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TACTICAL COMBAT CASUALTY CARE: TRANSITIONING BATTLEFIELD LESSONS LEARNED TO OTHER AUSTERE ENVIRONMENTS

Managing Traumatic Brain Injury: Translating Military Guidelines to the Wilderness

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Traumatic brain injury (TBI) is a common injury on the battlefield. Much of what medics do to manage these injuries on the battlefield can be translated to other austere environments, such as wilderness or disaster settings. The recognition and diagnosis of TBI can be difficult even in the hospital, but basic understanding of how to define a TBI and prevent secondary injuries can be accomplished with relatively few resources and little training. This article outlines what a TBI is and how to manage it in the field.

Keywords: traumatic brain injury, concussion, head trauma, intracranial pressure, prehospital, wilderness

Introduction

Traumatic brain injury (TBI) is the signature injury identified from the most recent conflicts in Iraq and Afghanistan.[1] While most brain injuries on the battlefield are due to blast and fragments from explosive devices, wilderness TBIs are primarily due to falls during mountaineering activities, but can also occur during cycling, snowboarding, skiing, diving, and hunting and via any other mechanisms that transmit enough force to the victim's head to cause an injury to the brain.[2–5]

Five to 50 percent of traumatic events in the wilderness result in some form of TBI.[2–8] The incidence in avalanche victims has been reported to be as high as 25%.[9–13] The US Centers for Disease Control and Prevention estimated that the combined rates of TBI injuries and deaths increased from 521 per 100,000 in 2001 to 824 per 100,000 in 2010.[14] This increased incidence may represent an increase in detection with the widespread use of computed tomography (CT) scan imaging and increased recognition as an entity by medical providers. The rate of US TBI deaths during this period has remained stable at 17 to 18 per 100,000.[14,15]

While rapid evacuation has been aggressively used by the military, especially in a mature combat theater, many wilderness injuries must be treated for hours to days before transport to a medical facility can be accomplished. Diagnostic modalities in both scenarios are similar, however, because both the battlefield and the wilderness medic must rely on a basic clinical examination and history (this examination and history, rather than CT imaging, is used to determine the mode and urgency of evacuation). In addition, many of the therapies available are the same. Prevention of secondary injury and rapid evacuation are the keystones of prehospital TBI treatment.[16–22] While prehospital TBI management is really no different in the military and civilian arenas, other than medication use (ketamine and hypertonic saline) perhaps, the military's emphasis on immediate evacuation, early and aggressive decompression, and invasive monitoring during early postoperative care has been demonstrated to lead to improved outcomes in penetrating brain injuries.[23,24]

Definition

TBI has been broadly classified as either mild, moderate, or severe. Part of this definition is based on the 15-point, modified Glasgow Coma Score (GCS), which has been

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used to assess neurologic condition after a head injury (Table). A pathoanatomic classification also helps define the underlying injury and includes subdural hematoma, epidural hematoma, subarachnoid hemorrhage, cerebral contusion, and diffuse axonal injury. Often, the more severe the anatomic injury, as documented by CT scan, the more severe the TBI.[25,26]

Mild TBI, which accounts for over 80 to 90% of all TBIs, has been defined by the American Congress of Rehabilitation Medicine criteria as an acute condition in which the patient has sustained a trauma-induced (which includes the head being struck, the head striking an object, or the brain undergoing an acceleration/deceleration movement without direct external trauma to the head[27]) physiologic disruption of brain function, as manifested by one of the following: 1) any period of loss of consciousness (LOC); 2) any loss of memory of events immediately before or after the accident; 3) any alteration of mental state at the time of the accident (feeling dazed, disoriented, and/or confused); and 4) focal neurologic deficits that may or may not be permanent. To meet criteria for a mild TBI (mTBI) LOC must be less than 30 minutes in duration, the initial GCS (post LOC) should be 13–15, and posttraumatic amnesia should be less than 24 hours.

Most TBIs will be mild (a concussion). The military has developed diagnostic tools for evaluating mTBI on the battlefield using the Military Acute Concussion Evaluation (MACE) and the Standardized Assessment of Concussion (SAC).[28,29] Concussions have 3 grades of severity based on LOC and duration of altered mental status (AMS).[30,31] Grade 1 is no LOC and less than 15 minutes of AMS; grade 2, no LOC and greater than 15 minutes of AMS; grade 3 is any LOC. The GCS ranges from 13 to 15.

Moderate TBI is prolonged LOC greater than 30 minutes (but less than 24 hours) and a neurologic deficit with a GCS of 9 to 12.[32] Severe TBI is LOC greater than 24 hours with a GCS less than 9. Moderate and severe TBI patients usually have an intracranial abnormality and significant neurologic deficits; in addition, they may be comatose, have a seizure, or have unstable vital signs.[16,17,20]

While the GCS was originally devised to predict outcome in head injury cases, it is more complex to use than other scores, and conditions other than TBI (ie, drugs, high altitude cerebral edema, or shock) may lower the score even in the absence of brain injury. Other methods of evaluation in the acute phase may be more expedient in the field, such as the best GCS-motor score (GCS-M) or the AVPU scale, which uses 4 simple categories (**A**lert; **V**erbal response; response to **P**ain; **U**nresponsive). While not used to define the severity of TBI, the AVPU scale is simple and a practical assessment of level of consciousness for first-providers.[17,32,33]

Table. Glasgow Coma Score[a]

	1	*2*	*3*	*4*	*5*	*6*
E	No eye opening	Opens eyes to painful stimuli	Opens eyes to verbal stimuli	Opens eyes spontaneously	N/A	N/A
V	Makes no sounds	Incomprehensible sounds	Incoherent words	Confused, disoriented	Oriented, converses normally	N/A
M	Makes no movements	Extension to painful stimuli (decerebrate)	Flexion to painful stimuli (decorticate)	Withdrawal to painful stimuli	Localizes to painful stimuli	Obeys commands

E, eye; V, verbal; M, motor.

[a] Clinicians use this scale to rate the best eye opening response, the best verbal response, and the best motor response an individual makes. The final GCS score is the sum of these numbers.