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Title: Traumatic brain injury in children; initial assessment and management

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Abstract

Traumatic Brain Injury (TBI) as a result of road traffic accident or falls is the leading causes of death or disability in children. Children and young people frequency access health services as a result of a TBI. Consequently many nurses working with children and young people, in both primary and secondary care settings will care for a child following a TBI and have a role to play in accident prevention. Understanding the initial stabilisation of a child who has sustained a TBI, and the principles of pre-hospital management are essential to ensure optimal care of the child and family. This article provides an overview of TBI and its management in children and the key role of primary care practitioners in relation to the identification of TBI and accident prevention.

Introduction

Traumatic brain injury (TBI) is a significant health issue in children and young adults. TBI is the leading causes of death or disability in children, accounting for a quarter to one third of childhood accidental deaths (Parslow et al 2005, Durkin et al 1998). Approximately 44% of children aged between 14-15 years have sustained one or more TBI (Body and Leathem 1996). Data suggest incidence rates of 100-300 per 100 000 children (British Society for Rehabilitation Medicine (BSRM) 2000; Hawley et al 2003), however, rates as high as 1000-3000 per 100 000 children per year have been reported (McKinlay et al 2008). Boys are at greater risk of TBI compared to girls, and the risk of TBI increases with age (Rivara 1982; McKinlay et al 2008). Evidence also suggests that children who have sustained a TBI are at increased risk of sustaining a subsequent TBI (Swaine et al 2007). Following assessment the majority of children can be managed without admission to hospital (Swann and Teasdale 1999). Peak attendance at A&E occurs during the winter when shorter daylight hours increases the risk of accidents and during school holidays when children are more likely to be playing outside (Parslow et al 2005). This article will outline the initial stabilisation of a child who has sustained a TBI and the principles of pre-hospital management. In addition, the role of the school nurse in relation to the identification of TBI and accident prevention will be discussed.

Defining TBI

Traumatic brain injury can be defined as an alteration in brain function (for example loss of consciousness and neurological deficits), or other evidence of brain pathology (for example visual and neuroradiological), caused by an external force (Menon et al 2010). External forces include the head striking or being struck by an object, which may penetrate the brain, and the brain undergoing an acceleration/deceleration movement. Closed-head injuries are far more common than open-head injuries and can result in both focal and diffuse patterns of injury. Primary brain injury occurs at the time of impact; secondary injury occurs after the impact due cerebral oedema, vascular injury, seizures and infection. Cerebral oedema can result in cerebral hypoxia and raised intracranial pressure, and if uncontrolled has life threatening consequences.

Classification of severity of TBI

It is important to make the distinction between the minor, moderate and severe TBI because of the morbidity associated with severe trauma to the head, and the need for these children to be transferred immediately to a children's intensive care with expertise in caring for children with TBI (NICE 2007). The vast majority (>90%) of TBI's will be classified as mild TBI often as a

result of sport or leisure activities (McKinlay et al 2008). The term concussion is often used interchangeably with mild TBI. Mild TBI is usually defined as a brief loss of consciousness, a Glasgow Coma Score (GCS) 13-15, and transient symptoms such as dizziness, confusion, headache and vomiting. Admission to hospital is not always necessary following mild TBI but is often a precaution if there has been a seizure, a skull fracture, unstable GCS, the cause is suggestive of more serious injuries, the cause is suspicious, and symptoms such as vomiting require additional management from healthcare professionals (NICE 2007).

In moderate TBI the GCS is between 9 and 12, consciousness often fluctuates and there may be persistent neurological sequelae, such as poor motor coordination and memory loss. Children with a minor or moderate TBI have the potential to deteriorate and become neurological unstable, therefore require a detailed initial neurological assessment and ongoing monitoring.

Severe TBI is defined as a GCS of less than 8 (NICE 2007) and the depressed conscious state is potentially life threatening because vital functions are compromised including the inability to maintain the airway. If unconsciousness is prolonged following the initial injury there will be decreased responsiveness, dilated pupils and decreased response to light, abnormal motor activity, headaches, nausea and vomiting. A rise in blood pressure with a compensatory bradycardia, apnoea and progressively elevated intracranial pressure are indications of imminent catastrophe and requires urgent medical management.

Cause of TBI

In England and Wales road traffic accidents are the leading cause of death in children 5-19 years of age (ONS 2011). However the cause of TBI changes with age of the child. The main causes include:

- Falls, accounting for 20-30%, although severe head trauma is rare in home accidents;
- Assaults, accounting for approximately 10%;
- Pedestrian and cycle accidents;
- Under 14 year olds falls are the most common cause of TBI;
- Road traffic accidents which cause the greatest severity of injury and most common cause of moderate to severe TBI in 15-25 years:
- Children over 14 year's most common cause of TBI are motor vehicle accidents, falls, sports injury and assaults;
- Other causes of TBI include sports related trauma and abuse injuries.

(Durkin et al 1998; Parslow et al 2005; McKinlay et al 2008)

Assessment and early management

The National Institute of Clinical Excellence (NICE) (2007) guidelines relating to the triage, assessment and management of head injuries in infants, children and adults outlines the initial priorities of care as:

- Assessment and stabilisation of the airway, breathing and circulation;
- Assessment of neurological status;
- Ascertaining the degree of the injury in order to initiate appropriate levels of care.

Acute management of a child who has sustained a TBI begins with the assessment of ABCDE; ensuring the airway is clear and maintained, and assess breathing, and circulation and if necessary initiate resuscitation measures. Neurological status should be assessed using the Glasgow Come Scale (GCS). The GCS (Teasdale and Jennett 1974), considered the international standard for determining conscious levels, should be recorded at the time of injury to determine the severity of injury with ongoing assessments to identify and record changes in the child's condition. A modified GCS should be used when assessing children, as outlined in Figure 1 (NICE 2007; Tatman et al 1997). Nurses not experienced in using the GCS should undertake a rapid neurological assessment using the Alert (A), Verbal (V), Painful (P), Unresponsiveness (U) (AVPU) scale (Gaichas et al 2006). The AVPU score provides a quickly assessment of the child's level of consciousness but has limited application and is not a replacement for the GCS.

The GCS consists of three parameters: best eye, best verbal and best motor response. These three parameters are assigning a numerical value with the lowest score achievable being 3 (no response) and the maximum score is 15 (alert and fully responsive appropriate to age and stage of development). Summation of each of the scores for each parameter provides the overall GC Score.

Figure 1: Overview of Child's Glasgow Coma Scale (Kirkham et al 2008)

Child's Glasgow Coma Scale		
	<5yr	>5yr
Eye opening (E)		
E4	Spontaneous	
E3	To voice	
E2	To pain	
E1	None	
C	Unable to open eyes (swelling, ptosis)	
Verbal (V)		
V5	Alert, babbles, coos, uses words or sentences that are normal for age	Orientated
V4	Less than usual ability, irritable cry	Confused
V3	Cries to pain	Inappropriate words
V2	Moans to pain	Incomprehensible sounds
V1	No response to pain	
ET	Child is intubated	
Motor (M)		
M6	Normal spontaneous movements	Obeys commands
M5	Localises to supraorbital pressure or withdraws to touch	Localizes to pain
M4	Withdraws from pain	Flexion withdrawal
M3	Abnormal flexion to pain to supraorbital pain	
M2	Extension to pain to supraorbital pain	
M1	No response to pain to supraorbital pain	
Total coma score	3/15-15/15	

Establishing the level of consciousness is an important factor in determining outcome and prognosis with the duration of unconsciousness often proportional to injury severity. If the child does not attempt to verbalise or move then a painful stimulus must be applied to elicit a respond. Failure to apply an appropriate stimulus of sufficient intensity and duration will result in an inaccurate picture of the child's neurological status. Unless there are facial fractures or swelling of the orbital area, supra-orbital pressure is the stimulus of choice. The motor response is the most accurate predictor of poor outcome; any child with a reduction in motor score for example unable to obey commands should be managed as having a severe head injury. In cases of TBI the initial assessment along with the guidance outlined in Box 1, will assist making decisions about whether the child requires emergency care and further assessment.

Box 1 Indications for referral to hospital for children following TBI (NICE 2007; Scottish Intercollegiate Guidelines Network 2009)
Witnessed loss of consciousness more than 5minutes
Post-traumatic amnesia more than 5 minutes
Drowsiness
Seizure since injury
GCS less than 14 in children (1-16 years)
Suspicion of non-accidental injury
Evidence of skull fracture
Focal neurological deficit such as cranial nerve deficits, diplopia, speech deficits, weakness and gait or balance problems:
Difficulty making a full assessment
Mechanisms of injury

During the initial assessment it is essential to establish how the child has sustained the TBI. However, in unwitnessed injuries in young children, this may be difficult. Certain mechanisms of injury are red flags to seeking immediate treatment, outlined in Box 2.

Box 2 Red flags
• Falling from height greater than 1 metre • Axial loading injuries – in which the individual lands on his or her feet or head • Pedestrians hit by vehicles and high speed injuries (NICE 2007)

Role of the school nurse in recognising and assessing TBI

School nurses should be alert to the possibility of the signs and symptoms of a TBI that a child may present as a result of trauma for example a bump, blow of bolt to the head during playtime, or during school based sports activities where there is potential for collision or accident. Typically the child with minor TBI has a combination of transient symptoms often referred to as postconcussive symptoms (PCSs) these include:

- Somatic such as headache, nausea and vomiting, dizziness, fatigue or feeling tired;
- Physical such as loss of consciousness not exceeding 20 minutes, amnesia;
- Cognitive such as feeling like in a fog, slow reaction times, lack of concentration;
- Emotional symptoms such as lability, irritability and nervousness.

(McCrory et al 2009)

These signs and symptoms may not be immediate and often become apparent during school activities that require concentration, rapidly processing information, and undertaking multiple cognitive tasks. Children are more susceptible to concussion due to their developing brain and consequently they may take longer to recover from minor TBI with ongoing neurological and cognitive effects (Halstead and Walker 2010). During assessment a young injured child may not be able to articulate clearly these symptoms. A child may present with symptoms of minor or moderate TBI having sustained a TBI prior to arriving at school. Awareness of the seasonal peaks incidence of TBI is an important consideration when monitoring/observing for minor TBI. The child or the teacher may observe a range of behaviours which may be present in school, which may not be usual for that child and may be suggestive of minor TBI, including;

1. Attendance:
    - Unexpected absences from school or from specific classes;
2. Cognitive/academic performance:
    - Inattentiveness beyond what is normally expected of the child
    - Academic performance lower than before the injury
    - Weak orientation to task
    - Difficulty shifting from task to task (inflexible)
    - Relatively slow performance
    - Delayed responses
    - Difficulty remembering new information
    - Difficulty organizing large tasks
    - Unexpectedly poor comprehension;
3. Social/behavioural performance:
    - Unexpected conflicts with peers
    - Inappropriate or impulsive behaviour in class
    - Disrespectful behaviour in relation to the teacher
    - Excessive moodiness
    - Unexpected mood swings
    - Excessive tiredness.

(Ylvisaker, Feeney & Mullins, 1995)

If a child is suspected of having sustained a minor or moderate TBI immediate discussion with the family is essential and referred to their general practitioner or primary care provider for further assessment and access to services may be necessary. A number of assessment tools have been devised to assess for sports related minor TBI or concussion. The Sports Concussion Assessment Tool (SCAT) provides a useful comprehensive evaluation for children aged 10 and over (McCroy et al 2009).

Recognising non-accidental head trauma

Non-accidental head trauma involves an inflicted injury to the head and its contents, including those caused by both shaking and blunt impact. Although non-accidental head trauma is the most common cause of TBI in children under one year of age (Parslow et al 2005), non-accidental head trauma can occur in the older child the mechanism of injury generally as a result of blunt trauma such as being hit with an object. However there is evidence that shaken head injury may occur in older children leading to diffuse brain injury (Salehi-Had et al 2006). The school nurse needs to be alert to the signs of abuse and help others in school in recognising the signs. During the assessment of a child who present with a TBI, alternative reason for the mechanism of injury may need to be considered when the cause of injury does not seem plausible or doubtful. In suspected NAHT trauma a full and detailed physical assessment will be required and referral to appropriate child protection services.

Education

The school nurse can play a crucial role in identifying those children who are at risk of TBI and the provision of education and advice about the potential dangers risk taking activities in particular for children engaging in sport activities. In addition, the school nurse can provide, and work with in collaboration with teachers in relation to developing and implementing age-appropriate school-based programs that address risk factors such as traffic safety, conflict resolution (DH 2006). The school nurse can assist in creating a school environment that minimising the impact of injuries such as shock-absorbing playgrounds surfaces. Education should encompass all those involved teachers, administrators, children and their parents. School nurses can also provide information about national and local brain injury services that are available to children with a TBI and their families.

Conclusion

Traumatic brain injury is a common occurrence in children, with the majority of TBI being classified as minor. Early recognition and appropriate responses when they occur are critical to prevent further injury and aid recovery. It is also important to realise that signs and symptoms may take time to manifest and alerting teachers and children to recognising the signs that may develop. Recognition of the potential risk factors for a TBI across the age trajectory of children may help to target relevant education programmes.

Further Information

Child Brain Injury Trust

The Child Brain Injury Trust (CBIT) supports anyone in the United Kingdom affected by childhood acquired brain injury. They provide information, support and training to families and professionals.

http://www.childbraininjurytrust.org.uk/index.html

Helpline 0303 303 2248

Brain Injury Foundation

A charitable organisation helping to provide a wide range of information for people affected by brain and spinal injury and includes information and resources for children and young people.

http://www.brainandspine.org.uk/acquired-brain-injury-resources

Free Helpline 0808 808 1000

Headway the brain injury association

Charity that works to improve life after brain injury with services divided into regions throughout the UK and Channel Isles.

https://www.headway.org.uk/home.aspx

Free helpline 0808 800 2244 helpline@headway.org.uk

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