 15-49 years of >70 years).<sup>3</sup> If a rigid cervical collar is unavailable, the patient's head can be stabilized manually by personnel in the transporting vehicle, or by placing sandbags on either side of the patient's head to maintain midline positioning. If there is clinical evidence of increased intracranial pressure (ICP), such as asymmetric or non-reactive pupils, fixed downward gaze, Cushing's physiology (bradycardia, hypertension, abnormal respiration), or vomiting, empiric treatment with mannitol (0.5g/kg to 1g/kg infused over 15 minutes) should be considered if available (see the *ENLS Pharmacotherapy* module). Mannitol may cause volume depletion and/or renal injury, and its appropriateness for individual patients should be determined by the treating clinician.



Isotonic fluids should be administered to replace urinary losses as needed, as hypovolemia and/or hypotension may compromise cerebral perfusion in patients with increased ICP. Before transport, the peripheral facility should communicate with triaging staff at the referral center as able to prepare them for the patient's arrival and allow advanced coordination of acute diagnostic imaging and emergency stabilization interventions on arrival.

*Emergency department management of moderate to severe TBI:* All patients with moderate-severe TBI should be evaluated immediately by neurosurgical and emergency medical consultation upon arrival to the emergency department. Patients with an unstable airway should be promptly intubated with care to avoid hypotension during induction of anesthesia. Once stabilization and resuscitation measures have been performed, CT scans of the head and cervical spine should be prioritized. If CT is unavailable or likely to be delayed by prohibitive out-of-pocket costs or scanner availability, ICP-lowering therapies should be administered empirically if there is clinical concern for increased ICP (see ENLS pathway for "Intracranial Hypertension and Herniation"). If available, CT angiography of the head and neck should be obtained to assess for blunt cerebrovascular injury.

<u>**Triage:</u>** Patients with moderate to severe TBI should ideally be triaged to an ICU, although ICU bed space may be constrained in many resource-limited settings. If ICU space is limited, patients with moderate TBI (GCS 9-12) and reassuring CT findings may be monitored in the emergency department for 48 hours with the highest feasible frequency of vital signs and neurologic exams before considering triage to a general ward in the event of a stable neurologic exam. Patients with moderate TBI who experience neuro-deterioration, and those with severe TBI (GCS <9) and/or non-reassuring CT should be managed in the highest acuity area of the emergency department until an ICU bed becomes available, with co-management from neurosurgery and neurology.</u>

*Early critical care management:* Key critical care management priorities for patients with TBI in resource-limited settings include circulation, airway, and breathing management as above, ongoing monitoring for neurologic deterioration, medical management of ICP, prevention and control of seizures, and supportive care including ventilator management, hemodynamic support to avoid hypotension and hypertension, early nutrition, skin care, early mobilization when clinically appropriate, and fever and glucose control to prevent secondary brain injury. Most resource-limited health care settings are not equipped to provide invasive ICP monitoring. External ventricular drain (EVD) placement may be available in some settings for CSF diversion, though access to ICP transducers is limited in many LMICs. Protocols for clinical neuromonitoring including imaging and clinical exam have been developed in resource-limited settings. The CREVICE protocol<sup>4</sup>, adapted from the 2012 BEST-TRIP trial<sup>5</sup>, provides an algorithmic decision-support tool to guide the use of CT imaging in response to markers of neurologic deterioration. Protocols such as CREVICE may be adapted to suit the needs and resources of a particular setting.



## References

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