

INTRODUCTION

Every year approximately 700 children die as a result of accidents in England and Wales.¹ About half of them die as a result of motor vehicle incidents. Fatalities as a result of cycle and pedestrian incidents are most common in children.

While the law states that all children should be restrained in vehicles,^{2,3} this is often not complied with and ejection also causes a significant number of deaths and serious injuries.

A third of childhood fatalities occur in the home. Burns and falls are the main cause of death in this environment.

It is a truism that **MOST** child deaths could be regarded as avoidable if injury prevention methods had been rigorously applied.

The basic principles of the ABC approach to paediatric trauma management are very similar to those of the adult. There are, however, areas of difference in terms of anatomy, relative size and physiological response to injury. This guide is intended to highlight those differences.

BASIC TRAUMA APPROACH

Scene:

- triage if more than one casualty.

Situation:

- observe and note mechanisms of injury (MOI)
- always look for evidence of children such as toys or child seats that may indicate that a child has been ejected from a vehicle or wandered off from the scene but may still require medical attention.

ASSESSMENT

Primary Survey – Rapid In-depth primary survey (60-90 seconds)

- **A**irway with cervical spine control (see C-spine collar)
- **B**reathing
- **C**irculation
- **D**isability
- **E**xposure, Examine and Evaluate

The management of a child suffering a traumatic injury requires a careful approach, with an emphasis on explanation, reassurance and honesty. Trust of the carer by the child makes management much easier.

If possible, it is helpful to keep the child's parents/carers close by for reassurance, although their distress can exacerbate that of the child!

Stepwise Primary Survey Assessment

As for all trauma care, a systematic approach, managing problems as they are encountered before moving on.

Airway Assessment

Initial spinal immobilisation is mandatory using manual methods at first; subsequent use of a correctly sized cervical collar, head blocks and forehead/chin tapes on a long board is ideal, although, a compromise using less formal measures, such as manual immobilisation may be necessary (*refer to neck and back trauma guideline*).

In a small child, the size of the occiput may result in the head being flexed forward and it may be appropriate to consider using a small amount of padding under the shoulders to return the head to the neutral position.

Airway obstruction may result from vomit, blood or foreign material. Gentle aspiration under direct vision should be used. Blind finger sweeps are contraindicated.

If an airway adjunct is needed, then an oropharyngeal airway can be inserted directly with down pressure on the tongue. A nasopharyngeal airway can also be used, but with adenoidal tissue there is the potential for bleeding.

Burns are a special case (*refer to burns and scalds in children guideline*). Looking for soot in the nostrils and mouth, erythema and blistering of the lips with a hoarse voice may indicate potential airway injury.

There may be a need to progress to endotracheal (ET) intubation, but only if trained and airway reflexes are absent. If airway reflexes are present then rapid sequence intubation will be required; either initiate emergency transfer to further care or bring such skills to the scene e.g. immediate care Doctor (*refer to paediatric resuscitation charts for ET sizes*). The next step on the airway ladder is needle cricothyroidotomy.

Administer high concentration oxygen (O₂) (*refer to oxygen protocol for administration and information*) via a non-rebreathing mask, using the stoma in neck breathing patients. High concentration O₂ should be administered routinely, whatever the oxygen saturation, in patients sustaining major trauma and long bone fracture.

High flow oxygen through a tightly fitting oxygen mask with a reservoir is the ideal, although a compromise, even to the point of the mask being held close but not in contact may be needed. All efforts should be made to increase the level of inspired oxygen.

Breathing Assessment

The chest wall in a child is very elastic and it is quite possible to have significant injury without there being apparent external signs on the chest wall.

The chest should be inspected for pattern bruising and for the rate and adequacy of breathing. Chest wall movement and the presence of any wounds should be sought.

Palpation may reveal some crepitus suggesting fractured ribs or surgical emphysema. Poor excursion may suggest an underlying pneumothorax.

Auscultation should reveal good bilateral air entry and the absence of any added sounds. Areas to be listened to:

- above the nipples in the mid-clavicular line
- in the mid-axilla under the armpits
- at the rear of the chest, below the shoulder blades.

Table 1 – Normal Respiratory Rate

Age	Respiratory Rate
<1 year	30 – 40 breaths per minute
1–2 years	25 – 35 breaths per minute
2–5 years	25 – 30 breaths per minute
5–11 years	20 – 25 breaths per minute

Assess for a tension pneumothorax (*refer to thoracic trauma guideline and below*)

Remember to consider a tension pneumothorax if there is:

- severe and increasing breathlessness
- absent or greatly reduced breath sounds on one side of the chest
- distended neck veins (difficult in children)
- in ventilated patients, increasing resistance to ventilation with reduced or absent air entry on one side of the chest
- tracheal deviation (late sign).

Assess for a haemothorax (*refer to thoracic trauma guideline*).

For sucking chest wounds (*refer to thoracic trauma guideline*).

Inadequate ventilation resulting in hypoxia and hypercarbia may be tolerated for a prolonged period before rapid progression to cardiac arrest. Treatment should be based on restoring ventilation, possibly by augmenting respiratory effort with bag-valve-mask ventilation using high flow oxygen.

- consider assisted ventilation at a rate equivalent to the normal respiratory rate for the age of the child (*refer to paediatric resuscitation charts for normal values*) if:
 - SpO₂ is <90% on high concentration O₂
 - respiratory rate is <half normal or >three times normal
 - expansion is inadequate.

Circulation Assessment

A normal mental state with good skin colour and temperature are useful crude indicators of adequate circulation. A normal capillary refill time (<2 seconds) can be another useful indicator.

In the first instance, assess for evidence of significant external haemorrhage and apply direct pressure to stop any loss.

Feel for radial or brachial pulse rate and volume (depending on age and see table). Tachycardia with a poor pulse volume suggests shock. Bradycardia can also occur in the shocked child but is a **PRE-TERMINAL SIGN**.

Table 2 – Normal Heart Rate

Age	Heart Rate
<1 year	110 – 160 beats per minute
1–2 years	100 – 150 beats per minute
2–5 years	95 – 140 beats per minute
5–11 years	80 – 120 beats per minute

Immobilisation of major long bone fractures on a longboard or by application of traction to femoral fractures in older children can help control bleeding.

Vascular access should be gained, where possible, en-route to hospital, not prolonging the time on scene. The widest possible cannula for identifiable veins should be used.

The administration of a fluid bolus at a rate of 20ml/Kg body weight has been the standard treatment while observing for a physiological response. This was then repeated until a physiologically normal state was restored. This has become controversial with the adoption of the concepts behind hypotensive resuscitation in adults⁴ and recent paediatric guidelines now recommend **5ml/Kg** bolus administration until an effect is observed.

Disability / Level of Consciousness Assessment

Note: the initial level of consciousness on the AVPU Scale and the time of this assessment, together with information on the pupil size, shape, symmetry and response to light, and whether the child was moving some or all limbs.

- A** Alert
- V** Responds to voice
- P** Responds to painful stimulus
- U** Unresponsive

If the child does not score **A** then the patient should be considered **time critical**. A formal GCS (**see below**)⁵ en-route may be valuable to the receiving hospital but should only be recorded if it can be accurately done. A misleading score is worse than a simple AVPU with a description of progression.

If there is no movement, then ask the patient to “wiggle” their fingers and toes, paying particular note to movements peripheral to any injury site.

Stepwise Disability Management

Confusion or agitation in the injured child may arise directly from a head injury, but equally may be secondary to hypoxia from airway impairment, impaired breathing or hypoperfusion due to blood loss and shock.

The management of any child with changed level of alertness is based on ensuring an adequate airway, oxygenation, ventilation and circulation.

A plasma blood glucose level in a child with a changed level of alertness is mandatory and the need is not restricted to those with diabetes. If the child is hypoglycaemic then for treatment **refer to glycaemic emergencies in children guideline**.

Evaluate

Children are prone to rapid heat loss when exposed for examination and immobilisation during trauma care. Investing in protecting the child from a cold environment during the primary survey is very important. Exposing a child can also have lasting negative psychological effects.

EVALUATE patient as TIME CRITICAL or NON-TIME CRITICAL at the end of the rapid **PRIMARY SURVEY**, on the basis of the following criteria:

A and B problems should have been identified and addressed as encountered during the primary survey. In the presence of any difficulties, rapid packaging and urgent transport, immobilised on a long board, to nearest suitable Emergency Department is indicated.

Consideration should be given to the need for a **HOSPITAL ALERT** en-route.

If there is no apparent problem with the Primary Survey then the situation may be less time critical and there may be value in a more careful Secondary Survey. This should take no more than a few minutes and should not significantly delay the transfer to definitive care. A large part can be done while in transit to hospital.

Secondary Survey

This is a systematic and careful review of each part of the injured child looking for less clinically critical and/or occult injuries.

Head:

- re-check the pupil size, shape, symmetry and response to light
- assess and palpate for bruising, lacerations or tenderness over the scalp. Significant blood loss can occur through a scalp laceration and this should be guarded against.

Conscious level:

- assess the neurological status using the standard Glasgow Coma Scale (**refer to Glasgow Coma Scale – Appendix 1**)
- in smaller children the speech component may require modification to allow for their relative lack of maturity and this is also listed
- a GCS of <8 is the definition of coma, however a GCS of <12 in a child post-trauma that is not rapidly returning to normal mandates meticulous airway management, optimising of the ventilation and cerebral perfusion and a formal investigation of brain injury using a computerised tomography (CT) scan.

Neck:

- it is often impractical to clinically clear a cervical spine of a child in the pre-hospital environment.
- immobilisation in the older and more cooperative patient (*refer to neck and back trauma guideline*).

Chest:

- changes to the respiratory function and chest may evolve with time. At this stage, a more thorough assessment is indicated, looking particularly for evidence of pattern bruising, rib fractures, instability and surgical emphysema (skin “crackling”)
- listening for breath sounds needs to be in all areas. A trauma patient is often supine and the pneumothorax will be anterior and, more deceptively, the haemothorax will be more posterior.

Abdomen:

- pattern bruising, particularly in relation to the use of a lap seat belt is helpful
- feeling for tenderness in all four abdominal quadrants is informative but an awareness that many serious abdominal injuries have a delayed presentation is important
- triage is dynamic.

Pelvis:

- traditionally the pelvis was “sprung” by lateral compression or front to back pressure to assess its stability. It is now felt that the risk of exacerbating the bleeding outweighs the benefits of compressing the pelvis to assess for potential fractures. Such injuries should be assumed from the mechanism and other associated pattern injuries.

Limbs:

- look for wounds and evidence of fractures. Dress and immobilise any injuries found. A simple MSC check for **ALL** four limbs may be valuable (*see below*):

M	MOTOR	Test for movement
S	SENSATION	Apply light touch to evaluate sensation
C	CIRCULATION	Assess pulse and skin temperature

ANALGESIA IN TRAUMA

Injured children may require analgesia (*refer to management of pain in children guideline*) once their life threatening problems have been resolved in the same humanitarian way adults do. This should be via the IV route and titrated to effect, administer morphine sulphate (*refer to morphine drug protocols for dosages and administration*).

NOTE: paediatric drug doses are expressed as mg/kg, (*refer to specific drug protocols for dosages and information*). These protocols **MUST** be checked prior to **ANY** drug administration, no matter how confident the practitioner may be.

SUMMARY

Read the scene for mechanism of injury and manage in a manner similar to the adult trauma process. Remember that there are anatomical and physiological differences as the assessment progresses through the airway, breathing, circulation and disability areas.

Children can physiologically compensate very well and so can conceal serious injury unless a high index of suspicion is retained. Agitation and/or confusion may indicate primary brain injury, but could just as readily be due to inadequate ventilation and cerebral perfusion.

DEFG (**DON'T EVER FORGET GLUCOSE**) in terms of assessment of an altered mental state.

Key Points – Trauma Emergencies in Children

- Detect time critical problems early.
- Toys or child seats may indicate that a child has been involved in the incident and ejected from a vehicle or wandered off from scene.
- Drug doses are expressed as mg/kg. Refer to specific drug protocols for dosages and information. These protocols **MUST** be checked prior to **ANY** drug administration, no matter how confident the practitioner may be.
- Continuously re-assess ABCD, AVPU.
- Provide hospital alert.

REFERENCES

- ¹ Quan L, Seidel JS, editors. *Pediatric advanced life support: instructor's manual*. Dallas: American Heart Association, 1997.
- ² The Motor Vehicles (Wearing of Seat Belts by Children in Rear Seats) Regulations 1989:1989 No. 1219
- ³ The Motor Vehicles (Wearing of Seat Belts by Children in Front Seats) Regulations, 1993 1993 No. 31
- ⁴ Revell M, Porter K, Greaves I. Fluid Resuscitation in Pre-hospital trauma care: a consensus view. *Emergency Medical Journal* 2002;19(494-98).
- ⁵ Teasdale G, Jennett B. ASSESSMENT OF COMA AND IMPAIRED CONSCIOUSNESS: A Practical Scale. *The Lancet* 1974;304(7872):81-84.
- ⁶ Stiell IG, Wells GA, Vandemheen KL, Clement CM, Lesiuk H, De Maio VJ, et al. The Canadian C-Spine Rule for Radiography in Alert and Stable Trauma Patients. *JAMA* 2001;286(15):1841-1848.

METHODOLOGY

Refer to methodology section.

APPENDIX 1 – Glasgow Coma Scale and modified Glasgow Coma Scale

GLASGOW COMA SCALE	
Item	Score
Eyes Opening:	
Spontaneously	4
To speech	3
To pain	2
None	1
Motor Response:	
Obeys commands	6
Localises pain	5
Withdraws from pain	4
Abnormal flexion	3
Extensor response	2
No response to pain	1
Verbal Response:	
Orientated	5
Confused	4
Inappropriate words	3
Incomprehensible sounds	2
No verbal response	1

MODIFICATION OF GLASGOW COMA SCALE FOR CHILDREN UNDER <4 YEARS OLD

Item	Score
Eyes opening:	as per adult Scale
Motor response:	as per adult Scale
Best verbal response:	
appropriate words or social smiles, fixes on and follows objects	5
cries, but is consolable	4
persistent irritable	3
restless, agitated	2
Silent	1