

# Paediatric Trauma Resource Manual

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**Disclaimer:**

It should be noted that this resource manual reflects what is currently regarded as a safe and appropriate approach to care. However, as in any clinical situation there may be factors which cannot be covered by a single resource manual, therefore this manual should be used as a guide, rather than as a complete authoritative statement of procedures to be followed in respect of each individual presentation. It does not replace the need for the application of clinical judgement to each individual presentation.

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## Introduction

This package was developed as a resource tool for staff working in emergency departments who care for paediatric patients injured as a result of trauma. It is important to be conversant with the anatomical, physiological and psychological differences unique to the paediatric population across the age continuum. This resource manual is not all encompassing and should be used in conjunction with other resource material available. Web links to other resources are highlighted throughout the package.

**If in doubt or confused about a child's condition, signs or symptoms; consult with someone more experienced.**

**Paediatric specialists are very approachable and prefer to be called too early rather than too late.**

## Significance

"Trauma is the leading cause of death in children aged 1 to 14 years in the developed world. Traumatic injury is a major cause of disability."<sup>1</sup>

Paediatric trauma is a specialist area of trauma care. It is important to identify in the paediatric population any risk factors, as inadequate evaluation and inappropriate treatment contributes to approximately 30% of early deaths in severe trauma. Head injury is the most common cause of morbidity and mortality in paediatric trauma and children are particularly susceptible due to their relatively large heads, lack of neck control and the plasticity of brain tissues. Multi system trauma is typical in children who present with severe traumatic injury. Due to their smaller body mass, greater energy force is being applied per unit of body area.<sup>1</sup>

**The goal of treatment is to ensure the survival of the child, treat the injury appropriately and prevent physical and psychosocial complications so that the child and family can resume a normal lifestyle.**

## Aims of the manual

- Recognise the differences between children and adults
- Recognise the importance of the Mechanisms of Injury (MOI) and the influence it will make on triage and treatment decisions
- Recognise the importance of communication between the child, parents and staff
- Recognise the importance of **OBSERVATION, OBSERVATION** and **OBSERVATION**

"Children are at risk of injury, particularly road trauma, due to their inquisitive and often unpredictable behaviour. As children develop, their inquisitive behaviour often develops into risk taking behaviour as part of the process of learning and development."

"Young children are less visible to drivers and less predictable around roads than other pedestrians."<sup>2</sup>

## Mechanisms Of Injury (MOI)

- Motor Vehicle Accident (MVA) ★
  - Major deformation of the vehicle
  - Patient projected from the vehicle
  - Fatality within any of the vehicles
- Fall < 1 m ★
- Fall 1 – 5 m ★
- Fall > 5 m ★
- Child cyclist/pedestrian hit by a vehicle travelling at > 30 km/hr ★
- Airbags deployed into child. Inflating airbags can violently impact the child with such force to cause facial trauma, upper extremity fractures, intra-abdominal injury, cervical spine injury and partial to complete decapitation
- Non-Accidental Injury (NAI) ★<sup>3</sup>
- Motor Bike Accident
- Burns

★ = in the top 6 mechanisms of injury resulting in significant injury

## Assessment considerations

It is very important to be aware of the anatomical and physiological characteristics that make children unique.<sup>1</sup> Paediatric trauma care differs from that of adults, as children sustain different injury patterns.

When assessing an injured child it is important to understand that:

- Size and relative body proportions change with age
- Treatment and management is related to **age** and **weight** \*
- Children have special psychological needs<sup>4</sup>

**\* If the weight is not known use the following formula to determine same:**

$$\text{Weight in kg} = (\text{age in years} + 4) \times 2$$

(From 1 year to 10 years of age)<sup>5</sup>

**Use the Primary, Secondary and Tertiary Survey - A, B, C, D, E approach when assessing trauma patients (see pages 8 to 19 of this manual).**

## What's different about children?

Children are **NOT** mini adults and have significant anatomical and physiological differences to adults. Health professionals need to be mindful of these many differences.

### Anatomical characteristics

- Small body size
- Large surface area : mass area ratio
- Relatively large head : body mass ratio
- Compliant, elastic skeleton
- Airway characteristics
- Vital signs vary with age <sup>4</sup>

### Psychosocially

Security in a child's world comes from the parents. Consideration of this fact must be taken into account when treating or nursing children, regardless of the age or developmental level of a child.

As well as the physical trauma a child may be experiencing, the psychological stress may in turn lead to physiological complications:

- The release of catecholamines (epinephrine and norepinephrine) can lead to an increase in blood pressure and heart rate.
- Cardiac glycogen becomes depleted during periods of stress and the release of vasopressin may result in a decrease in urine output.
- Blood coagulation can accelerate and increase fibrinolysis.
- Basal metabolic rate may increase, therefore body temperature regulation may be more difficult.
- Adrenocorticotrophic hormone (ACTH) is released causing increased secretion of glucocorticoids, which can lead to hyperglycaemia, suppressed immune system and inflammatory reactions. <sup>6</sup>

### Developmentally

Issues to be considered according to developmental age are:

**Newborns and infants** Do not like separation from their parents/caregivers and have minimal stranger anxiety.

**Toddlers** Suffer separation anxiety from parents/caregivers, understand more than they can communicate, frighten easily and have a fear of needles and pain.

**Pre-schoolers** Suffer separation anxiety but can handle longer periods of separation; have a fear of blood, pain and permanent disfigurement; are curious, modest, communicative and can be cooperative.

**School age** Usually cooperative but like their opinions heard; fear blood, pain, disfigurement and permanent injury and are modest.

**Adolescents** Want to be treated as adults and generally feel that they are indestructible, but fear permanent injury, disfigurement, death, loss of autonomy and loss of peer acceptance.

Overall these fears can be alleviated by:

- Encouraging parental involvement
- Communication (appropriate for age) - ie get down to a child's eye level to speak, as it can be intimidating for the child if you stand over them
- Be honest and explain procedures - one step at a time
- Respect their feelings of modesty
- Distraction/play therapy appropriate for age
- Touch, cuddles from the family
- Siblings
- Where possible treat children in a location area where they will not be subjected to witnessing treatment given to a seriously ill or injured adult, as this can cause additional emotional trauma.

Effective care and management requires the appreciation of the intimate relationship of a child to the family and the provision of psychological support.<sup>6,7</sup>

**Alert: Encourage parents/caregivers to be present if possible.**

**Remember: Children are generally scared.  
Be calm and quiet.  
Be gentle (emotionally and physically).**

## Universal Precautions

“Universal Precautions” is the term used by the health industry to describe the set of measures introduced to allow health staff to safely handle material that may carry blood or body fluids infected with diseases.

The main principles are washing hands, care of intact skin, protection of damaged skin, proper handling and disposal of sharp objects, good hygiene practices and careful handling of all blood and body fluids.

Personal protection equipment (PPE) such as gloves, waterproof aprons/gowns and masks or protective eyewear must be worn where appropriate.

**ALL TRAUMA TEAM MEMBERS ARE TO WEAR THEIR PPE.<sup>8</sup>**

## Primary survey

The primary survey is the initial assessment for life-threatening injuries in the trauma patient using the mnemonic **A, B, C, D, E**. When assessing a child, be aware that children often **compensate** for their injuries by maintaining respiratory effort and circulation. However, without recognition and then correction of the underlying problem they may deteriorate rapidly. Ideally, paediatric patients involved in major trauma should be placed on a cardiac monitor, receive supplemental oxygen and have constant reassessment of vital signs and oximetry. It is important to remove all garments to enable adequate assessment of the injuries.

### **A - Airway with cervical spine stabilisation** (look, listen, feel for air movement)

It is important to assume that “**SCIWORA**” **Spinal Cord Injury Without Radiologic Abnormality** exists in **ALL** trauma patients until proven otherwise. Spinal immobilisation must be a concurrent priority in initial airway management of a paediatric trauma patient.

### **B - Breathing and ventilation** (respiratory rate, effort, ventilation, air entry).

### **C - Circulation and haemorrhage control** (heart rate, pallor, capillary refill, blood pressure). Blood Pressure measuring is important for all infants and children.

### **D - Disability – neurological deficit screening**

- **A Alert** + Glasgow Coma Score (GCS)
- **V Voice**
- **P Pain**
- **U Unresponsive**

### **E - Exposure – environmental control:** Complete examination of the child (undressed) with “protection against hypothermia and hypoglycaemia”. <sup>1,4</sup>

**Don't forget to keep the child warm, sweet and pink.**

## A / B: Airway and Breathing

### Why children are different

- Obligatory nose breathers – up to approximately six months of age.
- Diaphragmatic breathers.
- Large tongue / small mouth.
- Larynx more cephalad and anterior, making visualisation of the vocal cords more difficult.
- Shorter trachea.
- Narrower airway at the cricoid – just below the larynx. There is a risk of intubation of right bronchus.
- Larger occiput.

*Note:* By 8 years of age children's anatomy and physiology approximates that of adults. <sup>1,6</sup>

### Signs of airway obstruction

- Restlessness.
- Cyanosis.
- Low SaO<sub>2</sub>.
- Respiratory distress.
- Use of accessory muscles.
- Wheeze.
- Stridor.
- Visible swelling of the tongue, pharynx or neck.
- Dysphonia. <sup>9</sup>

### Management:

- Immobilise the cervical spine.
- Give O<sub>2</sub> at 10 litres/min by mask to any severely ill child and to any child who has suffered significant trauma.
- Open and clear the airway – establish a patent airway for the delivery of oxygen – chin lift and jaw thrust, Guedel airway.
- If suctioning is required – gently suction the pharynx via a soft 10 FG catheter (infants < 1 year of age) or a Yankauer sucker (older children) under direct vision using a laryngoscope or a tongue depressor – try not to touch the mucosa, as this may cause bleeding or laryngospasm.
- Insert oral/nasal tube - (nasal tube if appropriate, but **NOT** if head injury suspected).
- Ventilate with facemask support.
- Intubate if necessary (only if experienced professional available). <sup>9</sup>

**Note: If facial injuries sustained be aware that loose teeth, blood and vomitus may obstruct the airway and clearance of the upper airway is a priority. A chest xray may be indicated to exclude aspiration of dental fragments or foreign bodies.** <sup>9</sup>

## 1 Jaw thrust:

Due to a child's shorter neck, small anterior larynx, floppy epiglottis, short trachea and large tongue the **jaw thrust manoeuvre** is used to improve the airway:

- Placing fingers behind the angles of the mandible bilaterally, lift the jaw forward towards the tip of the nose.
- Technique may be easier if the elbows of the person performing the jaw thrust are resting on the bed or the surface the child is lying on.



Jaw thrust manoeuvre

(Picture reproduced from Royal Children's Hospital Paediatric Trauma Manual, with their permission.)

## 2 Face masks

- Ideally should be **clear** so you can see the child's colour and the possible presence of vomit.
- Fit should create a tight seal. <sup>9</sup>

## 3 Oropharyngeal airway insertion

*Indication:*

- Jaw thrust manoeuvre has failed to correct airway obstruction.
- Oxygenation needs to be optimised prior to intubation.

*Sizing:*

- Measure from the centre of the incisors to the angle of the mandible, when laid on the face concave side up. <sup>9</sup>



Oropharyngeal airway sizing

(Picture reproduced from Royal Children's Hospital Paediatric Trauma Manual, with their permission.)

## Procedure

- Pre-lubricate with either patients own saliva or a small amount of lubricating jelly.
- Insertion:
  - \* **< 8 years** – insert under direct vision, **concave side down**, using a tongue depressor.
  - \* **> 8 years** – insert an adult size, **concave side up**, pass to back of palate then rotate 180° to concave side down. <sup>9</sup>

## Indications for intubation

- Airway obstruction persists despite oropharyngeal (Guedel) airway for definitive airway stabilisation.
- Adequate ventilation not possible via bag and mask ventilation.
- Needs definitive airway protection.
- Unresponsive to pain GCS < 8.
- Neurologically flaccid, decerebrate/decorticate posturing.
- Needs prolonged ventilation.
- Respiratory burn injury.

**In trauma, oral intubation is always used.** <sup>9</sup>

## Remember

- Cuffed tubes are **NOT** used in children under 8 years of age as cuffs can cause pressure necrosis on the narrow cricoid cartilage.
- **Continue ventilating any child after cardiac arrest** (including SIDS and near-drowning), even if they appear to be breathing adequately. <sup>9</sup>
- Children can have **loose teeth** at some stages of their development.

## Bag and mask ventilation

Laerdal Air Viva Circuits are available in two sizes:

500ml: **Paediatric 2.5 to 25 kg**

1500ml: **Adults > 25 kg**

## Note: may need two operators

“Resuscitation bags used for ventilation of full term newly born infants, infants and children should have a minimum volume of 450 to 500 ml.” <sup>10,11</sup>

## Technique:

- Place patient in the supine position.
- Fix the appropriate-sized mask to the bag.
- Connect the oxygen tubing with 15 litres flow rate.
- Ensure equipment is functioning correctly (inflation of reservoir and opening of leaf-flap valve on squeezing of bag – ideally done as a routine check).
- Apply the mask to the patients face, establishing a good seal.
- Assess effectiveness of ventilation, then continue.  
(May need to increase or decrease application of jaw thrust). <sup>9</sup>

## Cervical Spinal Immobilisation (CSI)

CSI is essential where there is the potential of cervical spine or cord injury – the principles include:

- Soft collars do not provide protection to the unstable spine (but may be all that is available for the infant <1 year old).
- Semi-rigid collars (eg Stiffneck®), even when appropriately fitted, allow some flexion/extension movement.
- Lateral support with 'sandbags' or head blocks provides additional support to a semi-rigid collar and may reduce movement.
- Infant occiputs are prominent, resulting in neck flexion when lying supine (unless the head is recessed to accommodate the occiput or the trunk is elevated).
- Manual in-line immobilisation can provide excellent stability and allows reassurance by the staff member to the child, but requires total dedication of the staff member to that specific task.
- Spine boards may be used in the short term to facilitate transfer between trolleys etc, otherwise the patient should lie supine on a trolley/bed with a firm, supportive mattress/base.
- Generally tapes should not fix the patient to the bed, but be placed across the forehead and chin to a spine board or head blocks/'sandbags'; thus allowing prompt rolling in the event of vomiting.
- Log rolling the patient to examine the back or apply a spine board, ideally should be undertaken by several people (preferably three for an infant and four for a child, with an additional person to examine).
- Combative children require urgent reassessment. Check for hypoxia, hypoventilation and pain/fear particularly. Reassure the child throughout. If the child remains combative DO NOT persist with attempts to restrain the child in order to provide spinal 'immobilisation'.
- Other devices like Jordan frames and scoop stretchers may be used to facilitate safe transfer of patients between beds/trolleys/x-ray and scanning tables.<sup>12</sup>

Potential problems – Infants and young children have disproportionally larger heads and lie with the neck in a position of flexion when immobilised flat on a spinal board.

To achieve a neutral position – Place 1 to 2 folded towels under the trunk from the buttocks to the shoulders. The occiput will then be 1 to 2 cm lower than the back, allowing the head to rest in a neutral position.<sup>9</sup>

**The process of 'clearing' a cervical spine requires clinical and radiological evaluation. Clinical staff uncertain about this process should seek early, appropriate consultation with paediatric experts.**

## C: Circulation

### Why children are different

- Normal vital signs vary with age.
- Circulating blood volume dependent on child's size:
  - Neonates 100 ml/kg
  - Infant 90 ml/kg
  - Child 80 ml/kg
  - Adult 70 ml/kg

**Note:** actual **blood volume is small** – therefore small blood losses can cause circulatory compromise.

- Children compensate for large intravascular losses (more than 30%) before becoming hypotensive. **Hypotension is a late and preterminal sign of shock in children.** <sup>13</sup>
- Body water volume is larger – child 70-80%, adult 50-60%. Daily turnover involves more than ½ of the extracellular fluid. In adults only one fifth of the extracellular fluid is exchanged daily – therefore there is greater potential for dehydration in children.
- Infants in the first few months of life have a decreased ability to concentrate urine. Normal urine output for children is 1-2 ml/hr.
- Infants have a higher cardiac output (200 ml/kg/min) than adults (100 ml/kg/min). This increased cardiac output provides for oxygen needs but leaves little cardiac reserve.
- Metabolic needs of children are **twice** that of adults, consequently children have a significant risk of hypoglycaemia as they have high glucose needs and low glycogen stores.
- Due to the higher metabolic rate, children have a higher cardiac output (greater gaseous exchange) and increased oxygen requirements, fluid and caloric demands/kg body weight than adults. <sup>9</sup>

### Circulatory failure or “shock”

Though the pathophysiology of shock doesn't differ remarkably between children and adults the manifestation does. Paediatric patients develop system dysfunction and organ failure in an overwhelming manner rather than the slower, progressive organ failure seen in adults. This is due to their higher metabolic rate and increased metabolic needs as a consequence of trauma. The limited stores of glucose/glycogen quickly depletes and anaerobic metabolism occurs earlier. <sup>1, 14</sup>

### Signs of circulatory insufficiency

	<b>Early</b>	<b>Prehypotensive</b>	<b>Hypotensive</b>
	< 25% blood loss	25-40% blood loss	> 40% blood loss
<b>Cardiac</b>	Weak, thready pulse, tachycardia.	Positive tilt test, tachycardia with weak pulse.	Frank hypotension, tachycardia and/or bradycardia.
<b>CNS</b>	Lethargic, irritable, confused, combative.	Changes in level of consciousness.	Comatose.
<b>Skin</b>	Cool, sweaty, clammy, mottled.	Cyanotic, decreased capillary refill, cold extremities.	Pale, cold extremities.
<b>Kidneys</b>	Decreased urinary output, increased specific gravity.	Minimal urine output.	No urine output.

The number one cause of traumatic shock in children is **hypovolaemia** and management priorities include:

- Appropriate ventilation and oxygenation.
- Restoring haemostasis - fluid resuscitation to maintain perfusion. <sup>15</sup>

### Management of circulation

1. Ensure adequate vascular access
2. Obtain blood specimens
3. Assess and manage haemorrhage
4. Fluid resuscitation
5. Hypoglycaemia
6. Drug administration
7. Reassessment

### Monitor:

- SaO<sub>2</sub>
- Respiratory rate and effort
- Heart rate – monitor with a cardiac monitor
- Capillary refill - if capillary refill > 2 seconds and patient has cold mottled peripheries = peripheral shutdown
- Temperature
- BP (hypotension is a late and preterminal sign of shock in children)

*Note:* Children are susceptible to **hypothermia** due to their large body surface : body mass ratio, therefore temperature must be monitored and maintained at all times. If they are hypothermic treat with warmed IV fluids, “Bair huggers”, space blankets, bonnets on babes, etc - unless a decision has been made to actively cool for cerebral protection. <sup>9,12</sup>

**Circulation: should be assessed by palpation of a carotid, brachial or femoral pulse. External cardiac compression should be commenced if a pulse is not palpable or is < 80 beats per minute in an infant, 60 bpm in a young child or 40 bpm in an older child.** <sup>16</sup>

### 1. Chest compressions

#### Infant < 1year:

Landmark: 1 finger breadth below inter-nipple line

Technique: Two fingers depth – 1/3 of the AP diameter of the chest

Rate: 100 per minute

Ratio of compressions to breaths: **30:2** (1 rescuer) or **15:2** (2 rescuers)

#### Young child - 1 to 8 years of age (inclusive):

Landmark: 1 finger breadth above the xiphisternum

Technique: Heel of one hand-depth – 1/3 of the AP diameter of the chest

Rate: 100 per minute

Ratio of compressions to breaths: **30:2** (1 rescuer) or **15:2** (2 rescuers)

#### Older child – 9 years of age till Puberty

Landmark: Two fingers breadth above the xiphisternum

Technique: Two hands overlaid – as in adults

Rate: 100 per minute

Ratio of compressions to breaths: **30:2** (1 rescuer) or **15:2** (2 rescuers)

**NB: The new born ratio of 3:1 is used at delivery and for the first few hours after delivery only** <sup>9,16</sup>

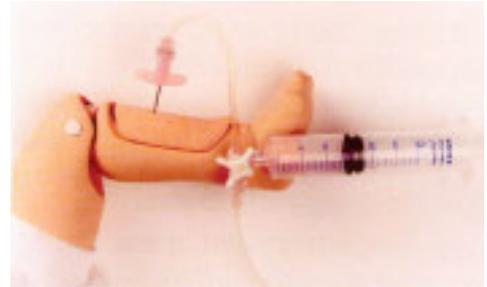
## 2. Ensure vascular access

- At least two large bore cannulae
- If unable to obtain access in 90 secs → insert intra-osseous needle

**Note: Fluid boluses are pumped in.**<sup>9</sup>



Insertion of needle



Intraosseous set up

*(Pictures reproduced from Royal Children's Hospital Paediatric Trauma Manual, with their permission.)*

## 3. Obtain blood specimens

- FBC
- Blood sugar
- Cross-match
- Other as indicated by injuries sustained

## 4. Assess and manage haemorrhage

- Control obvious haemorrhage by direct pressure
- Splint and stabilise fractures
- Small volumes of haemorrhage may result in hypothermia. Practitioners should regularly check any dressings/bandages to assess volume of blood loss.  
**(Remember the scalp, which can be a major source of blood loss in children).**

## 5. Fluid resuscitation

If signs of circulatory compromise are present give as a fluid bolus:

20 ml/kg normal saline  
↓  
↓ reassess  
↓  
20 ml/kg normal saline  
↓  
↓ reassess  
↓  
10 ml/kg packed cells  
(type specific or use O negative)

- ★ Fluids should be warmed using a **blood warmer** – **DO NOT** warm fluids in a **microwave oven**

## 6. Drugs

If hypotension or signs of shock persist after a bolus of 40 ml/kg:

- Give packed cells
- Consider adrenaline<sup>9</sup>

## 7. Reassess

**Remember:** check the **blood glucose** frequently and give **glucose** if necessary as children have low stores of glycogen and high glucose requirements due to their high metabolic rate. Hypoglycaemia left untreated can lead to cardiovascular depression and permanent neurological injury.

**Note:** Children with a head injury are susceptible to cerebral oedema; therefore care must be taken to avoid unnecessary IV crystalloid fluids.

**Note:** Severe cardio-respiratory compromise in children is more often due to unrecognised **HYPOXIA** than unrecognised haemorrhage. <sup>4, 9</sup>

## D: Disability – neurologic screening

### Why children are different

The **Glasgow Coma Score (GCS)** provides the best quantitative measure of a patient's consciousness (but not in other causes of coma where it is simply a descriptive tool to describe the level of consciousness). **GCS has prognostic value for trauma patients.** A modified GCS (with amendments to the assessment of the verbal response) is used for young infants.

### Prognosis in trauma is associated with the *initial GCS*

- GCS 3 – 5 = severe head injury with the likelihood of some permanent impairment
- GCS 6 – 8 = moderately severe head injury, will require ICU and may have permanent impairment
- GCS > 8 = mild head injury, likely to have good outcome

A GCS of 3 or 4 at 24 hrs after injury (assuming this is not caused by sedation in the ICU) is a very poor prognostic sign.

Score	Eye opening	Verbal response	Movement/motor response	Modified GCS for young infants
1	Nil	Nil	Flaccid paralysis	None
2	To pain	Groans	Extensor/ decerebrate response to pain	Restless, agitated
3	To voice	Some words, inappropriate/ mumbled	Flexor/ decorticate response to pain	Persistently irritable
4	Spontaneous	Confused but recognisable speech	Withdraws to pain	Cries but is consolable
5		Appropriate conversation	Localises pain *	Appropriate words or social smile; fixes and follows
6			Obeys commands	

**Total = E + V + M = 3 to 15**

\* Purposeful movement in response to painful stimulus – patient will reach for painful area.

Regardless of the GCS, the following signs are also indicative of severe head injury:

- Unequal pupils
- Unequal motor response
- Open head injury with CSF leak or exposed brain tissue <sup>12</sup>

## E: Exposure with environmental control

### Why children are different

- Infants up to eight months of age have an immature thermoregulation system and are unable to produce heat through shivering. Therefore they must burn fat for thermogenesis, which leads to greater O<sub>2</sub> consumption, metabolic acidosis and vasoconstriction (hypothermia).
- The autonomic nervous system is not fully developed in infants up to eight months of age; therefore their ability to control body temperature in response to environmental changes is limited.
- Children can have significant heat loss from their head as it comprises 18% of the total body surface as opposed to 7% in adults.
- They have less subcutaneous tissue for insulation.
- They have a greater ratio of body surface area : body mass ratio. Therefore, they lose more heat to the environment through evaporation, conduction and convection.<sup>6,12</sup>

Body temperature must be maintained at all times and hypothermia treated. Hypothermia is the failure of the mercury in a clinical thermometer to rise above 34° Celsius.<sup>17</sup>

**Temperature may be measured at the axilla or rectally, but staff should be aware that axillary temperatures are up to 1 degree lower than a rectal temperature. Tympanic temperatures are not recommended as they are unreliable, and oral temperature measurement is not recommended because of lack of data.<sup>18</sup>**

Digital thermometers are commonly used.

**To avoid HYPOTHERMIA - use overhead heaters; blankets; warmed, humidified ventilation or patient body warmers. Use “Bair Hugger” or alfoil space blankets on babes when examining, unless a decision has been made to actively cool for cerebral protection.<sup>9</sup>**

**Important note: Space blankets only maintain the current temperature – they don’t “warm-up” a patient.**

NSW Health Paediatric Clinical Practice Guideline for *Acute management of infants and children with fever* is available at:

[http://www.health.nsw.gov.au/policies/PD/2005/pdf/PD2005\\_388.pdf](http://www.health.nsw.gov.au/policies/PD/2005/pdf/PD2005_388.pdf)

or visit

<http://www.kaleidoscope.org.au/privateAccess/members.cfm>

or

<http://www.kaleidoscope.org.au> and click on the Professionals button

## Secondary Survey

This involves a more detailed systemic evaluation and initiation of diagnostic studies and is commenced after the primary survey is completed and the child is stable.

### Head to toe examination

- **Vital signs** - HR, RR, BP, capillary refill, temperature, GCS at 15-30 min during stabilisation<sup>12</sup>
- **History**
  - A** - Allergies
  - M** - Medications
  - P** - Past History
  - L** - Last Ate/Last Tetanus
  - E** - Events preceding injury
- **Head to toe examination** – common sites that can be missed are the scalp, neck, hands, back and perineum. To assess a patient's back, log roll the patient (ideally undertaken by several people - preferably three for an infant and four for a child, with an additional person to examine, keeping the spine in alignment at all times).
- **Check urinalysis for blood.**
- **Assume injury present** - until excluded by clinical examination of the investigations.
- **Laboratory and radiologic studies**
- **Tetanus**

### Tetanus prophylaxis in wound management

Tetanus status must be assessed for every person. Check the table below.

History of tetanus vaccination	Time since last dose	Type of wound	DTPa, DT, dT Tet-Tox or dTpa as appropriate	Tetanus immunoglobulin* (TIG)
≥ 3 doses	< 5 years	All wounds	No	No
≥ 3 doses	5-10 years	Clean minor wounds	No	No
≥ 3 doses	5-10 years	All other wounds	Yes	No
≥ 3 doses	> 10 years	All wounds	Yes	No
< 3 doses, or uncertain	-	Clean minor wounds	Yes	No
< 3 doses, or uncertain	-	All other wounds	Yes	Yes

\* The recommended dose for TIG is 250 IU, given by IM injection using a 21-gauge needle, as soon as practicable after the injury.  
If more than 24 hours has elapsed, 500 IU should be given.<sup>19</sup>

**Note: If any deterioration in condition, IMMEDIATELY return to the PRIMARY SURVEY – A, B, C, D, E.**<sup>9</sup>

## Tertiary Survey

A routine head to toe examination of a patient should take place within 24 hours of the injury, to document any missed injuries and re-evaluate existing injuries and their treatment. This is particularly important in non-ambulant children – look for evidence of bruising, particularly in the facial, ear and/or head area.<sup>12</sup>

# Pain Control

## Why children are different

The influential factor determining a child's response to pain is dependent on their level of psychological maturity. Appreciating a child's age and stage of development, aids in assessing and planning analgesic strategies after traumatic injury. This includes parent and/or child self reports (ie. faces pain scale and for children who can't self report use a FLACC Behavioural Assessment tool - see appendix 1). Experienced paediatric staff are reliable at assessing a child's pain.<sup>5,20</sup>

Untreated or under-treated pain following trauma leads to complications such as:

- Hypoventilation
- Reduced oxygenation
- Increased stress response
- Increased cardiovascular output
- Muscle tension and rigidity
- Pain also interferes with sleep, rest and healing

Physiological signs of pain are:

- Tachycardia
- Tachypnoea
- Dilated pupils
- Sweating AND skin colour changes<sup>9</sup>

Physical measures like immobilisation, splinting, traction, positioning and elevation of limbs, ice packs or applying tap water to burned skin (not ice) can be useful adjuncts to pain management strategies.<sup>9</sup>

Other adjuncts to analgesic therapy according to developmental age are:

*Infants:* touching, holding - especially rhythmic movements.

*Toddlers:* cuddles, parental support, distraction techniques like play.

*School age children:* give simple verbal explanations about any procedures to be performed, reading, cuddles, music and TV/videos.

*Adolescents:* Distraction, relaxation techniques, thorough explanations of any procedures, music and TV/videos.

## Suggested analgesics<sup>5,9</sup>

*Mild pain:* Paracetamol / Ibuprofen

*Moderate pain:* Paracetamol and Codeine preparations (guide - undisplaced fractures, burns NOT requiring IV resuscitation)

*Severe pain:* Morphine (guide - displaced fractures, burns requiring resuscitation)

**Note:** IM injections are NOT recommended for analgesia following trauma in children. There is variable absorption of the drug from the muscle particularly if hypovolaemic, cold or shocked and once administered it cannot be further titrated.<sup>9</sup>

**Severe pain is best relieved by IV narcotics in small aliquots titrated to effect.**<sup>13</sup>

**All children who receive narcotics must be closely monitored for hypoventilation. Minimum monitoring should be pulse oximetry with alarm set to 93%.**<sup>13,14</sup>

**Note:** Infants are particularly prone to hypoventilation when given narcotics. They should be under direct observation and have full cardiorespiratory monitoring in place when the narcotics are given. The correct dose of Naloxone should be calculated and readily available.<sup>13</sup>

If respirations are reduced due to opioids:

- Stop administering the opioid.
- Stimulate the patient (shake gently, call by name, ask to breathe).
- Administer oxygen.
- Administer Naloxone if indicated.<sup>9</sup>

Be **PREPARED:**

- Have age appropriate airway equipment handy.
- Monitor respiration rate and depth, pulse, SaO<sub>2</sub> with pulse oximetry and pain response.
- Have reversal medication ready.

# Specific Trauma Issues

## 1. Non-Accidental Injury

Non-Accidental Injury (NAI) is the most common cause of injury in children < 2 years of age and in particular those < 6 months of age. An important facet of paediatric trauma is the careful examination of the child for other signs that might suggest the possibility of intentional or inflicted injury.

**Some diagnostic “red flags” or “alerting triggers” are:**

- Delay in presentation
- Injuries inconsistent with history
- Child implicates an adult<sup>9</sup>
- Fractures in children < 2 years of age, spiral fractures in children or long bone fractures in children < 3 years of age
- Burns, especially unusual or sharply demarcated
- Developmental capacity inconsistent with injury in a way described
- Certain types of injuries such as:
  - Multiple injuries of different ages
  - Ruptured internal organs with no history of major trauma
  - Bilateral or multiple skull fractures
  - Sub dural haematomas
  - Retinal haemorrhages
  - Cephalic haematoma (from severe hair pulling)
  - Perianal or genital injury
  - Shaken baby syndrome<sup>9,21,22</sup>

## Investigations

Consider:

- Full blood examination/clotting studies for children with bruising.
- X-ray any areas of clinically suspected fractures.
- Skeletal survey should be performed if bone scans are not available.
- Bone scan – if child is less than 3 years of age and occult or healing fractures are suspected<sup>4,9</sup>

## What to do?

- A thorough and detailed history is needed of the alleged mechanism of injury, and of where and when it happened – taking care to note who witnessed the injury and the child’s level of maturity and developmental capabilities.
- It is **MANDATORY** for all health care workers who have reasonable grounds to suspect a child is at *risk of harm* to report to DoCS the name or a description of the child and the grounds of suspecting that they are at risk of harm, as soon as practicable.
- Accurate and complete documentation is essential and assists in detecting inconsistencies in history given to staff members.

- **Call DoCS on 13 3627 or 13 DoCS or**
- **Fax the NSW Health confidential recording form to the DoCS Help line on 9633 7666**<sup>23</sup>

## 2. Head Injury

Head injuries, either alone or in association with multiple system injuries cause approximately 40% of deaths in the 1 to 14 years age group. Head injury should be suspected in any trauma victim who has cranial lacerations, haematomas and in any child with altered mental status, with or without focal neurological findings.

### Why children are different

The paediatric head is:

- Anatomically large and heavy.
- Fontanelles do not close until approx 16 to 18 months of age
- Occiput is more prominent
- Head size is disproportionate to chest until age 7 - hyperflexion or extension injuries may lead to cervical spine injury without bony injury
- Brain less buoyant
- Cranium is immature and thinner
- Neck muscles weaker

Most adult characteristics develop by the age of 8 years. <sup>1, 4, 6</sup>

### Management of head injury in children:

**Note:** Severe head injury GCS  $\leq 9$  → trauma call +/- retrieval to nearest paediatric referral centre. <sup>12</sup>

### Primary Survey – A, B, C, D, E

#### Secondary Survey

- Examine the scalp and cranium for lacerations, haematomas or other structural deformities, such as depressions.
- Examine the nose and ears for any clear fluid – assume to be CSF.
- Physical examination suggestive findings of a basilar skull fracture include haemotympanum, CSF leakage from the nose or ears, a post auricular haematoma (battle sign), bilateral periorbital ecchymosis (raccoon eyes) or seventh cranial nerve palsy.
- **AMPLE history**
  - A = Allergies**
  - M = Medications**
  - P = Past medical history**
  - L = Last ate**
  - E = Event – what happened?** <sup>4</sup>
- **NEVER insert a nasogastric tube** when head injury is suspected, as it can cause intracranial infection.

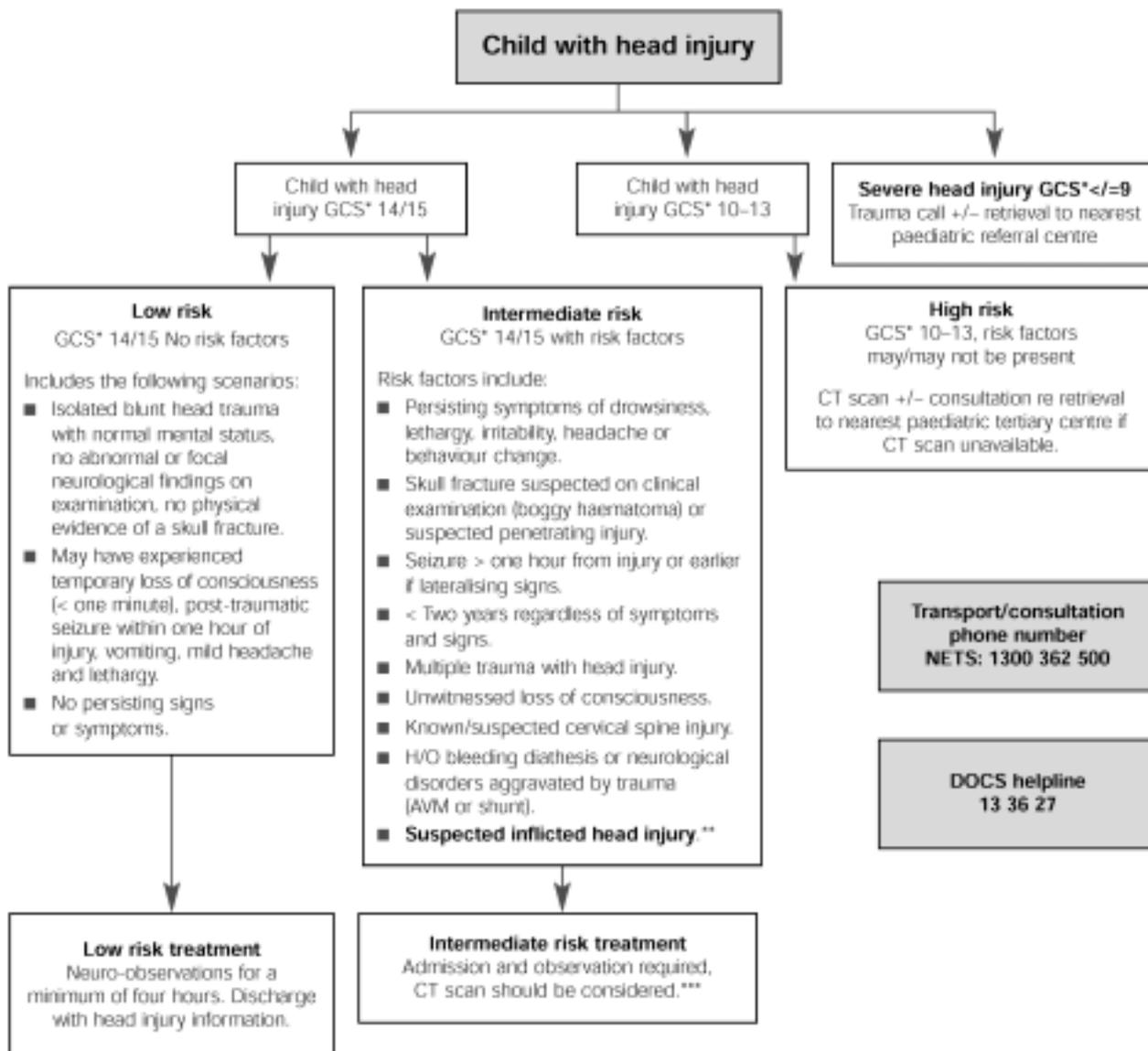
One of the major differences in assessing children due to their age/developmental sequelae is in using the Glasgow Coma Score – a modified version is used based on children's best response in three areas: motor activity, verbal response and eye opening. Traumatic brain injury in children is classified as mild (GCS > 8), moderate (GCS 6-8) and severe (GCS 3-5). <sup>12</sup>

See GCS table on page 17 - Primary Survey – D section.

NSW Health Paediatric Clinical Practice Guideline for *Acute Management of Head Injury in Children within the first 24hrs* is available at:

[http://www.health.nsw.gov.au/policies/PD/2005/pdf/PD2005\\_391.pdf](http://www.health.nsw.gov.au/policies/PD/2005/pdf/PD2005_391.pdf)

## Flow Chart of Initial Patient Care



\* GCS: Glasgow coma scale.

\*\* If inflicted head injury is suspected then there should be communication with the paediatric referral centre to discuss the indicators of the case. If it is agreed that it is a suspected case of inflicted head injury then transfer to the paediatric referral centre should occur. DoCS should immediately be notified of the suspicion and the transfer.

\*\*\* Consult with paediatric expert (neurosurgeon, paediatric surgeon, intensivist, emergency physician) if CT scan unavailable and/or staff are inexperienced in interpretation of clinical features.

Courtesy of NSW Paediatric Clinical Practice Guideline – Acute Management of Head Injury in Children within the first 24hrs

### 3. SCIWORA - Spinal Cord Injury Without Radiologic Abnormality

SCIWORA is defined as injury with objective signs of myelopathy as a result of trauma but with no evidence of fracture or ligamentous instability on plain x-ray or tomography. SCIWORA is most frequently seen in younger children (especially under about 8 years of age) and in injuries of the cervical spine.<sup>8</sup> Any paediatric trauma patient should be considered to have a spinal cord injury, likewise with head, neck or back trauma and trauma associated with height, speed, MVAs, diving and falls from any height.

#### Why children are different

- The vertebral ligaments are not strong enough to support the spinal column; the spinal cord can be stretched during an acceleration-deceleration or flexion-extension episode.
- Children have an inherently unstable atlanto-occipital joint (AO), which can lead to AO dislocation.
- Children have a relatively large head coupled with the relative instability of the cervical spine (particularly at the C2 level).<sup>1,6</sup>

**If diagnosis is difficult – seek expert help early.**

#### Essentials of diagnosis:

- Children who present unconscious or obtunded – impaired level of consciousness
- Children complaining of neck or back pain or tenderness
- Neurologic deficits in extremities; ie presence of paralysis, paresthesia, ptosis or priapism (lewdness)
- Suspect **ALL** children

**HYPOXIA and HYPOTENSION are the most immediate threats to life and spinal cord function of patients with spinal cord injury.**<sup>9</sup>

#### Management:

##### Primary survey – A, B, C, D, E.

- Immobilisation of the entire spine with a semi-rigid cervical collar, head blocks and 'sand bags'.
- High dose steroids are the only therapy with suggestive benefits (within 8 hrs of the traumatic event).
- Urinary catheter.
- NG tube. (After the possibility of a skull fracture has been ruled out.)
- Anti-emetic (for transport) – to prevent vomiting and spine movement or airway compromise.

In children < 8 yrs – most cervical spine injuries (about 80%) occur in the C1-3 region.  
In children > 8 yrs – most cervical spine injuries occur in the lower 3 cervical vertebrae.

Clinical evaluation of the cervical spine should be made in children:

- Who are conscious and alert.
- Who are not affected by drugs or alcohol.
- Who do not have other injuries that are painful or distracting enough to make assessment of neck pain difficult.<sup>9,12,15</sup>

(See page 12 for principles of management of **Cervical Spine Immobilisation**.)

## 4. Chest trauma

Isolated chest injury is rare in paediatric trauma and most cases occur secondary to blunt chest trauma; ie MVAs, pedestrian, motorbike and bicycle accidents. Penetrating injuries account for less than 10% of the total incidence. <sup>9,15</sup>

### Why children are different

- Children have a **COMPLIANT** chest wall due to the elasticity of the ribs and this allows greater deformation of the chest wall before the ribs fracture. **Therefore major internal injuries may occur WITHOUT any external chest wall injury.**
- Infants and young children are preferential diaphragm breathers therefore gastric distension in any form will elevate the diaphragm and severely lessen the respiratory capacity of the child– insert orogastric/nasogastric tube but **NOT nasogastric where head injury is a concern.**
- Children have a greater cardiopulmonary reserve therefore compensatory mechanisms may mask hypovolaemia and respiratory distress.
- The mobility of the mediastinum decreases the risk of major airway and vessel injury however if there is a mediastinal shift, ventilatory and cardiovascular compromise may occur rapidly.

Note:

- **Hypoxia** is the most important feature of chest injury.
- **Hypotension** is a late and preterminal sign. <sup>9,13,15</sup>

### Management

#### Primary survey - A, B, C, D, E.

- High flow oxygen
- Analgesia
- Ventilatory support if necessary
- Insertion of a chest drain if indicated

**Note: Chest injuries rarely occur in isolation, usually being associated with injury to other systems.** <sup>9</sup>

### Types of injuries:

Lung contusions	Haemothorax
Rib fractures	Penetrating trauma
Flail chest haemothorax	Traumatic asphyxia
Tracheobronchial	Burns
Cardiac tamponade	Pneumothorax - simple
Oesophageal	Tension pneumothorax
Diaphragmatic	Open pneumothorax

### The insertion of intercostal drains should be considered where:

- Intrapleural collection is causing compromise.
- There is significant chest injury and the child is to be placed on positive pressure ventilation.
- The patient is to be transported by air ambulance. <sup>9,15</sup>

**Note:** Treatment in the absence of major cardiovascular or tracheobronchial injury will be guided by oxygenation. In many cases, the use of adequate analgesia and oxygen may be all that is needed.<sup>9</sup>

**If in doubt about a child's condition, signs or symptoms; consult with someone more experienced.**

**Paediatric specialists are very approachable and prefer to be called too early rather than too late.**

## 5. Abdominal Trauma

Blunt abdominal trauma accounts for the majority of all paediatric abdominal injuries and should be suspected when trauma is related to high-speed acceleration-deceleration accidents or direct blows to the abdomen, flank or back. Penetrating abdominal trauma is rare and is usually the result of a gunshot, stab wound or impalement.

### Why children are different

- Children have less muscle and adipose tissue (connective tissue) - therefore abdominal organs are closer to the surface of the body and receive less protection.
- Abdomen receives less protection from the ribs therefore, the liver, spleen and kidneys are more vulnerable anatomically to trauma.
- Children have a protuberant abdomen and thin abdominal wall.
- Children under 5 years of age have a higher centre of gravity.

In children the abdomen begins at the level of the nipple. As children up to 6 years of age breathe primarily with their diaphragms, peritoneal irritation from blood or intestinal contents may result in an alteration in breathing patterns, ie shallow breathing to avoid pain.

**Due to the small body size, injuring forces dissipate over a small body mass resulting in a high frequency of multiple organ injuries and injuries to internal organs are commonly seen WITHOUT outward signs of trauma.**<sup>6</sup>

### Essentials of diagnosis

1. Mechanism of injury – such as MVA, lap sash seatbelt, fall from bike, direct blow.
2. Clinical examination - abdominal tenderness/distension, rigidity, abrasions, bruising, increasing abdominal girth, generalised guarding, absence of bowel sounds, haematuria (marker for injury to other organs other than the kidneys, such as the liver and spleen), and **shock**.<sup>4</sup>
3. Radiology - Focused Abdominal Sonography for Trauma (FAST) scan, CT scan, trauma series.
4. Laboratory studies – Routine bloods – FBC, electrolytes, x-match, lipase, LFTs. Blood gases. CBC, amylase, lactate.

### Management of abdominal injuries

#### Primary survey – A, B, C, D, E

- Fluid resuscitation with 20 ml/kg normal saline and Hartmann's
- Second bolus, if required
- If further bolus required, use blood
- Immediate further surgical review
- Pass orogastric tube

## Secondary survey

1. Detailed examination
2. A targeted history.  
**Note:** if the child is a victim of non-accidental injury then the history may be misleading – consider this diagnosis and look for telltale bruising and/or fractures and/or burns.
3. Appropriate investigations
4. Surgical consultation for further management. The surgeon determines the management approach – conservative or surgical:
  - All patients with free intraperitoneal air require a laparotomy
  - All penetrating wounds should be explored in the operating theatre under general anaesthesia
5. Consider pain relief<sup>9,13,21</sup>

**In trauma, oral intubation is always used.**<sup>9,13</sup>

**The vast majority of solid organ injuries (ie liver, spleen, pancreas and kidney) can be treated conservatively.**<sup>9</sup>

**Children with a history of significant trauma or high impact trauma should be admitted for observation even in the absence of examination findings.**

NSW Health Paediatric Clinical Practice Guideline for *Acute Management of Infants and Children with Acute Abdominal Pain* is available at:

[http://www.health.nsw.gov.au/policies/PD/2005/pdf/PD2005\\_384.pdf](http://www.health.nsw.gov.au/policies/PD/2005/pdf/PD2005_384.pdf)

## 6. Musculoskeletal trauma

### Why children are different

The paediatric skeleton:

- Is more elastic, flexible and compliant which leaves underlying structures more vulnerable, exposed and allows transmission of forces to internal organs.
- Has cartilaginous sternum and ribs.
- Has a softer and more compliant chest wall and is able to absorb high impact and transmit force to underlying structures. Therefore, it is less prone to rib fractures and more prone to internal structure damage without outward signs.
- Has a very elastic bony spine and its spinal ligaments are quite lax.
- Is not completely developed in the neck and paraspinal and paracervical muscles.
- Has incompletely ossified wedge-shaped vertebrae.
- Has a thick periosteum and the weak point is at the epiphyseal plate (open physes)  
- damage to the growth plate can cause long term orthopaedic retardation/alteration.
- Is different because everything is **SMALLER**.<sup>4,6</sup>

Injuries to the extremities are usually obvious or readily identified with x-rays and are rarely life threatening. However, the importance of these injuries should never be underestimated as mismanagement could result in serious sequelae, such as:

- Infection
- Growth disturbance
- Deformity
- Post-traumatic arthritis or
- Paralysis

Examples of life-threatening musculoskeletal injuries include:

- Pelvic crush injuries
- Traumatic proximal amputations and
- Multiple open or closed fractures

There is a high incidence of fractures in children – resulting from a combination of their slender bone structure, high activity level and a decreased awareness of their surroundings or recognition of potentially injurious situations. Non-accidental injuries should always be considered.<sup>9,14</sup>

**WARNING: “SCIWORA” = Spinal Cord Injury Without Radiological Abnormalities can occur without evidence of bone or fracture damage.**<sup>9</sup>

### Clinical signs of fracture in children<sup>4,14</sup>

Deformity, swelling, bruising

Pain

Point tenderness

Crepitus

Open wounds

Cold extremities

Pallor

Absent or weak pulse

Paresthesia

Paralysis

Amputation

## Initial assessment

- Rapidly identify injuries that pose a threat to life or limb. A top priority when evaluating musculoskeletal trauma is to estimate blood loss, as concealed haemorrhage from fracture(s) can cause **shock** in a child – **fractured bones can bleed profusely.**

Fractures associated with mechanisms of injury:

- A child who sustains a **fractured femur - suspect a spleen or liver injury.**
- A child who sustains a **fractured humerus - suspect a chest injury.**
- **Lumbar spine injury** – classically sustained by a **lap-sash seatbelt restrained child, is commonly associated with duodenal and/or pancreatic injury.**

## Management

**Primary survey – A, B, C, D, E.**

### Secondary survey:

- Immobilization/splinting
- Pain relief
- Clean and dress open wounds
- Antibiotics for wounds
- Neurovascular observation: pulses, perfusion, peripheral nerves, motor, sensory
- X-ray all suspected fractures
- Nil by mouth - if there is a possibility theatre will be required

## Vascular injury

### Signs of:

- Abnormal (absent or reduced) pulses
- Impaired capillary return
- Decreased sensation
- Rapidly expanding haematoma
- Overlying bruit

*Note:* Pallor and reduced temperature compared to the uninjured side can also be important signs.

### Clinical features:

- Pain out of proportion to injury
- Pain not controlled with standard analgesia
- Pain on passive stretching of muscles in compartment
- Firmness of compartment on palpation
- **Late sign – diminished sensation of nerves passing through compartment**

### Management:

- Constant neurovascular observation
- Urgent discussion with orthopaedic surgeons
- Transfer to paediatric specialist referral hospital

## Compartment syndrome

Occurs with injuries producing a rise in the interstitial pressure, to the point that tissue circulation is compromised.

**Clinical features:**

- Suspicion from injury mechanism
- Disproportionate pain
- Pain with passive stretch
- Paraesthesia
- Pulses usually present
- **Late sign - loss of function**

**High risk injuries for compartment syndrome:**

- High energy injury
- Tibial shaft fracture (especially open)
- Forearm fracture
- Supracondylar fracture
- Crush fracture of the foot

**Management:**

- Constant neurovascular observation
- Urgent discussion with orthopaedic surgeons
- Transfer to paediatric specialist referral hospital <sup>4, 9</sup>

## 7. Burns

Burns are the third leading cause of death in childhood. Burn injury results from damage or destruction of the skin by thermal, chemical, electrical or radiation energy.

The referral criteria for admissions are:

- Partial/full thickness burns in children > 5% Total Body Surface Area
- Burns to face, hands, feet, genitalia, perineum and major joints
- Chemical burns
- Electrical burns including lightning injuries
- Burns with concomitant trauma
- Burns with associated inhalation injury
- Burns in patients with pre-existing medical conditions that could adversely affect patient care and outcome
- Children with suspected NAI
- Pregnancy with cutaneous burns

Activate the retrieval team by calling **NETS line - 1300 362 500**.

Although not all patients in these categories will require transfer to a specialised burns unit, advice must be sought early in their management and **transfers should occur within four hours if possible**.

### Management

- Cool the burn for 20 minutes with cold running water (ideal temperature is 15° Celsius) - **never use ice or iced water**.
  - Prevent hypothermia - keep children warm, as they are at risk of hypothermia. Keep unburnt areas as warm as possible by removing wet packs and soaks and cover the patient in a clean sheet or plastic cling wrap and warm blankets, space blankets or patient-warming blankets (Bair Hugger).
  - Check the temperature regularly.

### Primary Survey – A, B, C, D, E

#### 1. Airway

- **Assess airway patency**
- Give 100% oxygen (preferably humidified) to all patients except those with minor burns
- 100% oxygen should be given to any patient retrieved from a fire or in a closed space even if cutaneous burns are not present

#### Criteria for Intubation –

1. Clinical evidence of possible airway compromise:
  - a. head and neck burns/scalds with increased swelling
  - b. stridor, hoarse voice, swollen lips
  - c. carbonaceous material around or in the mouth, nose or sputum
  - d. singed facial, head or nasal hairs
2. Intubate early:
  - a. if patient is unconscious
  - b. if there are head and neck burns with obvious swelling
  - c. if the patient is to be transferred and meets any of the above criteria
  - d. if there are other clinical signs and symptoms and ABG results indicative of respiratory dysfunction
  - e. select an endotracheal tube size that will allow for swelling

## 2. Breathing

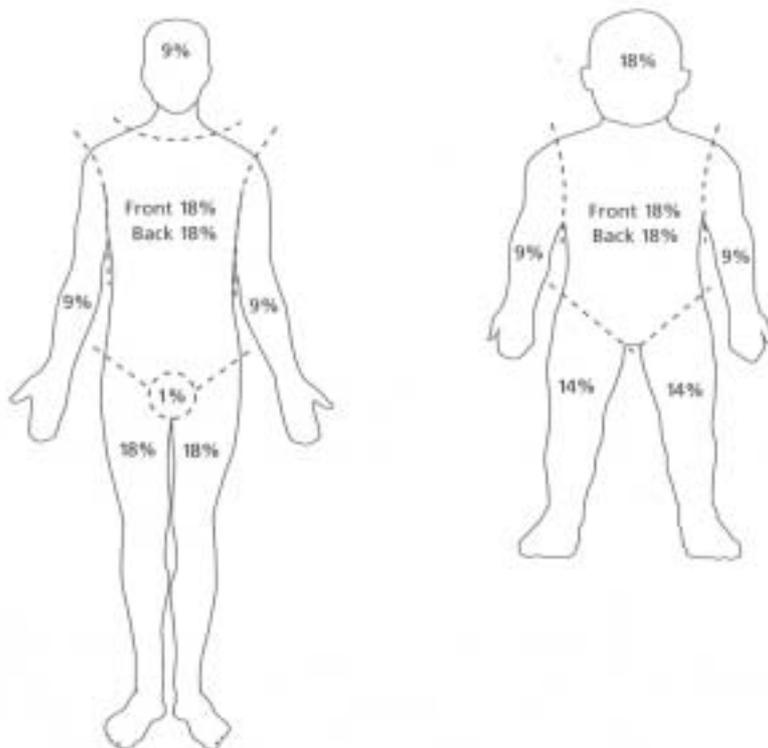
- Monitor respiratory rate and effort – pulse oximetry.  
**Note: pulse oximetry cannot differentiate between oxyhaemoglobin and carboxyhaemoglobin.**
- Measure carboxyhaemoglobin. Bloods should be taken to assess the level of carboxyhaemoglobin in any patient who received burns in an enclosed space.
- Normal carboxyhaemoglobin level is 0-13%. Toxic level >25%, Lethal level > 60%.

## 3. Circulation

- Two peripheral lines should be inserted – preferably through unburnt skin – never smaller than **22 gauge in children** (16 gauge in adults) or insert an intraosseous needle if unable to gain venous access in 90 seconds.
- Silastic urinary catheter should be inserted for all patients with > 20% burns.

## 4. Assessment of body surface area burnt

“Rule of nines” – ignore simple erythema



Total percentage burnt	Comments
Front	
Back	
Legs	
Arms	
Head	
Perineum	
Total %	

*Courtesy of NSW Severe Burn Injury Service, Burn Transfer Guideline*

## 5. Fluid resuscitation

Is necessary to maintain adequate circulating blood volume and renal function.

### Why children are different

Children require both **Fluid Replacement (FR) + Fluid Maintenance (FM)** as children have higher fluid and caloric demands/kg body weight due to their higher metabolic rate. If possible the child is **weighed or weight calculated**.

The **Modified Parkland Formula** is used to calculate the **Fluid Replacement (FR)** volumes needed for resuscitation.

### Modified Parkland Formula

#### 3 - 4 ml Hartmann solution x wt x % total body surface area burnt

- The calculation of resuscitation fluid requirements is based on the time of the burn, not the time of presentation. The initial volume administered should address any deficit.
- **Half** the calculated volume should be given in the first **8 hrs** post-burn injury
- **The remaining half** is given over the next **16 hrs**
- All care should be taken to avoid hyponatremia especially in young children
- The formula should only commence at 3 ml for patients with non-complicated burn injuries, who sought immediate medical attention
- The formula should commence at 4 ml for any patient with delayed presentation, multi-trauma, alcohol intoxication, conduction injury, chemical injury, or for patients arriving with poor urine output.

**Example:** A child weighing 25 kg with a 20% burn will require the following:

#### Child fluid replacement (FR) – Modified Parkland Formula

$$4 \text{ ml} \times 25 \text{ kg} \times 20\% = 2000 \text{ mls in 24 hrs}$$

1 <sup>st</sup> 8 hour period	1000ml/8 = 125ml/hr
2 <sup>nd</sup> 8 hour period	500ml/8 = 62.5ml/hr
3 <sup>rd</sup> 8 hour period	500ml/8 = 62.5ml/hr
<b>Total FR 24 hrs</b>	<b>= 2000mls</b>

### Plus

#### Child fluid maintenance (FM) 25kg child in 24hours

1 <sup>st</sup> 10 kg	– 100ml x 10kg	= 1000ml
Next 10 kg	– 50ml x 10kg	= 500ml
Next 5 kg	– 20ml x 5kg	= 100ml
<b>Total FM</b>	<b>1600ml/24hrs</b>	<b>= 67ml/hr</b>

### Therefore

The hourly rate for the first 8 hours is the FR + FM

$$\begin{array}{r} \text{FR 125 ml} \\ + \text{FM 67 ml} \\ \hline 192 \text{ ml/hr} \end{array}$$

**Total fluid requirement = 3600 ml for the 1<sup>st</sup> 24 hrs  
(ie 2000ml (FR) + 1600ml(FM))**

#### **Urine Output:**

- Aim for output 0.5-1 ml/kg/hr. (0.5-2 ml/kg/hr in a child)
- IDC should be inserted for burns > 20% BSA <sup>24</sup>

### **6. Pain management**

- Pain relief is essential, as even minor burns are painful.
- Analgesia is always given **IV**. Morphine is the best way to manage acute pain – give according to guidelines.
- Morphine is adjusted to the pain score and observation chart.
- All medication administered prior to and during transfer must be appropriately documented. This should include dose, time of administration and authorisation signature.

### **7. Wound care**

- Once the child is **stable, cling wrap or a clean sheet is recommended for transfer.**
- If there is a delay in transfer, wound management should take place in consultation with the burn surgeon who will receive the patient.
- **Facial burns – apply paraffin ointment.**
- If limbs are burnt, elevation (where possible) can be used to reduce swelling. Avoid application of tight bandages.
- Patients with head and neck burns should be nursed head up to reduce oedema and swelling.
- If escharotomy is required, it should only be undertaken after consultation with a burn surgeon.

- **NEVER use SSD on a patient's face.**
- **SSD is not recommended for newborn infants.**
- **SSD should only be used after consulting a paediatric surgeon.**

## Tetanus prophylaxis

**Tetanus status must be assessed for every person. Check the table below for follow-up.**

Immunisation Status	Action
More than 10 years since last tetanus toxoid booster <b>or</b> Person has never had tetanus immunisation <b>or</b> There is doubt as to their tetanus immunisation status.	<ul style="list-style-type: none"><li>• If burn occurred within the last 24 hrs – give tetanus immunoglobulin (TIG) 250 IU IMI.</li><li>• If burn occurred more than 24 hrs ago – give TIG 500 IU IMI.</li></ul> <p><b>Note:</b> Give ADT/DPT/Tetanus toxoid at the same time in the opposite arm with a separate syringe and make arrangements for the patient to complete the full course of tetanus toxoid vaccinations.</p>
Person has had 3 doses but it is 5 or more years since last tetanus toxoid booster.	Give ADT/DPT/Tetanus toxoid.
Person has had 3 doses and it is less than 5 years since last tetanus toxoid booster.	No Tetanus Toxoid required.

Give the same dose of TIG for adults and children:

- For adults and children >8 years, ADT is preferred to tetanus toxoid.
- For children, DPT (triple antigen) is preferred to tetanus toxoid.
- Use CDT if there has been a previous serious reaction to DPT.

*Reproduced courtesy NSW Severe Burn Injury Service, Burn Transfer Guidelines. <sup>25</sup>*

### 8. Gastrointestinal care

- Fast the patient and remain NBM until after consultation with appropriate burns unit.
- Children with TBSA burns >10% require insertion of a nasogastric tube prior to transfer.

### 9. Disability

- AVPU/GCS
- Monitor level of consciousness
- Monitor pain score

### Secondary Survey

Observe for any signs or symptoms of trauma.

## Transfer

**Transfer of major burns to a burns centre should occur within four hours if possible.**<sup>25</sup>

Patients requiring medical transfer include:

- Intubated
- Head and neck burns
- Burns >10% in a child and >20% in an adult
- Burns with significant co-morbidities eg trauma
- Conduction/chemical injury
- Significant pre-existing medical disorder<sup>24,25</sup>

NSW Severe Burn Injury Service *Burn Transfer Guidelines* are available at:  
[http://www.health.nsw.gov.au/pubs/2004/pdf/burninjury\\_guidelines.pdf](http://www.health.nsw.gov.au/pubs/2004/pdf/burninjury_guidelines.pdf)

## Transfer Information Chart

This form should be given to the Retrieval Team, NETS or faxed to the receiving hospital along with any signed consents, history, and relevant information.

<b>History</b>	
Date/time of injury .....	
Time of arrival at your hospital .....	
Type of accident .....	
% Total body surface area burnt.....	
Patient weight .....	
First aid given.....	
State of consciousness when found.....	
.....	
Associated injuries.....	
.....	
Allergies.....	
.....	
Other known medical conditions .....	
.....	
.....	
.....	
Tetanus toxoid given .....	YES/NO (circle)
Up to date .....	Given.....

<b>Patient ID sticker or write in details</b>

Person making referral.....

Designation .....

Hospital .....

Date..... Time .....

Contact Number.....

<b>Respiratory care</b>	
Smoke inhalation suspected	YES/NO
Soot in throat/nose/sputum	YES/NO
Hoarse voice	YES/NO
Stridor	YES/NO
Facial/neck swelling, burns	YES/NO
Intubation required	YES/NO
Size of tube .....	
Blood gases (if taken).....	
Carboxyhemoglobin.....	

IDC Inserted YES/NO

Urine passed .....

Fluid resuscitation: 3-4ml x TBSA x kg  
Add maintenance for children (see 5 Fluid resuscitation)

Calculations.....

.....

.....

.....

Hour	Fluid	Amount	Urine output	Analgesia type	Dose given/hr	Pain score
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

*Courtesy NSW Severe Burn Injury Service, Burn Transfer Guidelines*

## 8. Specialist referral/retrieval

Specialist consultation with a local surgeon and/or paediatrician experienced in managing paediatric surgical patients.

The number for the John Hunter Children's Hospital is **02 4921 3000** and ask for the surgeon/paediatrician on call.

**NETS**, the Newborn (and paediatric) Emergency Transport Service is available on **1300 362 500** – they will set up a conference call which includes a paediatric surgeon and other relevant paediatric specialists as well as organise urgent transfer of a child to a paediatric centre. <sup>12</sup>

### Important information

The NSW Department of Health issued a circular in 2002 on the *Early Notification of Severe Trauma in Rural NSW*. This circular explains the early notification process, combining the use of a pre-hospital trauma triage tool, a rural hospital emergency department triage tool and response, a regional response based on the NSW Rural Critical Care Networks and if necessary a state response co-ordinated by the Medical Retrieval Unit (MRU) and Ambulance Service of NSW. <sup>26</sup>

**MRU 1800 650 004**

**The MRU will task paediatric trauma cases to NETS**

NSW Health *Early Notification of Severe Trauma in Rural NSW Guideline* available at: [http://www.health.nsw.gov.au/policies/PD/2005/pdf/PD2005\\_266.pdf](http://www.health.nsw.gov.au/policies/PD/2005/pdf/PD2005_266.pdf)



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## Appendix 1: Pain assessment tool

<b>0</b>	=	<b>no pain</b>
<b>1 – 3</b>	=	<b>mild pain</b>
<b>4 –7</b>	=	<b>moderate pain</b>
<b>8 –10</b>	=	<b>severe pain</b>

**Assess** pain at rest and with activity.

**Plan** an intervention if necessary.

**Implement and document** interventions in progress notes.

**Evaluate** effectiveness and side effects and document in progress notes.

### FLACC Behavioural Assessment tool

*SUGGESTED AGE GROUP: 2 months to 7 years*

CATEGORIES	SCORING		
	0	1	2
<b>Face</b>	No particular expression or smile.	Occasional grimace or frown, withdrawn, disinterested.	Frequent to constant quivering chin, clenched jaw.
<b>Legs</b>	Normal position or relaxed.	Uneasy, restless, tense.	Kicking, or legs drawn up.
<b>Activity</b>	Lying quietly, normal position, moves easily.	Squirming, shifting back and forth, tense.	Arched, rigid or jerking.
<b>Cry</b>	No cry (asleep or awake).	Moans or whimpers, occasional complaint.	Crying steadily, screams or sobs, frequent complaints.
<b>Consolability</b>	Content, relaxed.	Reassured by occasional touching, hugging or being talked to, distractible.	Difficult to console or comfort.

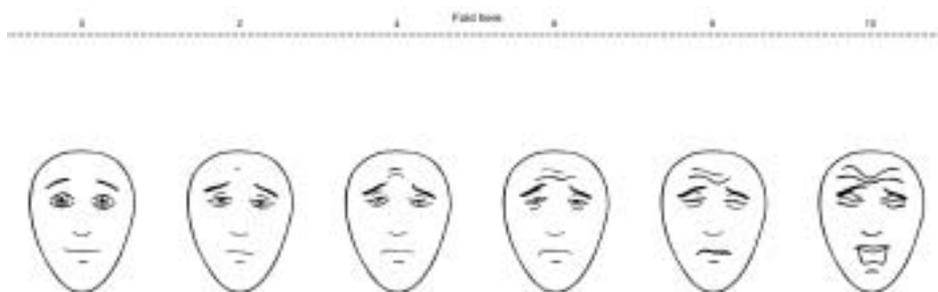
Each of the five categories: **(F)** Face; **(L)** legs; **(A)** Activity; **(C)** Cry; **(C)** Consolability; is scored from 0-2 which results in a total score between 0 and 10 (Merkel et al, 1997).<sup>20</sup>

### Faces Pain Scale – Revised (FPS-R)

*SUGGESTED AGE GROUP: 4 years and over*

Score the chosen face **0, 2, 4, 6, 8, or 10**, counting left to right, so **0** is 'no pain' and **10** is 'very much pain.'

Do not use words like 'happy' or 'sad'. Point to each face using words to describe the pain intensity. Ask the child to choose a face that best describes their own pain and record the appropriate number. The scale is intended to measure how children feel inside not how their face looks. (Hicks & von Baeyer et al, 2001).



#### Sedation Score:

- 0 = fully awake
- 1 = slightly drowsy
- 2 = very drowsy
- 3 = asleep, rousable
- 4 = unrousable

#### Vomiting Score:

- 0 = nil
- 1 = nausea/vomiting

*Tool courtesy of Northern Child Health Network (NCHN) Paediatric Outreach CNC*

## Appendix 2: Guide to equipment for resuscitation

### 0 to 6 months of age

#### Normal values

**RR**  
30 – 60

**HR**  
100 – 160

**BP**  
70 – 90

#### Equipment

Mask	Size 0
Oral airway	Size 000-00
Laryngoscope	1 Straight
Suction catheter	8 French
ETT	3.0-3.5
Lip	9 –10 cm
IV cannula	22-24 gauge
NG tube	6-8 French
Chest tube	10-12 French
IDC	6-8 French
Cervical collar	Maintain in-line immobilisation★

★ See principles of **Cervical Spine Immobilisation** page 12.

**Urine output: 1- 2 ml/kg/hr**

#### Guide to choosing appropriate ET Tube

- $(\text{Age}/4) + 4 = \text{Internal diameter}$
- $< 8 \text{ years age} = \text{uncuffed ET tubes}$
- $(\text{Age}/2) + 12 = \text{length @ lips in cm}$

**Laryngoscope** – the **straight blade** laryngoscope is recommended in infants and young children as:

- it lifts the epiglottis under the tip of the blade, allowing a better view of the vocal cords
- it can be placed short of the epiglottis and so is less likely to cause laryngospasm

In the older child use a **curved blade**.<sup>6,12,27,28</sup>

**For paediatric data printout visit:**

<http://hal.hunter.health.nsw.gov.au/icu/help%20library/new%20tables/fullscreenex.html>

and choose Paed Data Printout on the top right of the screen.

## Appendix 3: Guide to equipment for resuscitation

### 6 to 12 months of age

#### Normal values

**RR**  
30 – 40

**HR**  
110 – 160

**BP**  
70 – 90

#### Equipment

Mask	Size 0-1
Oral airway	Size 00-0
Laryngoscope	1 Straight
Suction catheter	10 French
ETT	3.5-4.0
Lip	10-11 cm
IV cannula	20 -22 gauge
NG tube	8 French
Chest tube	16-20 French
IDC	8 French
Cervical collar	Maintain in-line immobilisation ★

★ See principles of **Cervical Spine Immobilisation** page 12.

**Urine output: 1- 2 ml/kg/hr**

#### Guide to choosing appropriate ET Tube

- $(\text{Age}/4) + 4 = \text{Internal diameter}$
- $< 8 \text{ years age} = \text{uncuffed ET tubes}$
- $(\text{Age}/2) + 12 = \text{length @ lips in cm}$

**Laryngoscope** – the **straight blade** laryngoscope is recommended in infants and young children as:

- it lifts the epiglottis under the tip of the blade, allowing a better view of the vocal cords
- it can be placed short of the epiglottis and so is less likely to cause laryngospasm

In the older child use a **curved blade**.<sup>6,12,27,28</sup>

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## Appendix 4: Guide to equipment for resuscitation

### 1 to 2 years of age

#### Normal values

**RR**  
25 – 35

**HR**  
100 – 150

**BP**  
80 – 95

#### Equipment

Mask	Size 1
Oral airway	Size 0-1
Laryngoscope	2 Straight
Suction catheter	10 French
ETT	4.0-4.5
Lip	11-12 cm
IV cannula	18-22 gauge
NG tube	8 -10 French
Chest tube	20-24 French
IDC	10 French
Cervical collar	Maintain in-line immobilisation ★

★ See principles of **Cervical Spine Immobilisation** page 12.

**Urine output: 1 - 2mls/kg/hr**

**Calculating weight in kg = (age in years + 4) x 2**

#### Guide to choosing appropriate ET Tube

- $(\text{Age}/4) + 4 = \text{Internal diameter}$
- $< 8 \text{ years age} = \text{uncuffed ET tubes}$
- $(\text{Age}/2 + 12) = \text{length @ lips in cm}$

**Laryngoscope** – the **straight blade** laryngoscope is recommended in infants and young children as:

- it lifts the epiglottis under the tip of the blade, allowing a better view of the vocal cords.
- it can be placed short of the epiglottis and so is less likely to cause laryngospasm.

In the older child use a **curved blade**. <sup>5,6,12,27,28</sup>

**For paediatric data printout visit:**

<http://hal.hunter.health.nsw.gov.au/icu/help%20library/new%20tables/fullscreenex.html>

and choose Paed Data Printout on the top right of the screen.

## Appendix 5: Guide to equipment for resuscitation

### 2 to 5 years of age

#### Normal values

RR  
25 – 30

HR  
95 – 140

BP  
80 – 100

#### Equipment

Mask	Size 1-2
Oral airway	Size 0-1
Laryngoscope	2 Straight or Curved
Suction catheter	10 French
ETT	4.5-5.0-5.5
Lip	12-14 cm
IV cannula	18-22gauge
NG tube	10 -12 French
Chest tube	20 –24 –32 French
IDC	10 –12 French
Cervical collar	Maintain in-line immobilisation ★

★ See principles of **Cervical Spine Immobilisation** page 12.

**Urine output: 1 - 2 ml/kg/hr**

**Calculating weight in kg = (age in years + 4) x 2**

#### Guide to choosing appropriate ET Tube

- $(\text{Age}/4) + 4 = \text{Internal diameter}$
- $< 8$  years age = uncuffed ET tubes
- $(\text{Age}/2) + 12 = \text{length @ lips in cm}$

**Laryngoscope** – the **straight blade** laryngoscope is recommended in infants and young children as:

- it lifts the epiglottis under the tip of the blade, allowing a better view of the vocal cords
- it can be placed short of the epiglottis and so is less likely to cause laryngospasm

In the older child use a **curved blade**. <sup>5,6,12,27,28</sup>

**For paediatric data printout visit:**

<http://hal.hunter.health.nsw.gov.au/icu/help%20library/new%20tables/fullscreenex.html>

and choose Paed Data Printout on the top right of the screen.

## Appendix 6: Guide to equipment for resuscitation

### 5 to 12 years of age

#### Normal values

RR  
20 – 25

HR  
80 – 120

BP  
90 – 110

#### Equipment

Mask	Size 2 -3
Oral airway	Size 1 -2
Laryngoscope	2 Straight or Curved
Suction catheter	10 French
ETT	5.5-6.0 uncuffed 6.5 cuffed
Lip	14 -17 cm
IV cannula	18-20 gauge
NG tube	10 -12 French
Chest tube	28 - 32 French
IDC	12 French
Cervical collar	Maintain in-line immobilisation ★

★ See principles of **Cervical Spine Immobilisation** page 12.

**Urine output: 1 – 2 ml/kg/hr**

**Calculating weight in kg = (age in years + 4) x 2**  
(from 1 to 10 years age)

#### Guide to choosing appropriate ET Tube

- $(\text{Age}/4) + 4 = \text{Internal diameter}$
- < 8 years age = uncuffed ET tubes
- $(\text{Age}/2) + 12 = \text{length @ lips in cm}$

**Laryngoscope** – the **straight blade** laryngoscope is recommended in infants and young children as:

- it lifts the epiglottis under the tip of the blade, allowing a better view of the vocal cords
- it can be placed short of the epiglottis and so is less likely to cause laryngospasm

In the older child use a **curved blade**.<sup>5,6,12,27,28</sup>

**For paediatric data printout visit:**

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## Appendix 7: Guide to equipment for resuscitation

### > 12 years of age

#### Normal values

RR  
15 – 25

HR  
60 – 100

BP  
100 – 120

#### Equipment

Mask	3 - 4
Oral airway	3 - 4
Laryngoscope	3 Straight or Curved
Suction catheter	10 -12 French
ETT	7 cuffed
Lip	18 cm
IV cannula	16 – 20 gauge
NG tube	12 French
Chest drain	32 -38 French
IDC	12 French
Cervical collar	Maintain in-line immobilisation ★

★ See principles of **Cervical Spine Immobilisation** page 12.

#### Urine output: 0.5mls/kg/hr

#### Guide to choosing appropriate ET Tube

- $(\text{Age}/4) + 4 = \text{Internal diameter}$
- $< 8 \text{ years age} = \text{uncuffed ET tubes}$
- $(\text{Age}/2) + 12 = \text{length @ lips in cm}$

**Laryngoscope** – the **straight blade** laryngoscope is recommended in infants and young children as:

- it lifts the epiglottis under the tip of the blade, allowing a better view of the vocal cords.
- it can be placed short of the epiglottis and so is less likely to cause laryngospasm.

In the older child use a **curved blade**.<sup>6,12,27,28</sup>

#### For paediatric data printout visit:

<http://hal.hunter.health.nsw.gov.au/icu/help%20library/new%20tables/fullscreenex.html>

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