MANAGING THE INJURED CHILD: MORE THAN JUST TREATING THE INJURIES

Trauma remains a leading cause of death in children in South Africa and injuries account for about one-third of all paediatric emergency consultations.

L SCHOEMAN

MB ChB, FCS (SA)

Head

Emergency Unit

George Medi-Clinic

Leonie Schoeman qualified as a surgeon at the University of the Witwatersrand in 1995 and as a paediatric surgeon in 1998. She is currently head of the Emergency Unit of the George Medi-Clinic and in private practice as a paediatric surgeon. She is involved in an outreach programme to educate pre-primary schoolchildren about road traffic situations.

There are issues of particular importance to injured children and situations where special care should be taken. The constitution of infants and children varies substantially from that of adults, which has an effect on the way the injury presents and the child's physiological and psychological response to being injured.

AETIOLOGY OF CHILDHOOD INJURIES

The majority of childhood injuries and blunt trauma are caused by falls and vehicle accidents. Falls, although a significant part of paediatric trauma, rarely result in death, while traffic accidents are a significant cause of death and long-term disability. Penetrating trauma occurs less frequently in younger children, but is associated with more serious injuries.

SPECIAL CONSIDERATIONS IN CHILDREN

The principles and priorities of management in children are the same as in adults. Children's unique anatomical and physiological characteristics mean that multisystem injury is the rule rather than the exception in vehicle accidents. Therefore all systems must be assumed to be injured until proved otherwise. Penetrating injuries are rare, but occur with increasing frequency in older children and adolescents.

Skeleton

Owing to incomplete calcification and multiple growth centres the bony structures are more pliable. Therefore there is often internal organ damage in the absence of overlying bone fracture, the most common example being that of lung contusion without rib fracture. The presence of broken ribs should alert the examiner to the presence of greater energy transfer.

Surface area and thermoregulation

The child's surface to volume ratio is greatest at birth and diminishes as the child grows. A thinner skin and less subcutaneous tissue predispose the younger child to lose heat more rapidly and is a significant stress factor. The result is that burns has a greater effect on the child's metabolism.

Sedation

Visiting an emergency unit is a fearful and traumatic experience for a child. The need for procedures increases this trauma. Procedures performed on a child must not be more traumatic than the initial event and sedation is often appropriate. The procedure must be explained to the caregiver as well as the child, in child-friendly language, and the caregiver should be allowed to stay with the child as long as possible.

Equipment

Appropriately sized equipment similar to that needed for the management of adult trauma is required. A Broselow Paediatric Resuscitation Measuring Tape is useful to obtain the child's weight and the sizes of tubes and other equipment.

Intraosseous needles, paediatric cervical collars and blood pressure cuffs are necessary. Ideally drug dosages and protocols should be written down in the emergency unit and the appropriate drugs for paediatric sedation and analgesia should be readily available.

RESUSCITATION

Airway management

Children are more difficult to intubate than adults because of disproportion between the cranium and face, a smaller airway and a more anterior larynx. It may be better to ventilate with a bag-valve mask than repeatedly attempt intubation in a child with a problematical airway. There is some doubt as to the benefit of pre-hospital intubation, as there is a significant incidence of oesophageal intubations in field intubations. Lack of ventilation is a more common cause of cardiac arrest in children than lack of circulating volume.

Maintain the position of the face for intubation while stabilising the cervical spine. A jaw-thrust manoeuvre is safer than a chin lift. The child's larynx is higher and more anterior in the neck; the vocal cords have a more antero-caudal angle and soft tissues, e.g. large tonsils, may obstruct the view. The child has a short trachea, and if care is not taken the tip of the endotracheal tube can very easily be positioned in the main stem bronchus. The mouth must be cleared of secretions and foreign material before pre-oxygenation. It is helpful to place an oral airway before pre-oxygenation; it must be slipped over the tongue with the help of a tongue depressor, and not rotated through 180° as in an adult. In a child the oral airway can easily damage the soft palate. It is recommended that an uncuffed tube be placed in small children.

Breathing

Depending on their age children breathe at varying rates. A satisfactory breathing pattern is one where there is no intercostal recession, there are no or few audible breathing sounds, and there is normal chest expansion and normal abdominal excursions. Inadequate or obstructive breathing results in a noisy or irregular breathing pattern, with mottled or blue skin. In a small baby grunting is always a sign of an obstructed airway.

In the ventilated child, tidal volumes of not more than 7 - 10 ml/kg are adequate. Beware of too vigorous ventilation and aim to keep airway pressures low. In children the tracheobronchial tree is immature, fragile and vulnerable to barotrauma. Pneumothorax after intubation is a risk in all children; more so where there is underlying lung injury. Intercostal drains are inserted for the same indications as in adults. The tube may be tunnelled over the lower rib to create a subcutaneous tract, facilitating removal without purse string sutures. The position and technique are the same as in adults. The size of the intercostal tube should be adjusted to the estimated size of the intercostal space.

Circulation

The first compensatory mechanism for blood loss is tachycardia. Other subtle signs of blood loss are a decreased pulse pressure, mottled skin and a temperature differentiation between the truncal and peripheral areas. Loss of blood pressure and dullness of the sensorium indicate severe and uncompensated shock and a blood volume loss of greater than 45%. The child's blood volume is roughly 80 ml/kg. In suspected hypovolaemia a transfusion of 20 ml/kg warmed resuscitation fluid (Ringer's lactate, Plasmalyte B) is given as a bolus, and response monitored. If 3 boluses are needed prepare for blood transfusion.

Monitor urinary output by catheterising. Accepted urinary output varies with age, from 2 to 1.5 ml/kg/hour. The accepted adult volume of 1 ml/kg/hour is only applicable at adolescence. In babies weighing less than 15 kg a feeding tube may be used as a catheter.

When fluid therapy is administered, the following responses should be observed:

- slowing of the heart rate
- increase in pulse pressure
- return of normal skin colour
- warming of extremities
- clearing of sensorium
- increase in systolic blood pressure
- improved urinary output to more than 1 ml/kg/hour.

If the child fails to respond an urgent surgical opinion must be obtained.

Venous access

Obtaining venous access in a small child can be a challenge to the most experienced doctor. After 2 attempts at peripheral venous cannulation an alternative should be considered. Intraosseus cannulation in children under 6 years of age is a safe and easily mastered technique (Fig. 1). It is quicker than a venous cut-down and less equipment and expertise are required. The placement of central venous catheters in children should be avoided by the inexperienced.

Fig. 1. Cook intraosseous cannula.

Sites for venous access in children:

- percutaneous peripheral x 2
- intraosseus
- venous cut-down — saphenous vein at the ankle
- percutaneous placement in the femoral vein in groin
- percutaneous placement in the subclavian vein
- percutaneous placement in the internal or external jugular veins (risk of cervical injuries, remove cervical collar)

PSYCHOSOCIAL ISSUES

Psychosocial status

The child's response to trauma will vary according to his/her age, previous traumatic experiences and concurrent stresses. Traumatised children exhibit responses which may vary between all extremes of behaviour. However, children of all ages will cope better if supported by a calm and caring primary caregiver. Sending a parent out of the room during a traumatic or painful procedure is not in the child's best interests.

Long-term effects of trauma

A child has the added task to grow and develop as well as recover from an injury. The long-term physical and psychological recovery depends on the child's innate resilience, the quality of his/her relationships with a caregiver and other supportive persons, and the presence of disfigurement or disability after the injury. Post-traumatic stress disorder does occur in children and may be more difficult to recognise than in adults. Professional intervention is indicated when signs such as withdrawal, regression, aggression and poor school performance are noted after major trauma.

SPECIFIC INJURIES

Head and neck injuries

The developing brain has a higher water content than the adult brain and an increased weight (15% of the body weight in the neonate as opposed to 3% in the adult). There is also a smaller subarachnoid space which offers less protection to the brain. Thus, head momentum is more likely to result in parenchymal structural damage. The response to trauma is also different. There is incomplete neuronal synapse formation, which has an impact on recovery. Generally, the outcome of severe traumatic brain injury in children is better than in adults. However, the outcome in children under 3 years of age is worse than a similar injury in an older child.

Primary and secondary brain injury are stages in the development of head trauma. The primary injury occurs at the time of the impact and secondary injury refers to the cascade of events within the injured brain, including breakdown of the blood-brain barrier, intracellular oedema and ischaemic injury. Injury can be augmented by these developments, and in the early phase the injured brain seems to be particularly vulnerable to hypoxia and hypotension. Some authors have reported a strong association between diffuse brain swelling and early hypoxia and hypotension, and suspect that these factors are critical in the development of raised intracranial pressure in children.

Truncal injuries

Chest

Ten per cent of all injuries involve the chest. Sixty per cent of children with chest trauma will have other organ injury. While traumatic brain injuries are the most common cause of death in severe trauma, abdominal and chest injuries are the most common causes of preventable deaths in children. The paediatric ribcage is very pliable; therefore pulmonary contusion occurs more often than in adults. Rib fractures are an additional marker for severity of the injuring force. Pneumothorax and haemothorax occur as a result of blunt trauma, usually because of a tear in the lung parenchyma. A chest drain should be inserted in the same manner as in an adult. Surgery for blunt thoracic trauma is extremely rarely indicated. Diaphragmatic injuries occur more often in severely injured children. It is associated with other truncal injuries and the rupture usually occurs at the periphery of the diaphragm, and not in the dome, as in adults.

Abdominal

Abdominal trauma is mostly due to blunt trauma involving vehicle accidents and falls. Penetrating trauma is rare and usually requires prompt assessment by a surgeon. Abdominal distension in the injured child is often the result of gastric distension rather than bleeding. If intra-abdominal bleeding causes distension of the abdomen, it usually indicates catastrophic bleeding. If distension occurs the abdomen should be re-evaluated after gastric decompression. With gentle persuasion the child may indicate the specific area of tenderness. Gentle palpation should start away from the painful area, working towards it. Diagnostic peritoneal lavage is almost never indicated in children. Ultrasound, easily accessible in most hospitals, is non-invasive and quick. It is however operator dependent. A CT scan is a sensitive and specific investigation for most abdominal injuries with the disadvantage that it is time-consuming, expensive and requires moving a child who is in the process of being resuscitated.

An injured liver and spleen in a child can be managed non-operatively in the majority of cases. The child should be observed in paediatric high care by a surgeon experienced in paediatric trauma. Small bowel rupture often occurs owing to the thin abdominal wall and direct crushing of the viscera between the abdominal wall and vertebral column. Renal injuries occur more often in older children and bladder ruptures in younger infants owing to the bladder being intra-abdominal. Pancreatic injuries often present late, with the complications of pancreatitis or pseudocysts.

Peripheral injuries

Immature skeleton

Concerns include the potential of injury to the growth plate, difficulty in interpreting radiographs owing to ossification centres, and lack of mineralisation around joints. As the bone is more pliable the nature of injuries also differs, including the occurrence of typical childhood injuries, e.g. supracondylar fractures of the elbow and knee, greenstick fractures and growth plate injuries. Growth plate crushes may alter or retard further bone growth in that area. Unfortunately these injuries may also be difficult to diagnose on radiographs and a high index of suspicion is needed.

Blood loss

A child may become haemodynamically unstable owing to a fracture of the femur, and associated blood loss is

The constitution of infants and children varies substantially from that of adults, which has an effect on the way the injury presents and the child's physiological and psychological response to being injured.

Penetrating trauma occurs less frequently in children, but is associated with more serious injuries.

There is often internal organ damage in the absence of overlying bone fracture, the most common example being that of lung contusion without rib fracture.

Child abuse and neglect occur in boys and girls of all ages, in all racial groups and at all socioeconomic levels.

Table I. **Examination findings suggestive of non-accidental injury**

- Bruises that cannot be explained or do not collate with the given history
- Delayed presentation of serious injury
- Symmetrical injuries
- Bruises shaped like an instrument, e.g. belt buckle
- Cigarette burns
- Burns resembling socks or gloves (immersion)
- Multiple fractures in a young baby
- Fractures that occurred at different times
- Retinal haemorrhages in an infant (shaken baby)
- Severe head injuries unrelated to a motor vehicle accident
- Administration of alcohol or sedative drug

proportionally higher than for the same injury in an adult.

Immobilisation

Simple splinting is usually effective owing to less soft tissue. Vascular compromise is an acute emergency and needs urgent attention. A single attempt to reduce a fracture followed by simple splinting is usually sufficient.

CHILD ABUSE

Child abuse and neglect occur in boys and girls of all ages, in all racial groups and at all socioeconomic levels. There are various and complex reasons why parents abuse their children. Children may be abused by either the mother or the father. One parent is usually the active batterer, while the other passively accepts the battering. If physical abuse is suspected (Table I) the child should be referred to the most appropriate, available local agency for attention. Ensuring the child's immediate physical safety is of paramount importance. There are various organisations that can assist; ideally the emergency unit should have referral protocols in place.

Further reading

American College of Surgeons. *Advanced Trauma Life Support for Doctors*. 6th ed. Chicago: American College of Surgeons, 1997: 355-375.
Carney NA, Chesnut R, Kochanek PM, *et al.* Guidelines for the acute medical management of severe traumatic brain injury in infants, children, and adolescents. *Pediatr Crit Care Med* 2003; **4**(3) (Suppl): S9-S11.
Lewis S. *An Adult's Guide to Childhood Trauma. Understanding Traumatised Children in South Africa*. Cape Town: David Phillip, 1999: 92.
http://www.medpharm.co.za/safp/2001/aug01/truncal.html.

IN A NUTSHELL

Children are physiologically and psychologically different from adults. These differences have an effect on the way children react to trauma. Consideration must be given to the structural differences, unique anatomy and physiology when assessing injuries in children.

The child has the added task of growth, as well as recovery, and cognisance should be taken of the long-term effects of trauma on the injured child and the family.

Children are vulnerable to abuse and a high index of suspicion must be maintained to recognise the child at risk of non-accidental injury.