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AN OVERVIEW OF TRAUMATIC BRAIN INJURY EVALUATION IN EMERGENCY MEDICINE

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Abstract:

The emergency department (ED) is the primary gateway to the medical system for acute traumatic brain injury (TBI) patients. However, ED evaluations for TBI have not been sufficiently described. In our study review we discussed TBI evaluation in the ED of patients with both mild and severe symptoms and the need for advanced emergency methods in managing such cases, as there is a high rate of death and/or severe complications among these patients. We performed an electronic search through EMBASE, PubMed, and the Cochrane databases for studies concerning head injury evaluation in emergency departments through July 2018. Since its original publication in 1974 by Teasdale and Jennett, the Glasgow coma scale (GCS) has been the most widely used method of recording the level of consciousness in patients at presentation and at subsequent assessments. Assessment and management requires a multidisciplinary team including the trauma team, neurosurgeons, bedside nurses, respiratory therapists, and other members of the medical team.

Key Words: *Head Injury, Emergency, Trauma, GCS, ICP.*

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INTRODUCTION:

Traumatic brain injury (TBI) is a considerable strain (around 10 million sufferers each year) on the healthcare system throughout the world [1]. Moreover, people who stayed alive after the primary insult, some may still have long-lasting problems. Many of these issues are related to a high incidence of pre-hospital secondary head insults [2]. Consequently, the knowledge of these variables and the timely treatment of the problem during the pre-hospital period can significantly improve results and decrease mortality [2].

About 70-90% of traumatic brain injuries (TBIs) that happen all over the globe are considered moderate and described as a loss of consciousness at <30 minutes, amnesia at <24 hrs, or peri-injury confusion/disorientation in a patient with a Glasgow Coma Scale rating of 13-15 [3]. The emergency department (ED) is a significant and overlooked element of TBI care. Due to the serious consequences of head injury it is essential to diagnosis the severity and monitor vital functions and functionality of life-support devices in order to prevent death.

In this review we discuss TBI evaluation in the ED of patients with both mild and severe injury as TBI has a high rate of death and severe complications.

METHODOLOGY:

We performed an electronic search through EMBASE, PubMed, and the Cochrane databases for studies concerning brain injury evaluation in emergency departments through July 2018. Our search was limited to English-language articles only.

DISCUSSION:

- **Definitions**

Head injury is determined as any injury to the head, with or without injury to the brain. An injury to head can be called minimal, minor, moderate, or severe, depending on symptoms after the injury. The patient with a minimal head injury are those with injury to the head and no loss of consciousness, a typical Glasgow Coma Scale (GCS) score, and no symptoms of head injury. Minor head injury patients generally have a GCS rating of 13 to 15 [4].
Traumatic brain injury (TBI) is a term, which is nonspecific defining penetrating, blunt, or blast injuries to the head. TBI can be identified as mild, moderate, or severe, commonly depending on the GCS and/or neurobehavioral deficits after the injury.

- **Classification by clinical severity**

The Glasgow Coma Scale (GCS) has been thoroughly applied to identify TBI into levels of severity and prognosis [4]. After traumatic brain injury, there is a reverse relationship between the GCS score and the occurrence of positive results on a CT scan. The rate of intracranial injury (ICI) and need for neurosurgical intervention doubles when the GCS drops from 15 to 12 [4, 5]:

Mild/Minor TBI: GCS 13-15; mortality 0.1%
Moderate TBI: GCS 9-12; mortality 10%
Severe TBI: GCS <9; mortality 40%.

- **Evaluation of Adults with GCS score**

Physiological criteria including Glasgow Coma Scale (GCS) rate, systolic blood pressure, and respiratory rate are beneficial forecasters for the result and can be utilized in the pre-hospital triage of patients with TBI (Table 1) [6]. The GCS is a quick, reproducible scoring system that has universal acceptance and is used to specify the severity of TBI, with serious TBI defined as a GCS of ≤ 8. It is based on eye opening, spoken response, and the most effective motor feedback. An early, non-sedated GCS has been shown to anticipate prognosis. Higher first ratings tend to forecast far better recovery [6]. The data from the 2007 National Trauma Data Bank (NTDB) National Sample Program revealed that after regulating for age, gender, race, injury severity score (ISS), and the duration of time in the medical facility, patients who had a GCS score ≤ 13 were 17-times more likely to die than TBI patients who had a greater GCS rate [6]. The various other scoring systems such as the simplified motor score (SMS) measuring TBI intensity, are found to work as well as GCS and are confirmed in many trials. In a retrospective testimonial of 52,412 patients, the level of sensitivity, specificity, and area under the receiver-- running particular curves were comparable between the SMS and the GCS for all end results [7]. Sensitivity for death was 72.2% for SMS and 74.6% for GCS. Level of sensitivity for TBI was 40.8% for SMS and 45.4% for GCS. Level of sensitivity for neurosurgical interference was 52.9% for SMS and 60.0% for GCS [7]. However, the intensity and prognosis are anticipated more precisely by also considering the computed tomography (CT) scans and other scientific variables consisting of a disrupted pupil reflex and arterial hypotension [6]. X-rays and ultrasounds are also valuable to rule out other significant injuries [6],[8]. A very early non-contrast brain CT is needed to assist with future treatment. Often, CT scan check facilities located in the trauma bay or emergency room are present to minimize the time to diagnosis and improve total mortality [7]. Once airway, breathing or ventilation, and adequate blood pressure are maintained, providers can focus on the management of intracranial hypertension and assess the other associated injuries.

Table 1. Glasgow Coma Scale [6].

	1	**2**	**3**	**4**	**5**	**6**
Eye	Does not open	Opens to pain	Opens to voice	Opens spontaneously		
Verbal	No sounds	Incomprehensible sounds	Incoherent words	Confused	Oriented, normal speech	
Motor	No movement	Abnormal Extension to pain	Abnormal Flexion to pain	Withdrawal to pain	Localizes pain	Obeys command

- **Monitoring patients with severe TBI**

Monitoring patients with TBI is important for the optimization of treatment, largely for the purpose of early detection and diagnosis of secondary brain injury both systemic and intracranial. Therefore, the observation of patients with severe TBI needs to comprise both general and particular neurologic monitoring.

General monitoring

During the neurointensive care of patients with extreme TBI, basic specifications that are checked on a regular basis consist of electrocardiography (ECG) observation, arterial oxygen saturation (pulse oxymetry, SpO2), capnography (end-tidal CO2, PetCO2), arterial blood pressure (arterial catheter), central venous pressure (CVP), systemic temperature, urine result, arterial blood gases, and serum electrolytes and osmolality. Intrusive or non-invasive cardiac output monitoring might be called for in hemodynamically unstable patients who do not react to fluid resuscitation and vasopressors.

Neuromonitoring

Intracranial pressure monitoring

The Brain trauma foundation (BTF) advises that "intracranial pressure (ICP) ought to be monitored in all salvageable patients with an extreme TBI and an unusual computed tomography (CT) check" [9]. In addition, "ICP monitoring is indicated in patients with extreme TBI with a regular CT check if two or more of the following functions are kept in mind at admission: age of over 40 years, unilateral or bilateral motor posturing, and systolic high blood pressure (BP) < 90 mm Hg" [9]. Based on physiological concepts, prospective benefits of ICP surveillance include earlier detection of intracranial mass lesions, advice of therapy and evasion of indiscriminate use therapies to manage ICP, drainage of cerebrospinal fluid (CSF) with reduction of ICP and renovation of CPP, and resolution of diagnosis.

Readily available approaches for ICP surveillance consist of epidural, subdural, subarachnoid, parenchymal, and ventricular locations. Historically, a ventricular ICP catheter has been put to use as the recommended strategy when possible. It is the most accurate, low-priced, and reliable method of monitoring ICP [9]. It also enables therapeutic CSF drainage in case of intracranial hypertension to control increased ICP. Subarachnoid, subdural, and epidural screens may be positioned on the side with ultimate pathological features or swelling [11]. Routine ventricular catheter adjustment or prophylactic antibiotic use for ventricular catheter placement is not recommended to reduce infection [9]. ICP surveillance tools are normally continued for ≤ 1 week, with a day-to-day exam of the CSF for sugar, protein, cell count, Gram discoloration, and culture and sensitivity. Therapy for intracranial high blood pressure must be started with ICP thresholds above 20 mm Hg [9]. In addition to ICP values, medical and brain CT findings should be utilized to determine the requirement for therapy [9].

Brain tissue oxygen tension

Both SjvO2 and brain tissue oxygen tension (PbtO2) monitoring measure cerebral oxygenation. SjvO2 illustrates global cerebral oxygenation, whereas PbtO2 shows focal cerebral oxygenation by use of an invasive probe (Licox). Rosenthal et al. recorded that the dimensions of PbtO2 represent CBF and the cerebral arteriovenous oxygen tension difference, instead of a direct measurement of complete oxygen delivery or cerebral oxygen [12]. As PbtO2 gives a very focal measurement, it is mainly used to monitor the oxygenation of a seriously perfused brain tissue. PbtO2 is the most reputable strategy to observe focal cerebral oxygenation in order to protect against episodes of desaturation. However, global cerebral oxygenation changes may not be observed. The typical PbtO2 range is between 35 mm Hg and 50 mm Hg [13]. A value of PbtO2 < 15 mm Hg is thought to be the threshold for focal analytical ischemia and treatment [9].

Cerebral microdialysis

Cerebral microdialysis (MD) is a recently established intrusive research laboratory tool providing bedside screening to evaluate brain tissue biochemistry [14]. Normally, an MD catheter is placed in "susceptible" brain tissue to determine biochemical changes in the location of the brain most at risk to secondary insults. Different assays are available to determine dialysate focus consisting of glucose, lactate, pyruvate, glycerol, and glutamate.

Characteristically, cerebral hypoxia or ischemia results in a significant rise in the lactate: pyruvate ratio (LPR). A LPR > 20-25 is thought to be the limit for cerebral ischemia and is connected with a poor end result in TBI [14]. Although MD is a reputable device that supplies extra aid in the management of patients with severe TBI, its use is very minimal.

Transcranial Doppler Ultrasonography

A transcranial Doppler (TCD) is a non-invasive technique to determine CBF velocity. It is progressively used in neurocritical care including TBI. It is a medically beneficial device in the diagnosis of issues that may take place in patients with TBI such as vasospasm, crucial elevations of ICP and lowers in CPP, carotid dissection, and cerebral circulatory arrest (brain death). TCD can anticipate post-traumatic vasospasm prior to its professional indications. Given that ICP surveillance is an intrusive procedure with a prospective risk of connected problems, TCD has been recommended as a non-invasive alternative technique for the assessment of ICP and CPP [15]. The general level of sensitivity of TCD for verifying brain death is 75% to 88%, and the general specificity is 98% [16]. Although TCD is a recognized surveillance method in neurocritical care, there is no proof to sustain its regular use for ICP/CPP management in serious TBI patients.

Electrophysiological monitoring

The electroencephalogram (EEG) is a clinically useful tool for monitoring the depth of a coma, detecting non-convulsive (sub-clinical) seizures or seizure activity in pharmacologically paralyzed patients, and diagnosing brain death [17]. Sensory-evoked potentials (SEP) can yield data on current brain function in very severe TBI patients, however their use is limited in the initial management of TBI.

Near infrared spectroscopy

Near infrared spectroscopy (NIRS) is a continual, straight, and non-invasive display of analytical oxygenation and cerebral blood volume (CBV). In cerebral tissue, the two primary chromophores (light-absorbing compounds) are hemoglobin (Hb) and cytochrome oxidase. NIRS is based upon the differential absorption of the residential or commercial properties of these chromophores in the NIR array, i.e. in between 700 and 1,000 nm. At 760 nm, Hb takes place largely in the deoxygenated state (deoxyHb), whereas at 850 nm it occurs in the oxygenated state (oxyHb). For this reason, by monitoring the distinction in absorbency in between these two wavelengths the level of tissue deoxygenation can be reviewed.

In comparison with the SjvO2, NIRS is much less accurate in determining cerebral oxygenation [18]. Although NIRS is a progressing technology and has prospects as a professional device for bedside cerebral oxygenation and CBF dimensions, its use in neurocritical care continues to be very minimal.

Brain temperature

After head trauma, a temperature difference in brain temperature level as compared to body temperature of as much as 3 ° C greater in the brain has been reported. Raised temperature is a common additional systemic issue for the injured brain. Both invasive (The new Licox PMO: Integra Life Sciences, Plainsboro, NJ) [19] and non-invasive continuous cerebral temperature level surveillance devices are readily available for measuring brain temperature. Nevertheless, brain temperature surveillance is still not widely used during the neurocritical care of patients with severe TBI.

CONCLUSION:

Since its original publication in 1974 by Teasdale and Jennett, the Glasgow coma scale (GCS) has been the most widely used method of recording the level of consciousness in patients at presentation and at subsequent assessments. It is very important to properly evaluate patients and assess their vital functionality in the ED, because a wrong assessment can lead to wrong management, poor consequences, and even death. Assessment and management clearly requires the efforts of a multidisciplinary team including the trauma team, neurosurgeons, bedside nurses, respiratory therapists, and other members of the medical team.

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