Management of the multiply injured child

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Abstract

Injury is the commonest cause of death and morbidity in childhood and accounts for most attendances at paediatric emergency departments. However, the incidence of major trauma in UK children remains low. Optimal management of the multiply injured child relies on anticipation and preparation. This should be followed by a consistent and structured response from healthcare professionals. Initial management involves a primary survey with resuscitation using an 'ABC' approach and treatment of life-threatening injuries as they arise. The details of this are outlined in this review which also highlights important child-specific factors. Once stabilised, injured children must be assessed by secondary survey and, if necessary, transferred to an appropriate tertiary unit. Support from regionalised trauma networks and ongoing training for staff is paramount in optimising outcome of the multiply injured child.

Keywords injury; major haemorrhage; primary survey; resuscitation; secondary survey

The epidemiology of injury in children

An important global challenge

Injury is the commonest cause of death and morbidity in children. Worldwide >700,000 children under 15 years die each year because of accidental injury. Younger children, 0–5 years of age, are most commonly injured following a fall. They are therefore more likely to sustain a head injury, which accounts for 50% of injuries sustained in those under 1 year. Even in older children falls are the most common cause of non-fatal accidental injuries. Road traffic accidents (RTAs) are the biggest killer and account for over 60% of all childhood deaths.

Injury in the developed world

Whilst it is still common, injury is a less frequent cause of death in children in developed countries. Over 2 million children attend UK emergency departments with injuries each year. In 2012 over 700 children were treated for severe injuries (injury severity score >15) in England and Wales, of which 56 died, with many more having died at the scene.

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Injury prevention and non-accidental injury

Thanks to successful injury prevention measures, the mortality and morbidity from accidental injury continues to decrease but their impact remains significant. As safety improves, accidental injuries decline but the rates of inflicted or non-accidental injury (NAI) remain relatively constant. There is a peak incidence of severe injury in infants under 1 year, sadly often as a result of NAI. Research by the NSPCC published in 2011 revealed that 1.2% of children under 11 years, and 6.9% 11–17 years have been victim to severe physical abuse. It is important to be mindful that NAI in children often is presented initially as 'accidental'. Following stabilization a careful history is required to determine whether significant injuries such as fractures are plausible given the child's developmental age or the history of mechanism described.

Minimizing the impact

Improving outcomes with training, research, guidelines and concentration of expertise

Optimal management of the multiply injured child relies on anticipation and preparation followed by a standardised, consistent and structured response by healthcare professionals. Since the late 1970s, and the inception of Advanced Trauma Life Support (ATLS), this standardised management of critically injured patients has led to improved outcomes. ATLS and other equivalent courses such as European Trauma Course have become a mandatory part of training for some specialities. Paediatric trauma poses different challenges to adult trauma and these are comprehensively addressed in ATLS and other courses such as Advanced Paediatric Life Support (APLS), Paediatric Advanced Life Support (PALS) and the European Paediatric Life Support (EPLS). All these courses promote a systematic approach and have a shared language. The 'ABCDE' approach (see below) facilitates rapid, structured assessment and communication between team members.

There have also been significant advances in the delivery of trauma care over the past decade as lessons learnt from conflict internationally have been translated into civilian practice. Alongside this, expertise has been concentrated following the development of major trauma networks in the UK. Although the precise cause is sometimes difficult to establish, outcomes for children suffering trauma in the UK continue to improve.

As the incidence of major trauma in children is relatively low, it is important to keep skills of the team honed with regular simulation scenario training sessions in individual departments, so that when real trauma presents, responses are honed. The structured preparation and response to the multiply injured child are outlined below. More detailed information can be obtained from the manuals for the courses mentioned above.

Preparation

If you fail to prepare, prepare to fail

As soon as the injured child is expected, prepare. The trauma team should be rallied. This team should comprise a designated team leader, an experienced anaesthetist, surgeons and other emergency department and paediatric staff. It is better that a team member is called and then leaves after the primary survey, than for there to be a delay in their attendance. The team leader should assign roles and take a step back to observe and coordinate the resuscitation.

Once roles are established then it is helpful to run through a few basic checks. Equipment should be checked to ensure that it is available and operational. Drugs and fluids which are likely to be required should be prepared. If the age of the child is known then it is possible to estimate the child's weight using one of several formulae (see Box 1). Any history given by those at the scene should alert the team to potential injuries, bearing in mind the mechanism and the different effect this may have on the child given variations in their size and relative anatomy. A car bumper, for example, may cause lower limb injuries in an older child, but significant chest or abdominal trauma in a younger child.

Response

Primary survey and resuscitation

Always start with oxygen: *Give all multiply injured children high-flow oxygen, initially via a face mask with a rebreathi bag.*

The primary survey of the child involves a rapid, sequential assessment with simultaneous management of life-threatening problems as they arise, remembering to anticipate problems at each step so they can be managed swiftly and appropriately. It follows the simple adage of <C>'ABC'. Regular re-evaluation, especially after an intervention is essential.

<C> is for catastrophic external haemorrhage

Addressing any exsanguinating haemorrhage is the immediate priority in trauma. Apply pressure or use a tourniquet. Early transexamic acid (15 mg/kg) improves outcomes and should be given as soon as possible. It is now often given pre-hospital.

A is for Airway and Assume cervical spine injury

In the multiply injured child, attention must be given to the possibility of cervical spine injury. Where possible, immobilization (see Box 2) should be maintained until any injury has been cleared. Thankfully cervical spine injury is rare in children with just nine children sustaining a significant injury in 2013 across the UK. However the consequences are often devastating with damage to the upper part of the spinal cord being most common.

Assess the patient's airway by looking, listening and feeling. Look for any obvious obstruction and remove it if possible and safe to do so without causing further harm. Never perform a blind finger sweep. Observe chest and abdominal movement. Auscultate for breath sounds. Open the airway with positioning of the child and manoeuvres that do not compromise cervical immobilisation, i.e. jaw thrust. Infants have a flat occiput and short neck and require the neutral position to open their small, anterior airway. Padding under the shoulders may be necessary to achieve this. Young children require the sniffing position.

Use airway adjuncts if required and tolerated, such as an oropharyngeal airway. This is inserted directly as it lies in position and is not rotated during insertion as in adults. A tongue depressor can assist insertion. Avoid a nasopharyngeal airway if there is a risk of basal skull trauma or facial injuries. If the airway is or is likely to become compromised, establish a definitive airway by inserting an endotracheal tube (ETT) as quickly and safely as possible. Indications for endotracheal intubation are given in Box 3.

The appropriate ETT size can be estimated using the formula:

$$\text{Internal diameter (mm)} = (\text{Age}/4) + 4$$

Methods of estimating weight in an injured child

Children vary considerably in size and, therefore, doses of fluids and drugs, DC shock voltage and equipment size must be titrated to weight. This must be worked out quickly for the injured child, so as not to delay potentially life-saving treatment. Tools have been developed to assist the team in estimation. The most widely used formula based on age to give a weight in kilograms is:

$$\text{Weight (kg)} = (\text{Age} + 4) \times 2$$

Recent research showed that this underestimated the weight per age of a modern childhood population with increasing weight trends and obesity and proposed new formulae. APLS therefore now advocate the use of the following:

1–12 months: $(0.5 \times \text{age in months}) + 4$

1–5 years: $(2 \times \text{age in years}) + 8$

6–12 years: $(3 \times \text{age in years}) + 7$

However, plasma levels of drugs depend on numerous other factors than just actual body mass, including mode of administration, body temperature and pathophysiology. In fact, as most resuscitation drugs are hydrophilic, lean body mass may be more important than actual body mass. Having one easily remembered formula may be more beneficial than calculating an accurate weight. The Resuscitation council (UK) and European Resuscitation Council courses therefore still advocate the use of: weight (kg) = (age + 4) × 2.

An alternative to formulae is to use the Broselow tape, originally invented by an American family physician. This is based on length and weight statistics to reduce errors in estimating parameters. The tape is lined up next to the child and the child's length corresponds to colour-coded information with appropriate fluid volumes, drug doses and equipment, such as tracheal tube (TT), which are kept in matching colour-coded drawers of the resuscitation trolley. If a child is longer than the tape, adult values can be used. Although anecdotally easy to use, it is limited by availability and cost, and has also been found to underestimate the weight of todays' child.

Box 1

Spinal immobilisation

Immobilise the cervical spine using a trained person's hands with bimanual in-line technique, whereby hands are placed either side of the head and neck, keeping the spine neutral and still.

There has now been a move away from routine application of a hard collar in children. Use of head blocks and tape are still an important adjunct until the cervical spine has been cleared of injury. This can be done clinically if there is no midline cervical tenderness, no focal neurological deficit, the Glasgow Coma Scale (GCS) is 15/15 and there are no distracting injuries.

Otherwise imaging and further evaluation is required and immobilisation continued pending these. An uncooperative child who is frightened or hypoxic and confused should *not* be fought with to achieve immobilisation, as more harm than good may arise. Parental presence and reassurance of the injured child are important.

Box 2