

# Paediatric Blast Injury Field Manual

English language version

Pre-hospital phase

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Damage control resuscitation and surgery with intensive care

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Surgery

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Ward care, rehabilitation

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Psycho-social support

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# How to use this manual

This manual provides guidance for those with medical training but limited experience of treating injured children. It enables the user to adapt their knowledge to the treatment of severely injured children.

This manual is divided into sections for each stage of treatment of the blast injured child. Each section is a different colour so users can find the relevant stage quickly:



Pre-hospital phase

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Damage control resuscitation and surgery with intensive care

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Surgery

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Ward care, rehabilitation

---



Psycho-social support

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The pages are designed to be copied on a phone camera.

This manual is also for those who are required to plan for the treatment of severely injured children so they can see the resources, training and equipment that is required in a medical facility preparing to receive child patients today.

This manual can be downloaded as a PDF via the link on the last page.

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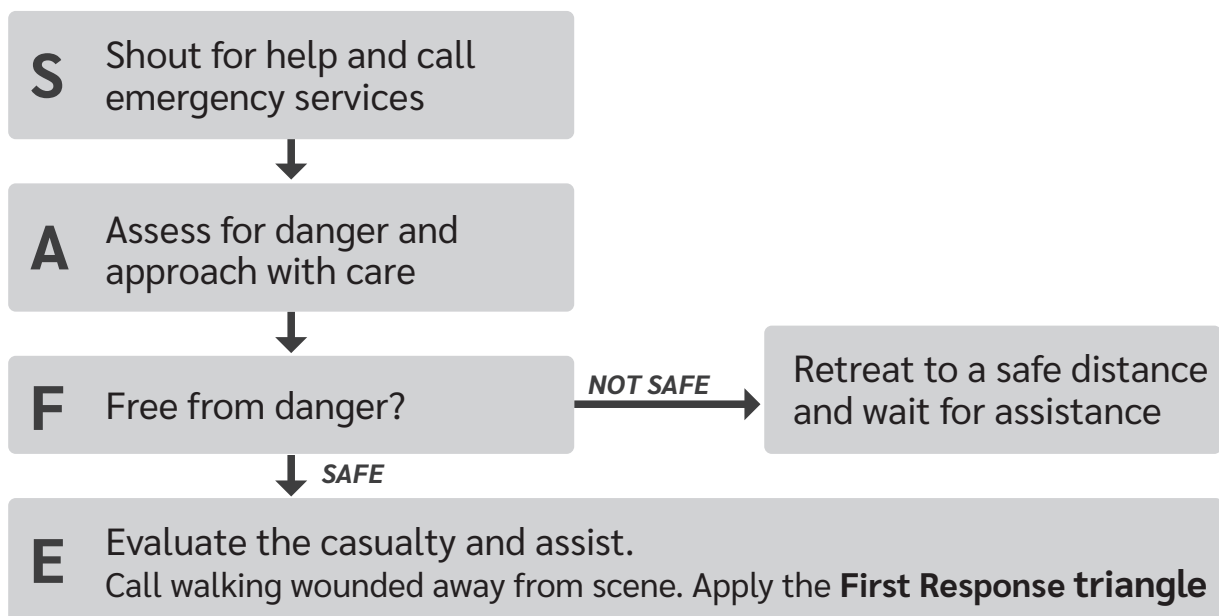
# First Response – Bystander

This section will cover the first response to casualties from a blast event. This response is likely to be from surviving bystanders.

- Do not become a second victim in your effort to provide aid to casualties
- Always use **the S>A>F>E** approach



## SAFE Approach



## SAFETY

First responders to blast injury victims can easily become victims themselves.

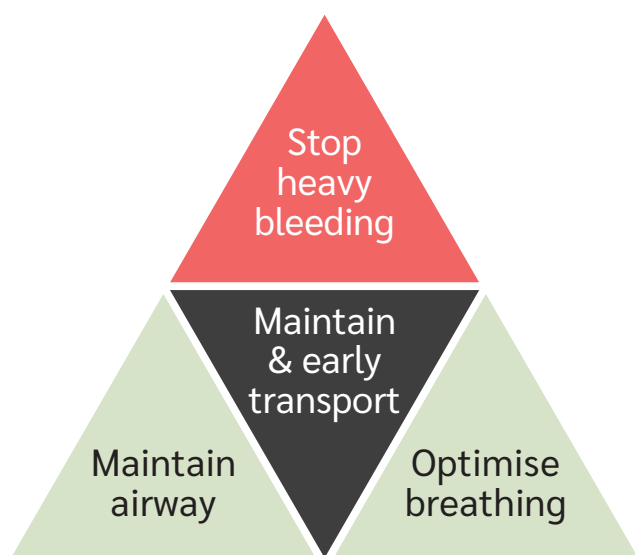
- Beware further explosive devices, incoming ordnance, fire and building collapse
- At all times try to keep parents with children for reassurance and safeguarding
- Multiple casualties without obvious physical injury should raise concern of a chemical attack – retreat to safety and do not approach

## APPROACHING SCENE

- A blast scene is chaotic, and it may not be clear who is in control. Engage with helpful bystanders to manage crowds and allow you to treat patients
- Approach the immobile casualty in their line of sight with your hand raised giving a loud clear verbal commands, but remember they may have hearing damage and cannot follow verbal commands
- Instruct walking casualties to retreat to a safe distance
- Handle casualties with care at all times to prevent further injury
- Task bystanders to speak with emergency services, control crowds and if required arrange transport if no support available

## IMMEDIATE CARE

*Immediate bystander care is summarised in the First Response Triangle*



### Stop heavy bleeding

To prevent death from blood loss by controlling heavy bleeding do the following:

- Apply a tourniquet to all amputations
- Apply constant and direct pressure with a dressing or clean material to any wounds with heavy bleeding – **do not remove material from the wound**
- If pressure does not stop bleeding from a wound limb apply a tourniquet immediately above the wound and tighten until effective. A second tourniquet can be applied. Try to note the time of application.

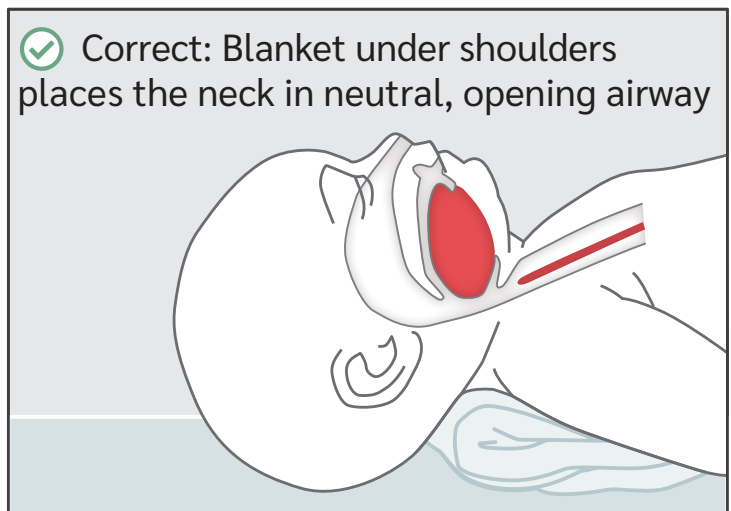
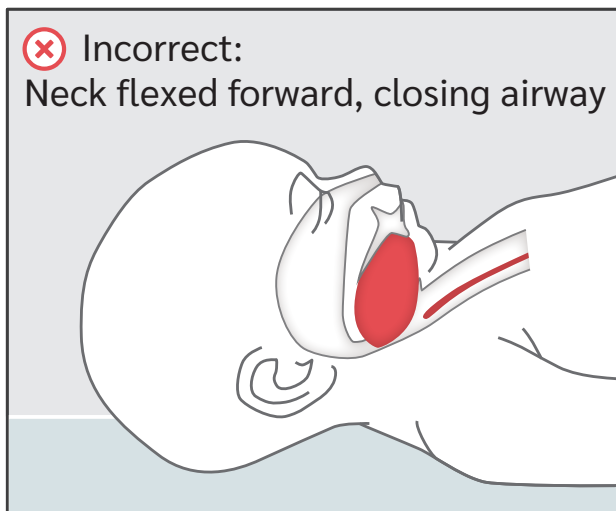
**Once heavy bleeding is controlled move onto airway.**

## Open and maintain the airway

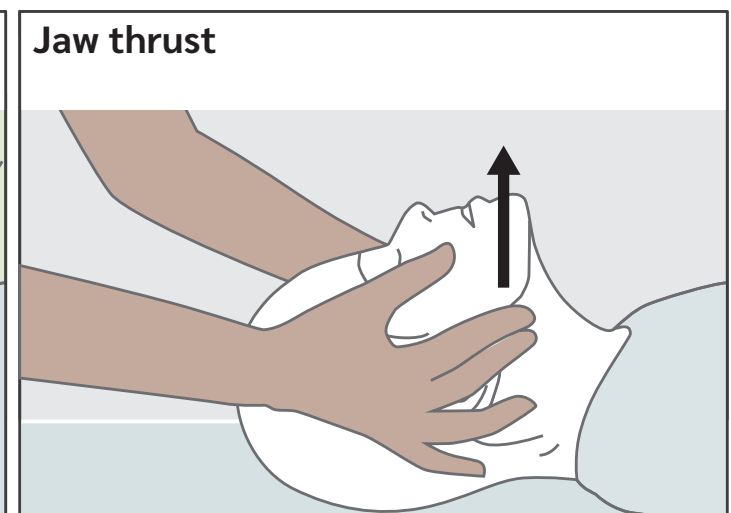
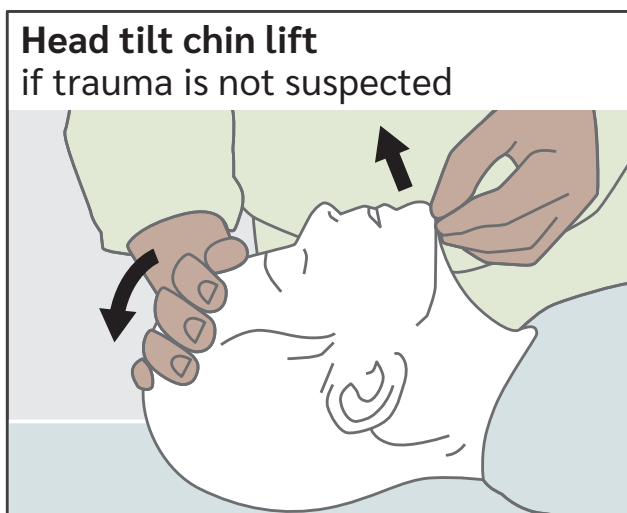
**In the blast injured child with reduced consciousness, support the head at all times.**

If the child has reduced consciousness with absent breathing or noisy breathing do the following:

*Infant – place the airway in the neutral position*



*Child over 1 year*



- Inspect mouth for debris and remove if can be easily picked out with fingers
- Do not handle the airway in a conscious child – allow them to position themselves



## Optimise breathing

To optimise breathing do the following three R's

- **Re-position airway if required and check**
- **Re-position child uninjured side upwards and in 'seated position'**
- **Remove restrictions – tight clothing, heavy objects**

## Maintain and early transport

Once initial care is given do the following:

- **Maintain control of bleeding and airway**
- Keep the child warm and dry. Move to shelter if possible and place clothing or **blankets over and beneath** the child
- Allow the child sips of water
- Cover minor wounds if time allows
- Do not delay transport, move to a medical facility as soon as possible – if no help is available source alternative transport
- Note down if possible the location and details of the incident, casualty and your actions to send with the child. Use a camera if available to record the scene.
- Ensure parents or guardians are kept with the child or if not possible are aware of the destination of the child

- Use the **S▶A▶F▶E** Approach at all times and use the **First Response Triangle**
- Control Heavy Bleeding
- Open and maintain the airway
- Optimise breathing with the 3R's
- Maintain and transport



# Multiple Casualty Pre-Hospital Management

## 1 SAFETY: DO NOT RUSH IN

Safety of SELF, then PATIENT, then SCENE

What are the immediate threats? Is the situation deteriorating?



## 2 EVALUATE: Is there a structured, workable response?

### YES:

- Find and report to the control point
- Get a quick situation report (SITREP)
- Hear the plan/Help develop the plan

### NO:

- Identify a suitable control point for your team
- Gather your staff
- Make a quick assessment of the situation
- Continue to use the ICP as focus so that others prepared to help may engage
- If adequate staffing, base experienced leader at ICP to engage other actors to structure a response



## 3 COMMUNICATION

If possible, communicate situation to hospital direct: METHANE message:

- **“MAJOR INCIDENT”**
- **Exact Location**
- **Type of incident**
- Hazards on scene
- Access routes
- **Numbers/type of casualties**
- Emergency response needed

If not, brief someone leaving to the hospital now and give them written summary



## 4 BASIC ACTION PLAN

If resources allow allocate people (in order) to:

- **Manage the walking wounded (Box 5)**
- **Triage (Box 6)**
- **Help at the transport point (Box 10)**
- **Immediate treatment on scene (Box 8)**
- Co-ordinate the response

## 5 MANAGE THE WALKING WOUNDED

Quickly separating patients with minor injuries allows the rest of the response to focus on those who need help and reduces the impact on the hospital.

- Brief a capable carer to stand at safe nearby location
- Call all those who are **injured** but **can walk** to them
- Set up with small first aid kit - analgesia, splintage, dressings
- Continue to call out to attract as many as possible
- Try to identify an ongoing management location other than the hospital (e.g. community clinic, pharmacy, church et.) where care can be provided
- Ensure staff able to manage minor injuries and detect deterioration based there
- As soon as practical hand over to local responder and re-task own resource



## 6 DO YOU HAVE THE RESOURCES TO TRIAGE?

**NO:** skip triage and treatment, go straight to **Help at the transport point (Box 10)**

**YES:** Go to **Triage**



## 7 TRIAGE

- Task personnel to perform triage.
- Find and rapidly triage patients: immediate intervention or not, or dead.
- Mark patients: Colour (RED/YELLOW/BLACK) or Number (Priority 1 or 2 or DEAD), consider cover or remove dead.

**Use a triage system you are familiar with, or:**

**DEAD** ● • No pulse and not breathing with opened airway

- RED** ● • Actual or impending airway occlusion, but still breathing with support
- Reduced conscious level
  - Obvious ongoing significant bleeding, or tourniquet

**Abnormal vital signs:**

Age:	RR	Pulse
Infant	More than 50 or less than 30	More than 140
Small child	More than 30 or less than 20	More than 130
Larger child	More than 25 or less than 15	More than 120

**YELLOW** ● All others who cannot walk

Note: heart rates et are given for adults - they are NOT reliable for children

continued on next page



## 8 IMMEDIATE TREATMENT ON SCENE

- Do not do CPR on dead patients if using that resource means that others will die
- As equipment allows, concentrate on basic airway management and haemorrhage control
- Rarely role for advanced procedures such as chest tubes, intubation etc.



## 9 IS THERE AN ORGANISED TRANSPORT SYSTEM ?

### YES:

Go to **Help at the transport point** (Box 10)



### NO:

With no scene structure and no effective resources available to implement one, you can only do the best you can. If the situation changes, go back to 1.

- Leave the walking wounded
- Move through casualties as you find them
- Call help to those alive but seriously injured
- Concentrate on postural drainage and haemorrhage control

## 10 HELP AT THE TRANSPORT POINT

- Move to main transport point
- Mark those most seriously injured (**see box 7**)
- Try to influence priority for transport
- Send info back to hospital when possible
- Minimal treatment to survive journey without significant deterioration
- If delay to transport or long journey, consider dressings and splintage
- Analgesia if possible
- Document findings briefly if possible

## IN-FACILITY MANAGEMENT

### 11 Prepare the STAFF:

- Get information from the scene if at all possible
- Brief all personnel on the incident, what is expected, their roles and responsibilities
- Task each group to prepare their area
- Consider engaging community support with tasks like managing relatives and walking wounded

### 12 Prepare the FACILITY:

- **MAKE SPACE** – move any patients who can safely go to a low dependency area with minimal support
- Identify areas for RECEPTION & TRIAGE, RED (P1) CASUALTIES, URGENT (P2), MINOR WOUNDED (GREEN) and MORTUARY

### 13 Can you increase resources?

- Consider pre-drawing key medications (analgesics, TXA)
- Do you have options for blood – can you trigger a donor panel?
- Are there off-duty staff who can be called in?
- Can you communicate with nearby facilities?

### 14 Manage flow:

- If safe to do so, **triage** before entry (**Box 7**). Use an experienced staff member, with supporting personnel to control flow into the facility
- Try to divert extra family members/uninjured to a holding area and keep them informed about what is happening. If possible use a local leader as liaison
- Early surgical planning is critical – those needing an operation now should go straight to theatre if possible
- Those who are not immediately critical should be moved to a ward area as soon as possible for analgesia, antibiotics, splintage/dressings and frequent review
- **Walking wounded should be managed in a separate area nearby if possible**

### 15 Keep resus for those waiting for an immediate operation/intervention:

- Only patients needing immediate life-saving interventions should be in resus or theatre
- Anyone stable enough to wait an hour or more should be moved to a ward area if there are others needing the resuscitation spaces
- On the ward they should be reassessed constantly, and other measures to prevent deterioration (analgesia, antibiotics, wound care et) undertaken while waiting

# Pre-Hospital Emergency Care

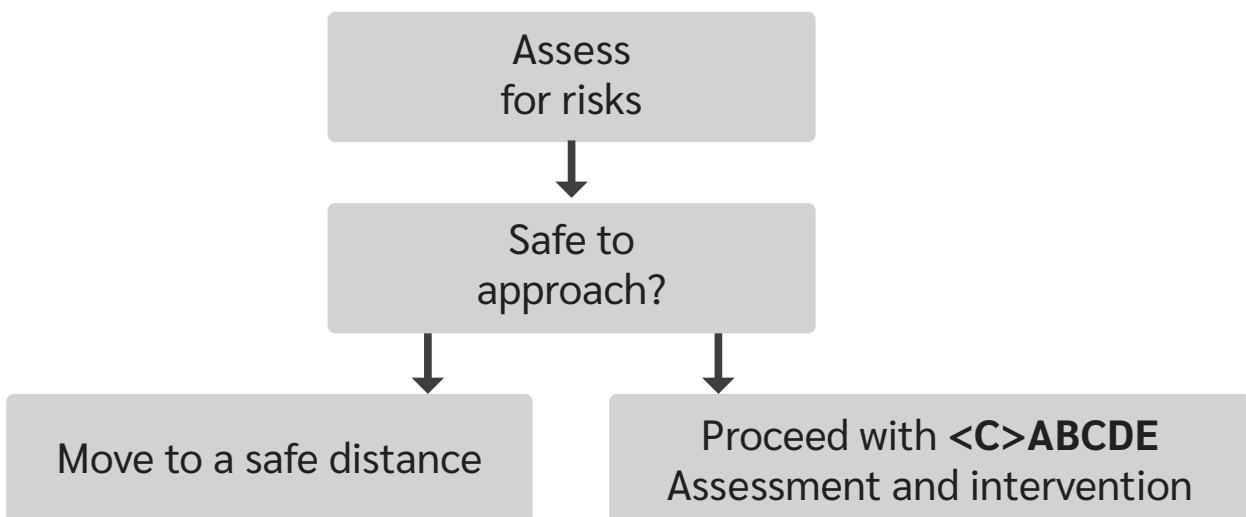
This section will cover the approach to treatment of the injured child at scene by trained responders.

## Summary

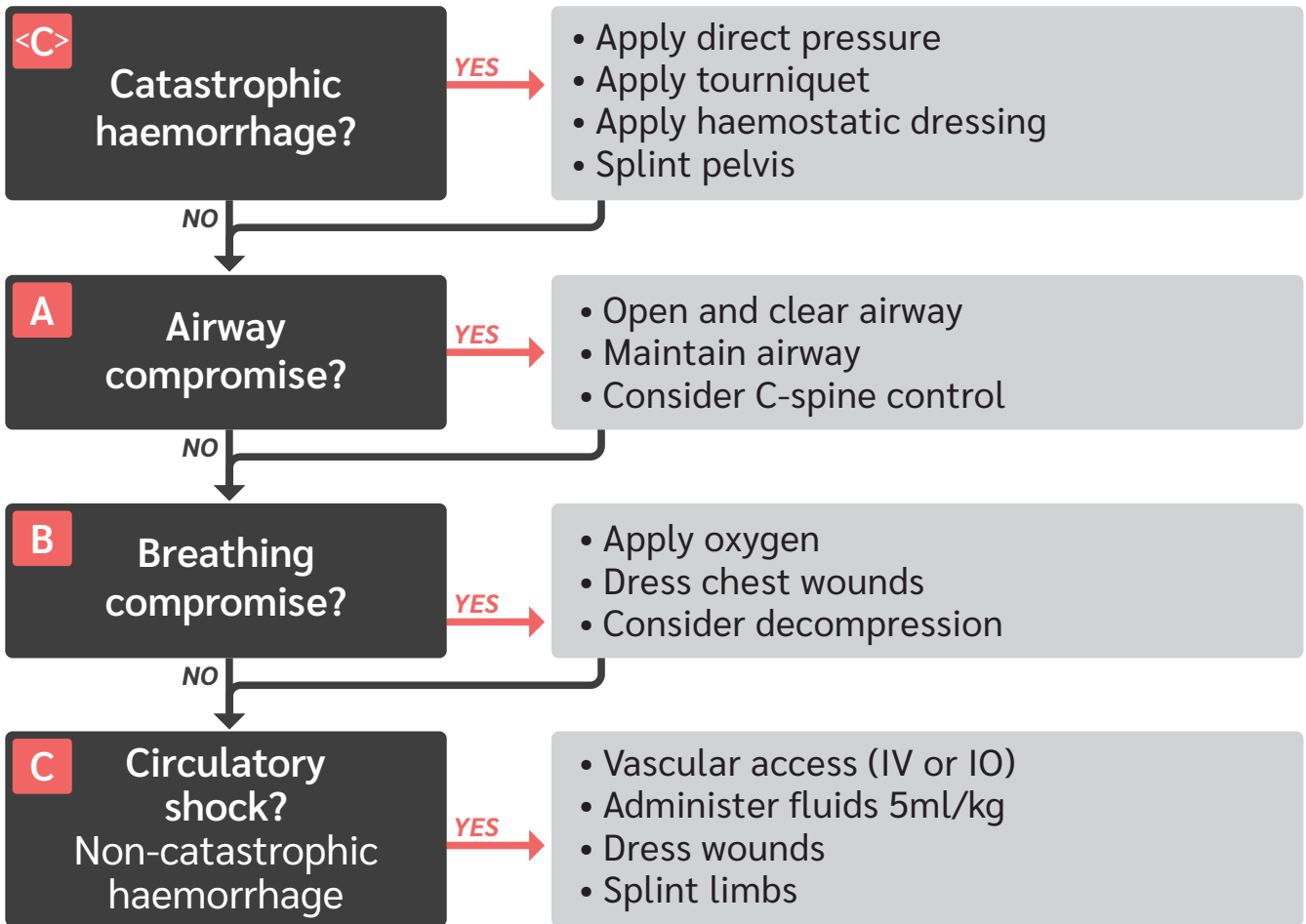
- Safety is the highest priority. Safety of SELF, then PATIENT, then SCENE. Assess for risks
- Assess and treat the child in using the <C>ABCDE approach to the injured child
- Use a continuous cycle of **ASSESSMENT** ► **INTERVENTION** ► **REASSESSMENT** at scene and in transfer
- Handle children carefully to preserve blood clots
- Do not delay transfer except for life saving intervention

## Safe Approach

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## <C>ABC Assessment and Intervention



### <C> Catastrophic Haemorrhage

#### Control of catastrophic haemorrhage is the first priority

- Check all over for catastrophic haemorrhage
- Apply direct pressure to all heavily bleeding wounds, once controlled apply a pressure dressing
- Consider a haemostatic dressing or continuous manual pressure if not controlled
- If still not controlled apply a tourniquet immediately above the wound. **Record time of application and reassess regularly**
- Apply a tourniquet to all limb amputations. **Record time of application and reassess regularly**
- Apply a pelvic splint in all lower limb amputations and children with shock, **never manipulate (spring) a pelvis**

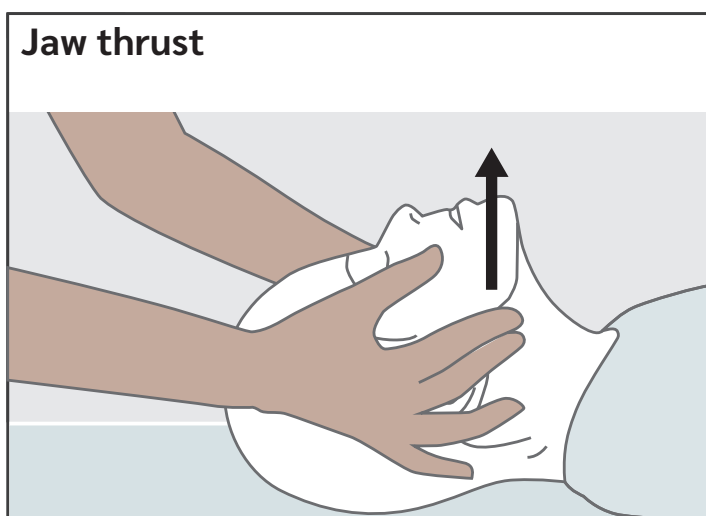
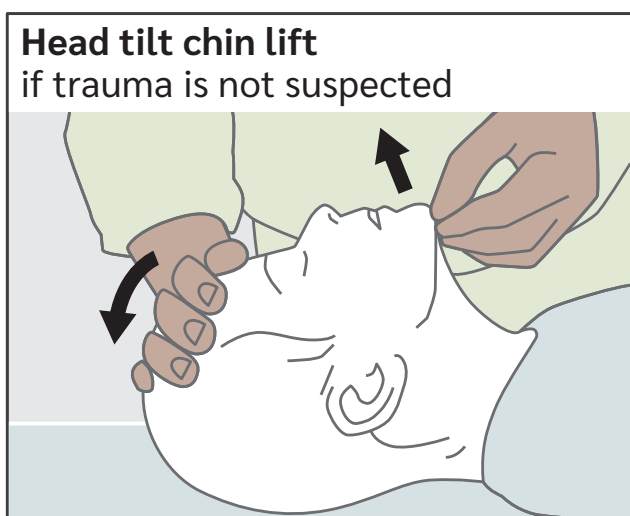
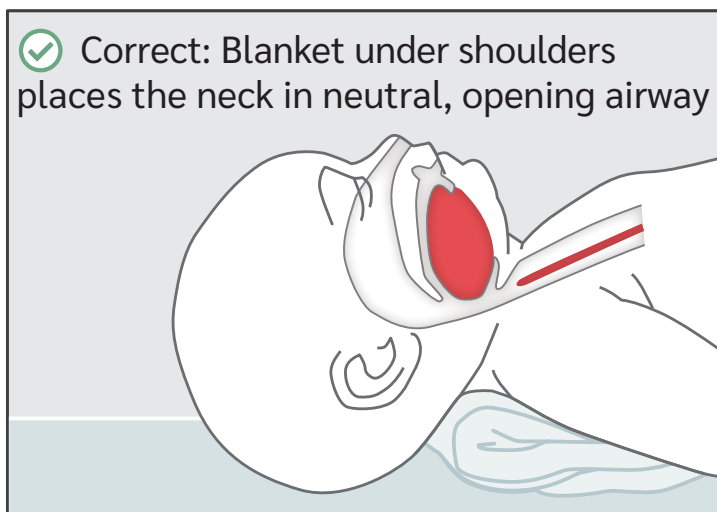
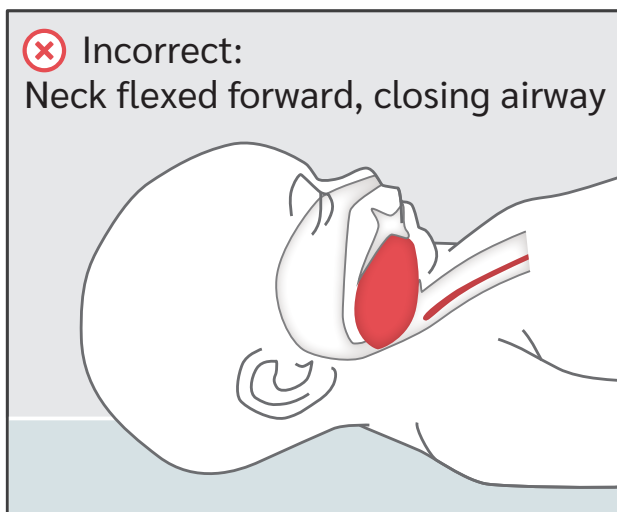
## CLOT PRESERVATION



- The first blood clot is the strongest blood clot
- Handle casualties carefully and to a minimum
- Use a scoop stretcher to move casualties
- Maintain a radial pulse with 5ml/kg fluid boluses repeated as required

## Airway

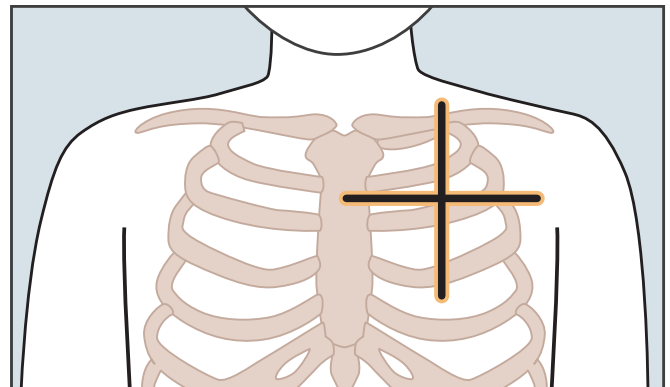
- Assess for signs of obstruction and burns
- Maintain in an open position appropriate to age, manually or with adjuncts
- Consider cervical spine injury and control, **do not use rigid collars in children**





## Breathing

- Assess for signs of increased work of breathing
- Measure and record respiratory rate and oxygen saturations (if available)
- Apply oxygen, maintain saturations >94%
- Check for penetrating chest wounds and dress with a non-occluding chest wound dressing  
Check patency regularly
- Position semi-supine if able or allow child to position themselves
- Remove restriction such as heavy debris/tight clothing
- Be vigilant for signs of tension pneumothorax and be prepared to perform needle decompression

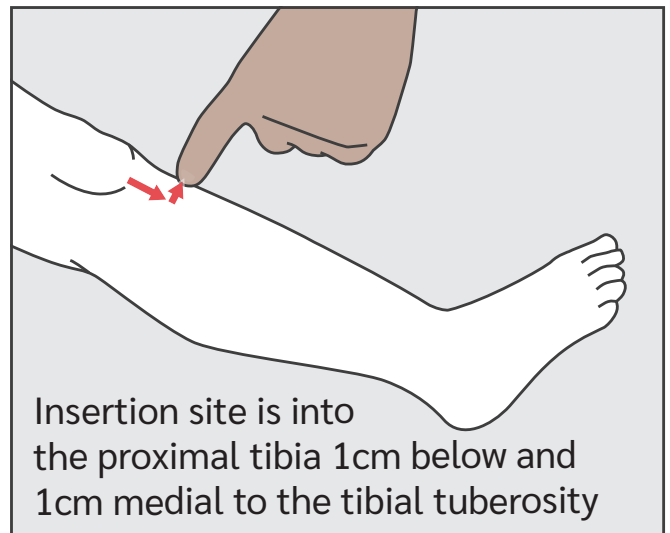


Needle Decompression Second intercostal space, mid clavicular line. Insert cannula over superior margin of third rib through second intercostal space into the pleural space in line with the mid clavicle.

## Circulation

Measure and record capillary refill time, pulse rate and presence or absence of radial pulse in children or brachial in infants

- If there are signs of shock gain access **IO is the easiest route in pre-hospital conditions**
- If the radial (brachial in infants) pulse is absent give available and warmed (if possible) blood product or crystalloid at a 5mg/kg bolus and tranexamic acid 15mg/kg
- Reassess, if still no radial (brachial in infants) pulse repeat bolus
- Repeat as required whilst arranging immediate transfer to medical facility

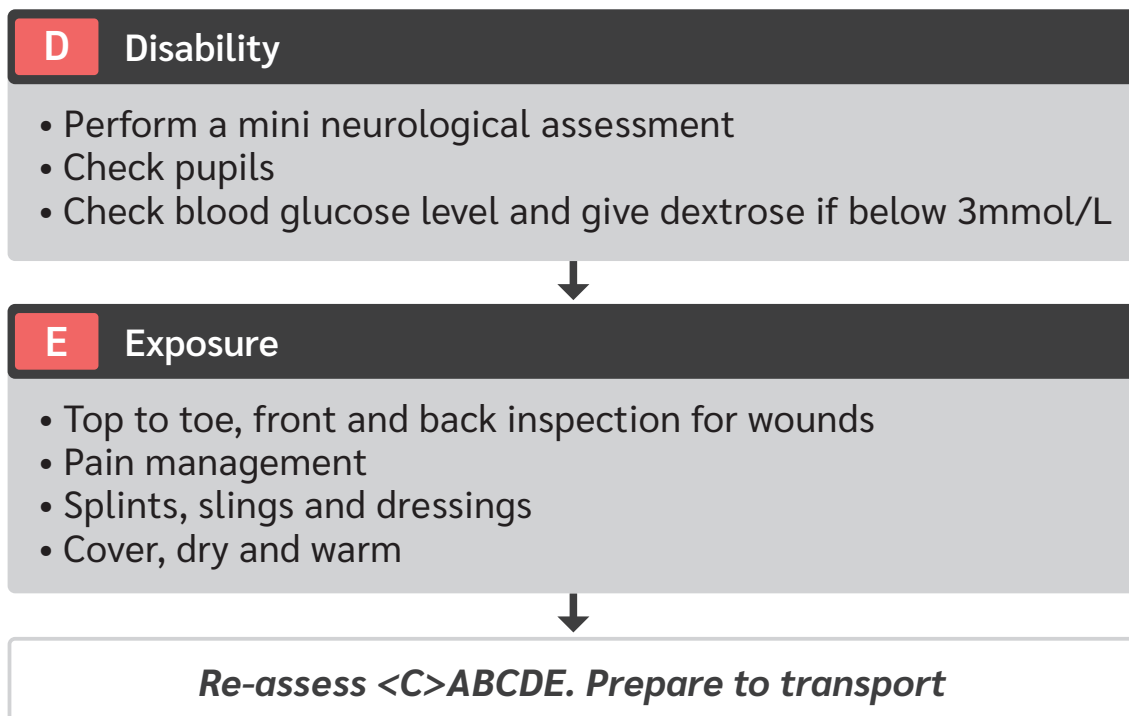


Insertion site is into the proximal tibia 1cm below and 1cm medial to the tibial tuberosity

**Important:** Do not replace intra-osseous in same bone if needle has fallen out - risk of fluid extravasation and inadvertent tissue tourniquet effect

## DISABILITY AND EXPOSURE

Once <C>ABC assessment and intervention is complete move onto **Disability** and **Exposure**



### Disability

- Record limb movement
- Record pupil size, symmetry and response
- Record consciousness (AVPU or GCS)
- Manage pain using pharmacological and non-pharmacological methods
- Measure blood glucose and give 2ml/kg 10% dextrose if less than 3mmol/l

### Exposure

- Expose children for examination for the minimum time necessary but complete an all over examination for wounds, top to toe, front to back
- Keep children dry and warm at all times
- If not already done, splint injured limbs and dress any remaining wounds
- Begin to package for transport


## PSYCHOLOGICAL FIRST AID

- Blast injury and treatment will be stressful to the child and caregiver
- Physical injury and intense fear will lead to psychosocial impact
- Negative psychosocial impacts can be mitigated at every stage of the care pathway
- Do not separate children from parents or guardians unless unavoidable
- Support caregivers in their care of children

### Make contact

- Introduce yourself by name and explain who you are, and ask the child's name
- Ask the child their concerns and what they might need
- Communicate with children in ways they can understand
- Stay calm and help parents to stay calm, and offer comfort and support
- Speak in your normal tone of voice and remain calm and reassuring

# Pre-Hospital Transport and En Route Care

- Prehospital transport of an injured child is a hazardous period for both patient and clinicians, requiring planning, vigilance and care to ensure safety. 
- Bring a parent if you can.
- It may be difficult to solve problems in transit; plan ahead – try to complete critical interventions before starting. If there are problems, consider stopping to deal with them.
- Ensure access to the patient and all critical equipment at all times.
- Recheck bleeding control treatments to ensure that they are still effective and ensure you can access them to adjust if needed.
- Ensure you can assess and access the airway.
- Remember Tension Pneumothorax if there is a sudden deterioration in Respiratory OR Cardiovascular status.
- Splinting and analgesia should be achieved if possible before transport.
- Give an ATMIST handover.

## SAFETY

- Encourage parents to travel with their injured children, visible to the child and ideally near them
  - Use the transfer checklist (below)
  - It may be safer to stop to carry out a procedure if needed
  - Such journeys may be risky – the safety of the driver and crew must be balanced with the need to move the child quickly.

## Prehospital Transfer Checklist

- 
- 
- Appropriate clinical team for transfer

---

  - Patient safely secured for transport

---

  - Is patient optimally packaged (warming, comfort, access)

---

  - IV lines accessible to clinician and patient

---

  - Emergency equipment rapidly accessible –  
BVM, IV fluids, airway adjuncts

---

  - Sufficient monitoring visible

---

  - Clinical team have possession of all their own equipment and drugs

---

  - Confirmed Patient Details and Parent/NOK details as available

---

  - Confirm destination with child's parent/carer

---

  - Check medical supplies for journey (O<sub>2</sub>, power supply)

---

  - Check transport supplies (fuel, driver, vehicle availability)

---

  - Communicated planned arrival with receiving facility including  
ATMIST handover

---

## ATMIST handover structure

<b>A</b>	Age of patient
<b>T</b>	Time of injury
<b>M</b>	Mechanism of injury
<b>I</b>	Injuries
<b>S</b>	Signs (pulse, RR, SaO <sub>2</sub> , Cap refill)
<b>T</b>	Treatment given (including Tourniquet timings)

## PREPARING FOR TRANSFER

### Catastrophic Haemorrhage

- Position the patient so that direct pressure can be applied throughout the journey
- Check any tourniquets are effective and accessible

### Airway

- Position yourself and the patient so that you can continue their airway management (such as insert an airway adjunct) while moving if needed.
- Ensure you can assess the airway even with the noise and movement.

### Breathing

- Check that oxygen is running at the effective minimum flow
- Check chest seals are patent

### Circulation

- Flush and secure cannulas
- Hang fluids and close tap

### Pain relief

- Immobilise injured limbs and provide analgesia for the journey.

## TRANSFER ACTIONS

### Assess ► intervene ► reassess



A patient's condition can change rapidly and will be less obvious because of the distractions of a transfer, compared to the hospital environment.

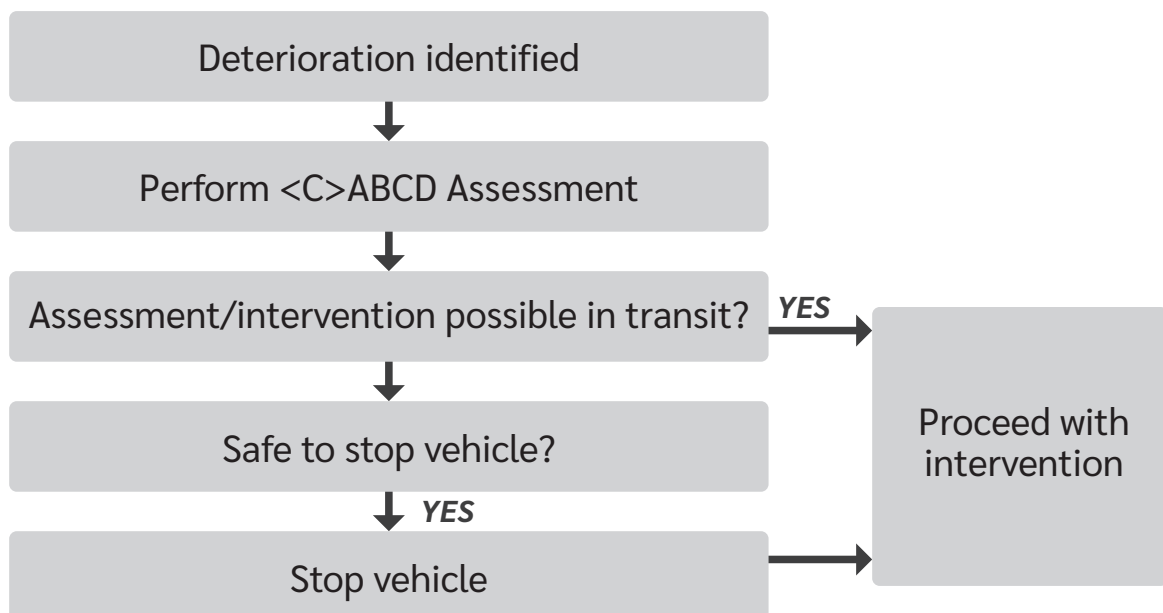
Transferring an injured patient involves a constant cycle of assessment along with any necessary interventions. A patient's condition is dynamic and can change rapidly and will be less obvious because of the distractions of the pre-hospital transfer environment.

Perform regular reassessment of the child using the **<C>ABCDE** structure to look for signs and causes of deterioration.



## Signs of deterioration

- Monitored deterioration in measured vital signs
- Mask stops fogging
- Reduced/asymmetrical chest movement
- Ventilation difficulty/high pressure
- Pallor/cyanosis
- Visible haemorrhage
- Loss of palpable pulses
- Change in consciousness
- Pupil asymmetry



Whilst in transit prepare an ATMIST handover and pre-alert the medical facility if you have communications with the facility.

## ARRIVAL AT DESTINATION MEDICAL FACILITY

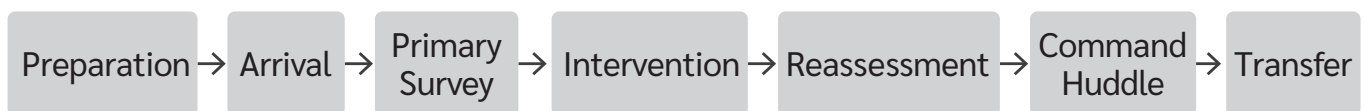
- Perform a final assessment of the patient near the end of your transfer so handover information can be as current as possible
- Provide a brief handover on arrival to the receiving team (ATMIST format)
- Allow the team to complete their initial assessment, and then provide the team leader with any additional details regarding the scene and family members who have travelled with the patient

# Damage Control Resuscitation and Surgery

- DCRS is the rapid and horizontal application of assessment resuscitation, critical care and surgery in order to control haemorrhage and restore normal physiology in the injured child as quickly as possible therefore increasing survival
- Children sustain mostly the same injuries in blast trauma as adults
- The structure to assess and treat an injured child is largely the same as that used in adults



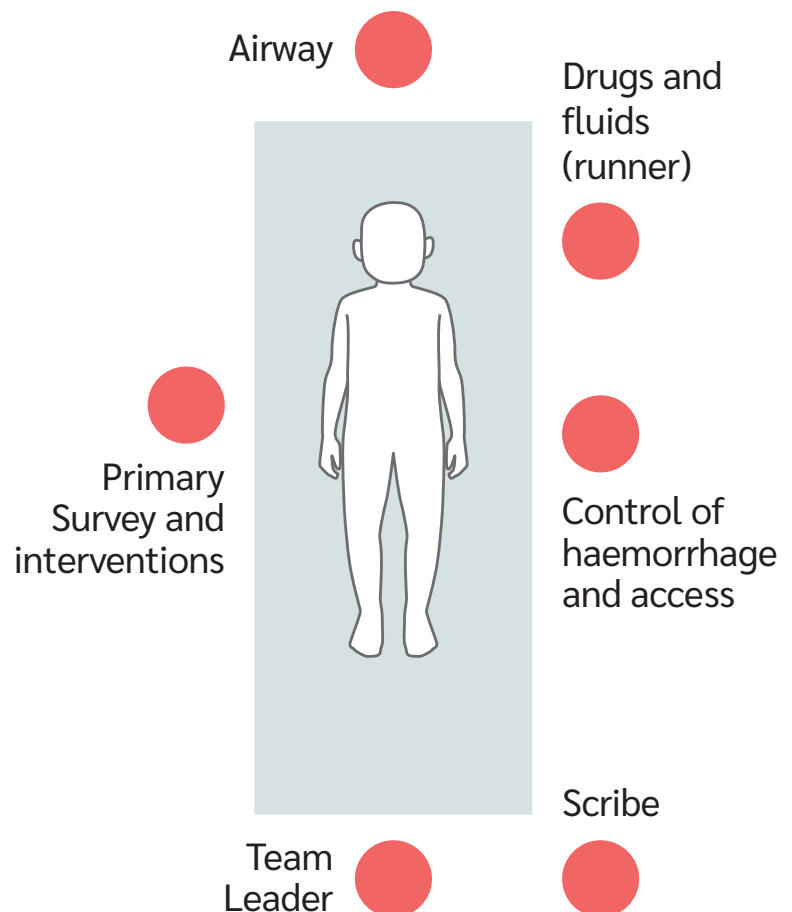
*The phases of DCRS are*



## PREPARATION

At 20 minutes prior to receiving casualties the team(s) should be briefed as to the nature of the casualty or casualties. Roles should be allocated and confirmed. Depending on number of personnel available these are:


- Team Leader
- Airway
- Primary Survey and interventions
- Control of haemorrhage and access
- Drugs and fluids (runner)
- Scribe





Once personnel have been allocated roles and briefed prepare equipment, drugs and fluid. Any equipment that might be used should be briefly checked and made available. Any fluids or drugs required should be calculated and prepared.

The presence of paediatric casualties raises emotions across the trauma team and this can be detected by the child so a calm and quiet approach is important. The trauma team leader must ensure this happens.

Weight estimation for resuscitation in trauma can be safely made using 

$$\text{Weight in Kg} = (\text{Age plus 4}) \times 2$$

A paediatric triage/treatment tape can be used to estimate weight. Children should be weighed as soon as is possible to get an accurate weight.

In low income setting subtract 2kg <6 years old and 4kg 6 years and over

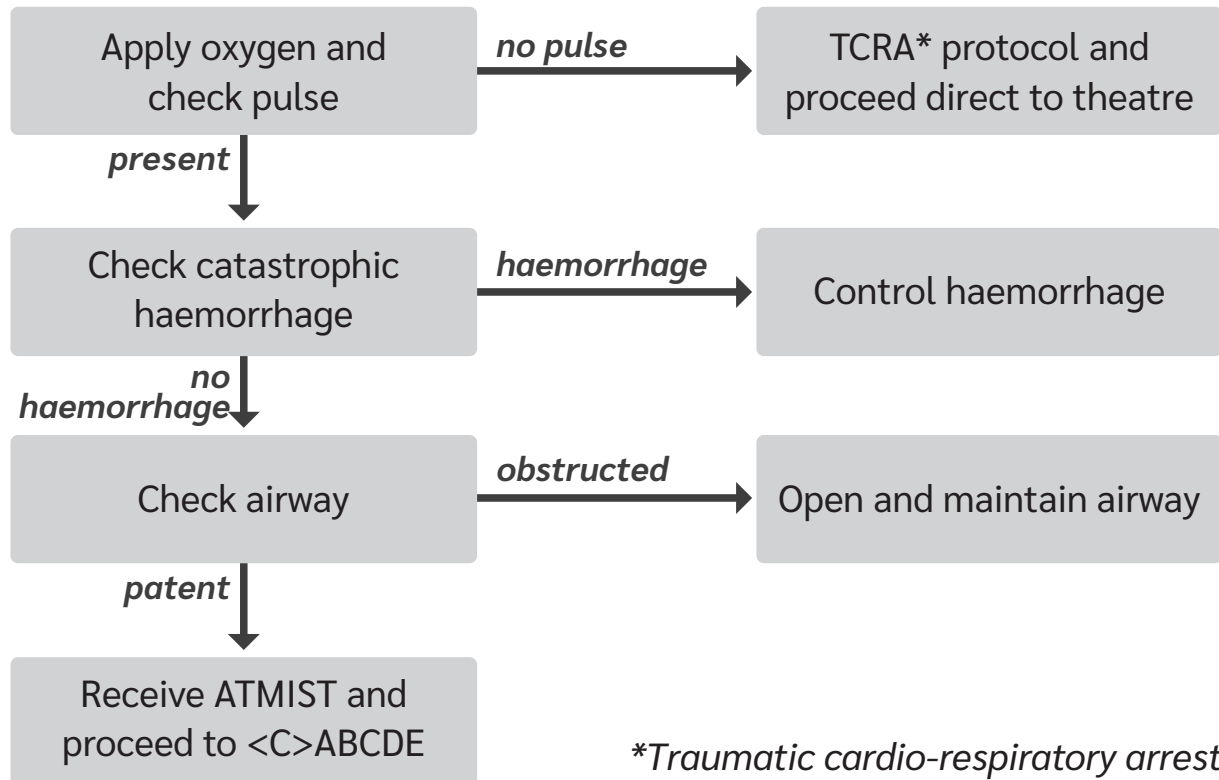
### Calculate and note down:

<b>W</b>	Weight
<b>E</b>	Endotracheal tube size
<b>T</b>	Tranexamic acid dose
<b>B</b>	Blood bolus volume
<b>A</b>	Antibiotic dose
<b>G</b>	Glucose dose

(See Annex 5A, page 42)


## ARRIVAL

On arrival the following is performed



\*Traumatic cardio-respiratory arrest  
See Annex 5D, page 47

## PRIMARY SURVEY

- The primary survey is performed using the <C>ABCDE structure. 
- Be familiar with the normal physiological ranges for children as per age
- Immediately life threatening injuries are dealt with as they are found

**Table: Normal physiological ranges**

Age	Guide weight (kg)	RR at rest Breaths per min 5 <sup>th</sup> -95 <sup>th</sup> centile	HR beats per min 5 <sup>th</sup> -95 <sup>th</sup> centile	BP Systolic		
				5 <sup>th</sup> centile	50 <sup>th</sup> centile	95 <sup>th</sup> centile
Birth	3.5	25-50	120-170	65-75	80-90	105
1 month	4.5					
3 months	6.5					
6 months	8	20-40	110-160	70-75	85-95	110
12 months	9.5					
18 months	11	20-35	100-155	70-80	85-100	110
2 years	12					
3 years	14					
4 years	16					
5 years	18	20-30	80-135	80-90	90-110	110-120
6 years	21					
7 years	23					
8 years	25					
9 years	28					
10 years	31	15-25	70-120	90-105	100-120	125-140
11 years	35					
12 years	43					
14 years	50					
Adult	70					


## <C> Catastrophic haemorrhage

- Apply or tighten tourniquets on amputated limbs to control bleeding
- Apply pelvic splint in all suspected pelvic injury and lower limb amputations
- Apply direct pressure to wounds in junctional areas and maintain until control is gained
- Consider moving straight to the operating theatre if peri-arrest in hypovolaemia

## Airway

- Assess for obstruction or imminent obstruction
- Open and maintain airway
- Consider rapid sequence induction of anaesthesia and intubation – (see RSI Section page 34)

## Breathing

- External signs of injury may be absent in children even if there is significant Intrathoracic injury. Rib fractures are an indicator of significant force 
- Children desaturate quickly
- Over-vigorous bag valve mask ventilation will lead to gastric distension and risk of aspiration or diaphragmatic splinting
- Tachypnoea is an early sign of injury and or hypovolaemia and should not be ignored

- Assess for signs of respiratory distress or failure
  - Tachypnoea
  - Increased work of breathing
  - Hypoxia/cyanosis
- Identify life-threatening chest injuries and intervene
- Prepare for early rapid induction of anaesthesia in respiratory failure – see RSI Section page 34
- Perform a plain chest radiograph and clinical examination of chest

## Summary of chest injuries in children

Injury	Signs	Interventions
Pneumothorax	Tachypnoea Hypoxia Unilateral breath sounds	Oxygen Chest drain
Open Pneumothorax	Penetrating wound Tachypnoea Hypoxia Reduced breath sounds	Chest seal dressing Surgery Chest drain
Tension pneumothorax	Tachypnoea Hypoxia Signs of shock	Oxygen Chest decompression Chest drain
Massive haemothorax	Tachypnoea Signs of shock Unilateral breath sounds Dull to percussion	Oxygen Volume replacement Chest drain
Blast Lung (See Notes on Blast Injury Annex 5E p51)	Tachypnoea Hypoxia Respiratory distress	Oxygen Respiratory support
Flail Chest	Paradoxical chest wall movement Tachypnoea Hypoxia	Analgesia Oxygen (Ventilatory support)
Cardiac Tamponade	Signs of shock Penetrating wound	Oxygen Volume replacement Thoracotomy

## Circulation



- In first hour after injury maintain a radial pulse and improve perfusion. After the first hour restore normal perfusion
- Children decompensate late and catastrophically
- There is no such thing as hypotensive resuscitation in paediatrics
- Do not use vasopressors in the management of hypovolaemia
- Tachycardia in trauma is always due to hypovolaemia until proven otherwise
- Intraosseous vascular access is easy and reliable in the shocked child
- **NEVER USE HYPOTONIC OR HYPONATREMIC FLUIDS IN THE RESUSCITATION OF A CHILD**

### **Always assume tachycardia is secondary to hypovolaemia**

- Assess for signs of shock
  - Tachycardia
  - Prolonged capillary refill time (<2sec)
  - Tachypnoea
  - Pallor
  - Examine abdomen
- Prevent further haemorrhage
  - Dress wounds
  - Splint fractures
  - Splint pelvis if indicated –  
**Never manipulate the pelvis to assess stability**
- Replace circulating volume
  - Gain vascular access, (consider intraosseous as an early or first option – see Annex 5B, page 43)
  - Administer blood and blood products as per massive transfusion protocol (Annex 5C, page 44)
  - **Reassess after every 5ml/kg bolus – aim to maintain a radial pulse in the first hour and to improve pulse, capillary refill time, and signs of perfusion.**  
(See massive transfusion protocol Annex 5C, page 44)
  - Give tranexamic acid
  - Give calcium chloride as per massive transfusion protocol

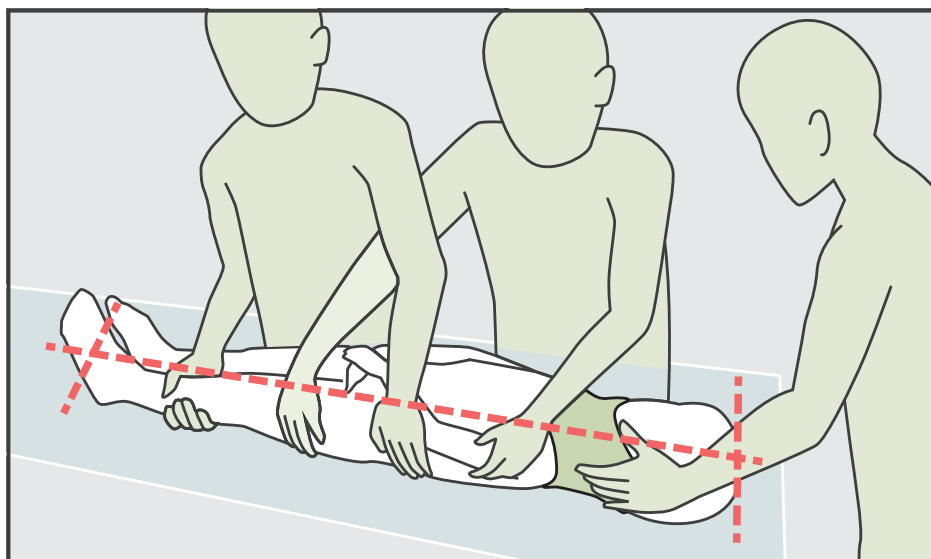
## Disability

- Stressed and injured children are at higher risk of hypoglycaemia – check serum glucose in all children
- Correct hypoglycaemia with 2ml/kg of 10% dextrose
- Perform neurological assessment including consciousness
- Check serum glucose and correct hypoglycaemia
- Take spinal precautions if indicated (see section 10)
- Take neuro-protective measures if indicated

## Exposure

- Children are at high risk of hypothermia which increases mortality
- Uncover – Examine – Cover, in body areas
- Log roll only once to examine posterior, minimise degree of tilt
- Examine this child from top to toe, 360 degrees for any injuries.
- This should be done at first available opportunity and may be after initial surgery but ensure it is done
- Ensure the child is kept warm and dry
- Warm fluids
- Warm the room
- Monitor temperature

### *Three person log roll for children*



## INTERVENTION

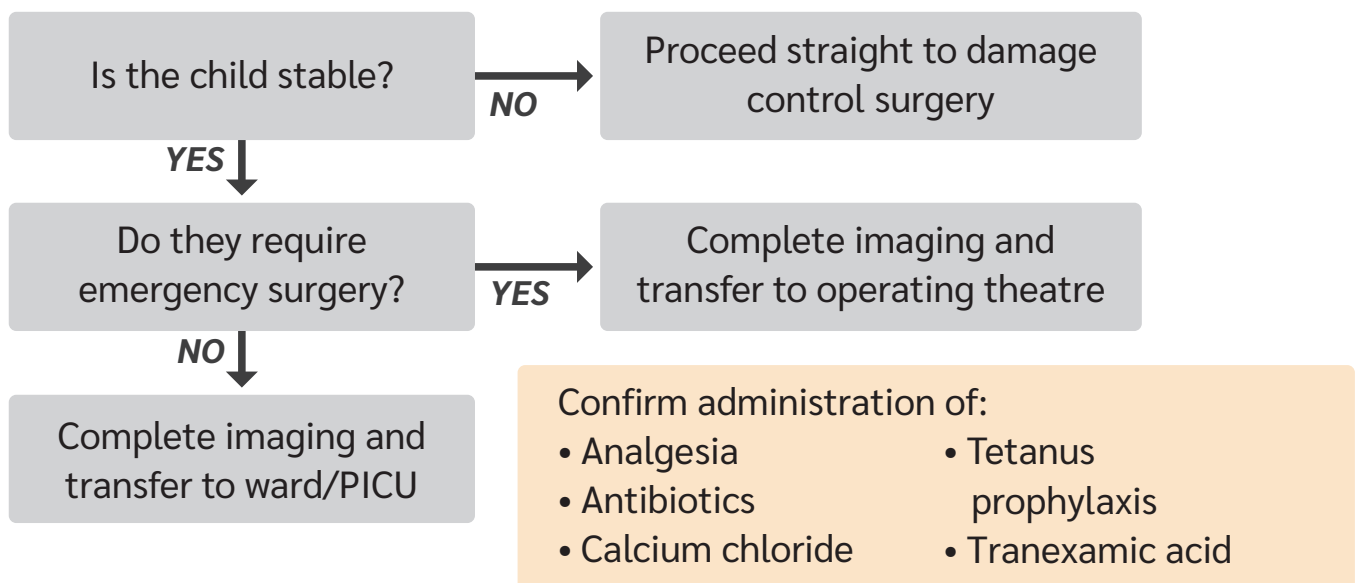
As the primary survey progresses there may be a requirement to urgently intervene in order to save life.

### Reassessment

- Following each intervention briefly reassess <C>ABC to establish if there has been any improvement
- At the end of the <C>ABCDE assessment briefly reassess to confirm that:
  - <C> Catastrophic haemorrhage remains controlled
  - Airway is patent and maintained
  - Ventilation and oxygenation are adequate
  - Transfusion has started if required
  - Consciousness is stable or improving and there is normoglycaemia
  - Child is warm and covered
- If immediately life threatening issues have not been resolved, go back, intervene and reassess

## COMMAND HUDDLE

Following initial assessment and intervention recap of the clinical situation is performed the team. At this point a decision is made on the next phase of care.

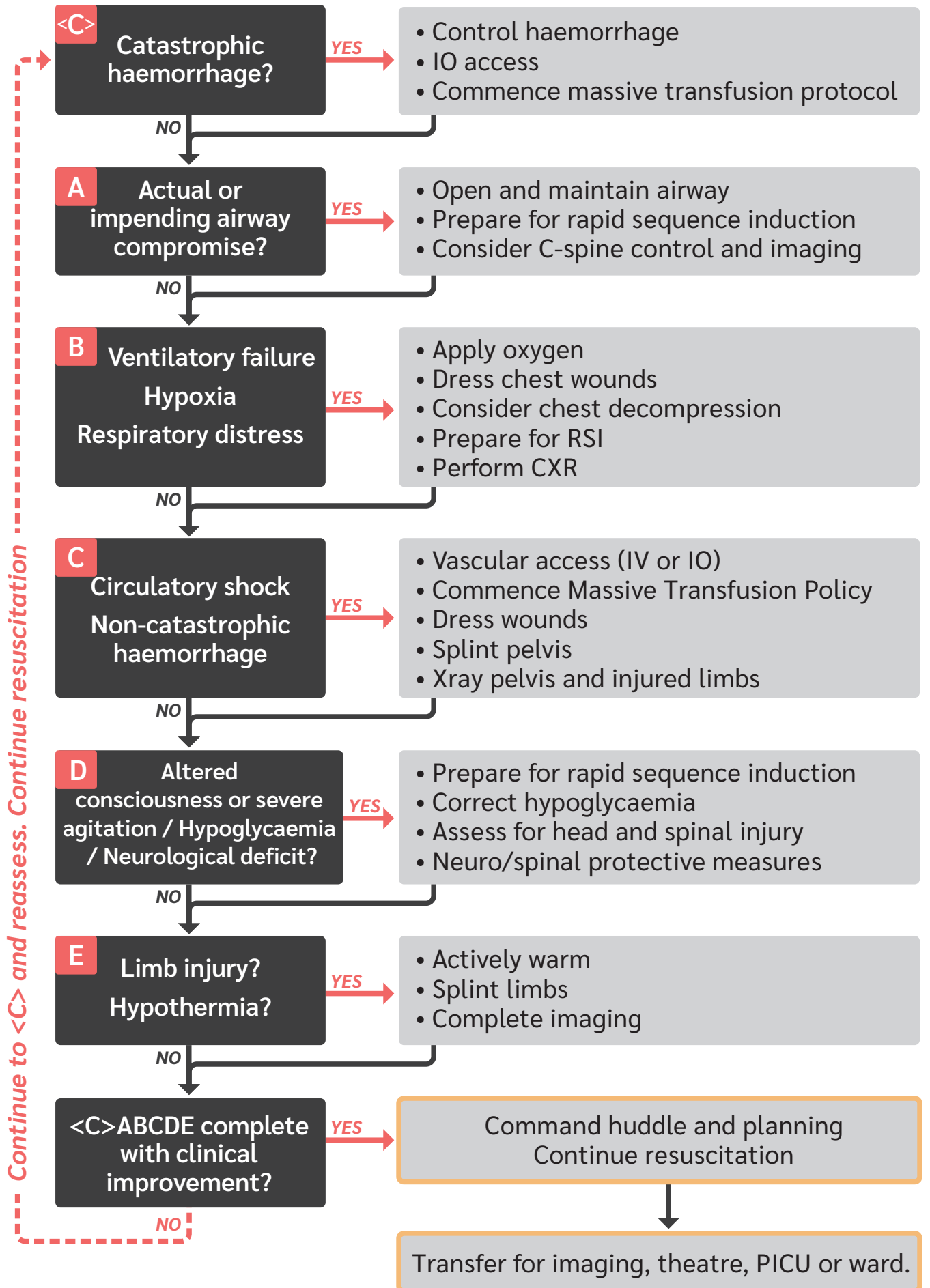


- The command decision should be brief and led by the team leader
- The decision should be clearly communicated to the whole team
- The decision should be communicated to the parents/guardians






# <C>ABCDE Algorithm



## RAPID SEQUENCE INDUCTION IN DCRS

- The decision to perform rapid sequence induction (RSI) must be taken in conjunction with the trauma team leader and the whole team should be aware 
- RSI is undertaken as safely as possible. Physiology should be optimal and all kit and personnel ready.
- Occasionally, immediate RSI on arrival is required. Be prepared

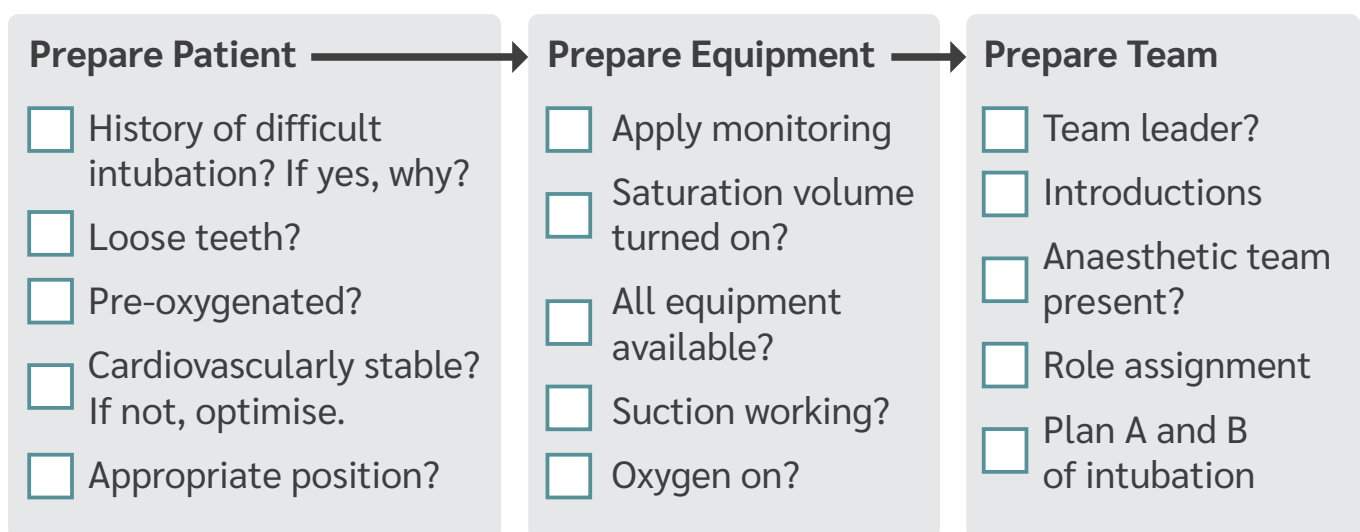
The indications for RSI in DCRS are

- Actual or impending (e.g. burns, expanding haematoma) airway obstruction
- Reduce consciousness or agitation
- Humanitarian e.g. uncontrollable pain or distress to the child
- Predicted clinical course e.g. will need immediate surgery

Prepare using a checklist and apply monitoring

- ECG
- BP
- Pulse Oximetry
- Capnography

### PRE-INTUBATION CHECKLIST: POSITIVE RESPONSE CHECKS



**PRE-INTUBATION  
CHECKLIST:  
EQUIPMENT NEEDED**



Oral airway



Suction



Oxygen mask



Fluid & drugs



Anaesthetic circuit



Laryngoscopes



Lubricant gel



Stethoscope



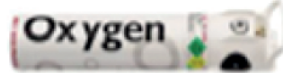
ERCO<sub>2</sub> Monitor



Syringe



Magill Forceps



Oxygen



Self-inflating bag



Tape



ET tubes



Stylet & boogie

## Induction and Intubation

- Pre-oxygenation is critical, children desaturate very quickly, you will have less time
- The sicker the child the lower the dose of hypnotic and opiate



Once the team is prepared and checklist is complete proceed to induction. The clinician performing this should use drugs they are familiar with but a recommended combination for trauma induction is:

Child's physiological status	Dose:		
	Fentanyl (mcg/kg)	Ketamine (mg/kg)	Rocuronium* (mg/kg)
Normotensive	3	2	1
Shocked	1	1	1
Peri-arrest	0	0	1

*\*or succinyl choline*

Intubate with a cuffed tube (inflated to a slight leak at low pressure. If cuffed tubes not available consider a moistened throat pack.


Confirm placement with inspection of chest movement, auscultation and a team confirmation of end tidal CO<sub>2</sub>. Reconfirm every time the child is moved.

Post intubation secure tube using 'trouser legs' (see section 7 page 81) and confirm ABC status and transfer to ventilator.

**Aim for 6ml/kg tidal volume and positive end expiratory pressure of 4cm H<sub>2</sub>O**

Commence maintenance of anaesthesia and paralysis (see section 7 page 82).

## DAMAGE CONTROL SURGERY\* (DCS)

- Damage control surgery is a brief resuscitative procedure in order to 
  - Control haemorrhage
  - Restore perfusion
  - Limit contamination with bowel content
- Damage control surgery is equally effective for children of all ages
- The principles of when to surgically intervene in children of all ages are the same as those in adults
- The goal is to allow restoration of a normal physical state, **NOT** achieve definitive repair
- Damage control surgery is limited to **ONE HOUR**
- **Resuscitation continues in parallel with the surgery – continually communicate with the resuscitation team and anaesthetist**

*\*See Section 8 for expansion on paediatric trauma surgery*

### Indications for DCS

Immediate intervention should occur for an injured child when despite resuscitation the child is:

- Peri-arrest
- Blood pressure cannot be quickly restored or maintained
- Evidence of non-compressible and continuing bleeding
- Evidence of bowel perforation/evisceration
- Worsening physiological state
- Requirement for urgent other life/limb saving intervention  
e.g. ischaemia or central nervous system

### Communication

Communicate the plan to move to damage control surgery to the whole team using the WHO checklist on page 100. Indicate goals, risks and plans to deal with complications.

## Thoracotomy or Laparotomy?

This will be guided by the pattern of injury and findings on imaging. The use of focused ultrasound may rule in presence of fluid in the peritoneum but must not be relied on to rule it out. Decisions will be aided by the following

- Control should be as proximal as necessary
- Access to the thoracic aorta is very quick and the aorta is easily manually controlled
- In the absence of sufficient blood to explain physiology, look elsewhere including long bones
- In hypovolaemic arrest thoracotomy should be first access

## Access:

### Abdominal

The quickest access is a midline incision. However the abdominal wall is much thinner and there is a risk of organ injury on breaching the peritoneum, particularly the liver which extends beneath the costal margin.

In children <15kg a transverse incision may be more effective in giving access to the whole abdomen.

### Thoracic

Clam shell thoracotomy is the quickest method of access. Median sternotomy gives good access but is time consuming. Lateral anterior thoracotomy is unlikely to be large enough to allow sufficient access except in adolescents.

### Retroperitoneal

Access to the retroperitoneum is facilitated readily by visceral medial rotation which is easier in children due to thin retroperitoneal attachments.

- Left to Right for expanding haematoma from suspected left renal or aortic branch bleeding
- Right to left (combined with Kocherisation of the Duodenum) for expanding haematoma from suspected right renal or IVC bleeding

## DAMAGE CONTROL PROCEDURES



- Packing is extremely effective at controlling solid organ and retroperitoneal bleeding in children
- Isolated blunt solid organ injury can almost always be managed conservatively in children
- Vascular shunting is difficult. There is a higher risk of ischaemia in children due to less developed collateral circulation

### Once in the abdomen:

- Eviscerate the bowel
- Pack all quadrants of the abdomen
- Pause for any anaesthetic catch-up
- Further control by manual compression of the supra-coeliac aorta. This is safer and more effective than clamping
- Reappraise and remove the packs sequentially from the quadrant of least bleeding/trauma, to the area of most bleeding

**Bowel** – Ligate or staple off of injured small/large bowel segments only rather than suture repair or formal resection-anastomosis.

**Soild organ** – Removal of spleen or (unilateral) kidney instead of protracted attempts to repair may be necessary but consider preservation. Pack liver.

**Vascular** – Ensure proximal and distal control. Ligate or shunt vessels instead of formal repair. Note that shunting is technically challenging in small vessels. Ligation of arteries may carry severe consequences due to ischaemia. Monitor for signs of organ or limb ischemia.

**Limb** – Fasciotomy is indicated in ischaemic or severely injured limbs as in adults (*See section 9*)

**Pelvis** – Pelvic retroperitoneal bleeding can be packed by taking down the pelvic peritoneum, entering the pre-peritoneal plane, dissecting around to the sacrum and packing the pelvis against external splinting. Packing without using the extraperitoneal plane will not result in adequate tamponade.

**Chest** – Non-anatomical lung resections or tractotomy either with stapling devices or by direct suture work well for lung injury with significant bleeding or air leak. Pneumonectomy is very poorly tolerated in young people.

## COMMUNICATION

- Schedule regular pauses to update between resuscitation, anaesthetic and surgery team
- Use the STACK format
- Pause surgery to allow resuscitation catch up if required
- Any member of the team should speak up if there is any problem at any time.



It is vital that there is good and continuous communication during DCRS. To facilitate this a STACK update should occur every 20 minutes. This should be initiated by the anaesthetist. During the STACK up date check the following.

<b>S</b>	Systolic
<b>T</b>	Time (taken operating so far) and temperature
<b>A</b>	Acidosis
<b>C</b>	Clotting (if no testing available then acute clinical signs should be used)
<b>K</b>	Kit used and resources needed

*This will allow the whole team to retain oversight of the clinical progress of the child.*



## POST PROCEDURE

When a damage control procedure has been conducted the abdominal fascia should **not** be closed in order to:

- Reduce the likelihood of abdominal compartment syndrome
- Facilitate planned relook surgery

Use an occlusive negative pressure dressing or other topical negative pressure dressing to cover the viscera, if available, to provide temporary abdominal integrity. A less appealing but practical option is to close the skin alone.

Following completion of DCRS the lead surgeon should complete an operative note. The template for this is in section 8, page 98.

- The aim of DCRS is to stop haemorrhage, reduce contamination and restore normal physiology within one hour of arrival at a medical facility, not to provide definitive surgical repair.
- Resuscitation, surgery and critical care should be simultaneous and not consecutive.
- Communication between all members of the team is vital and should be led by the trauma team leader.



## Pre-arrival Preparation List

**Team leader:**

**Airway/ventilation:**

**Haemorrhage control and access:**

**Primary survey and procedures:**

**Drugs/fluids/runner:**

**Scribe:**

**Weight estimated \***

(Age+4) x 2

kg

**Endotracheal tube diameter**

(Age/4)+ 3.5 cuffed tube

(Age/4)+ 4 uncuffed tube

mm

**Endotracheal Tube Length**

(Age/2)+ 12

cm

**Blood/Blood Product/Fluid Bolus**

5ml/kg (all fluids)

ml

**Tranexamic Acid dose**

15mg/kg

mg

**Antibiotic dose \*\***

mg/kg

mg

**Glucose 10% solution**

2ml/kg

mg

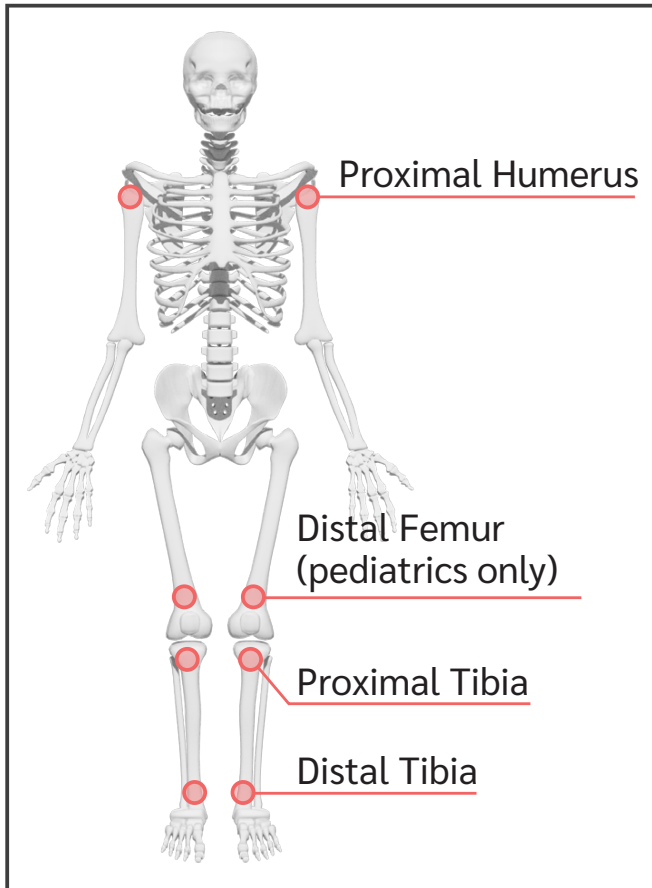
\* Adjust in low-income setting minus 2kg aged 1-5 years or 4kg 6 years and above

\*\* Co-amoxiclav 30mg/kg is appropriate or use local policy

## Intraosseus Access

Intraosseus access offers a very effective route to deliver resuscitation fluids and drugs. It is the easiest way to gain vascular access in small, shocked children.

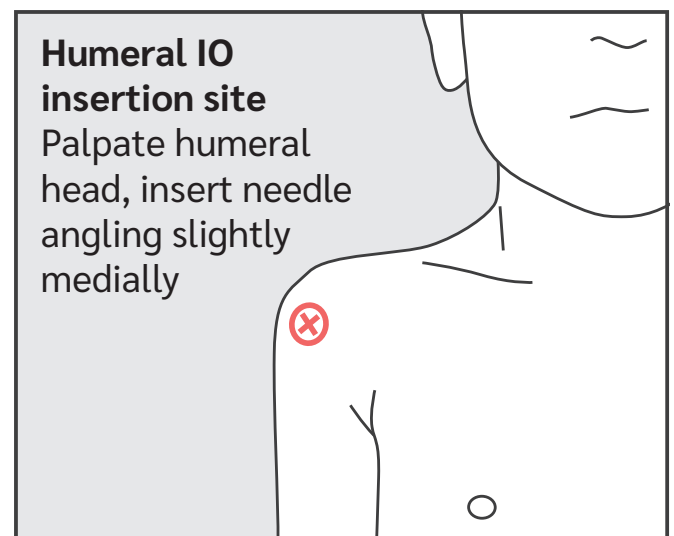
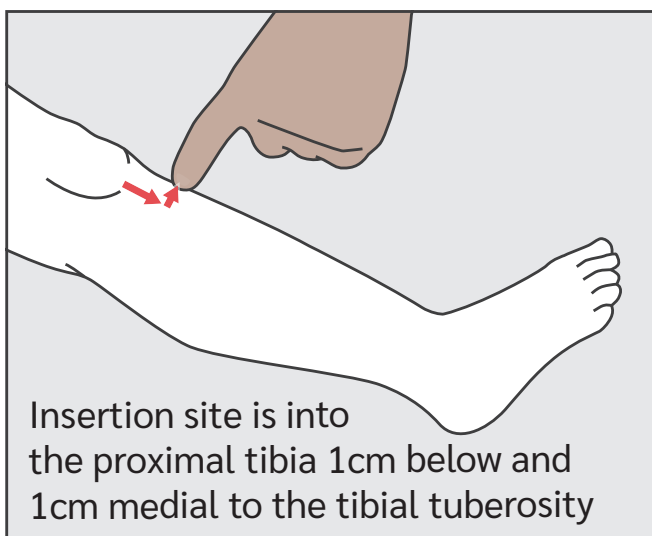
### 10 access points in children



The first option is the proximal tibial insertion point, approximately 1cm distal and medial to the tibial tuberosity. This will vary a little with the size of the child.

### Key points:

- The blood sample from an IO can be used to group/cross match for blood
- Always perform a firm flush of the needle on insertion
- Always deliver fluids actively using a 50ml syringe or an infusion device, they will not flow with gravity only
- All fluids and drugs can be delivered via the intraosseus route
- Be aware of growth plate damage



**Important:** Do not replace intra-osseous in same bone if needle has fallen out – risk of fluid extravasation and inadvertent tissue tourniquet effect

## Massive Transfusion Record Sheet

	Date	Time
Patient Name		
Patient Identifier		Date of birth:
Trauma Team Leader	Lead Anaesthetist	Lead Surgeon

### A. Number of units of products Used (cross off):

<b>PRBC</b>	1	2	3	4	5	6	7	8	9	10	11
<b>FFP</b>	1	2	3	4	5	6	7	8	9	10	11
<b>Cryo</b>	1	2	3	4	<b>Platelets</b>	1	2	3	4		

<b>B. Weight</b>	kg
Whole blood/PRBC/Plasma/PLT/Cryo at 5ml/kg	ml
Calcium Chloride 10% 0.2ml/kg	ml (max 10ml)
Other	mg

<b>Tranexamic Acid</b>	
Initial bolus and subsequent infusion 15mg/kg	mg (up to 1g)

### Abbreviations

PRBC – Packed red blood cells

PLT – Platelets

Cryo – Cryoprecipitate

## C. Bolus Count (see below for volume calculation)

Bolus Time	Volume	Product*	Total Volume	Blood tests	Consider
1				Clotting/Gas	TXA Ca2+ Fibrinogen/Plt Check K+
2					
3					
4					
5					
6					
7					
8				Clotting /Gas	Ca2+ Fibrinogen/Plt Check K+
9					
10					
11					
12					
13					
14					
15					
16				Clotting /Gas	Ca2+ Fibrinogen/Plt Check K+
17					
18					
19					
20					
21					
22					

### Notes:

**1. Maximum bolus volume for all patients is 250ml**

**2. Warm all fluids**

**3. Weight calculation in children**

Use broselow tape to estimate weight.

If not available and age is known use:

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

**4. Safe Transfusion in children using a rapid infusion device**

### Beware of over transfusion

**Under 20kg** – do not attach directly to IV line, used 50ml syringes to bolus

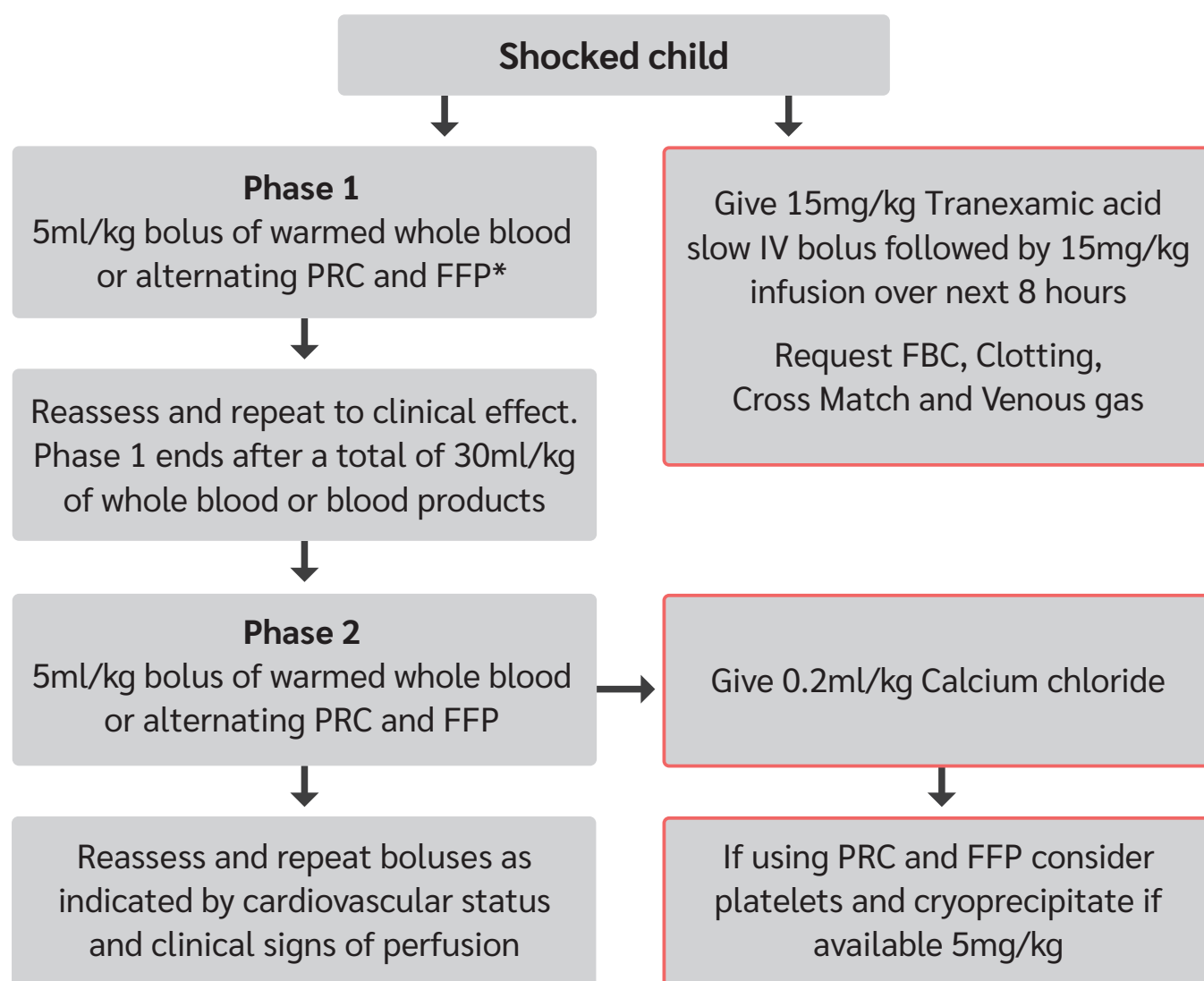
**20 to 30kg** – Use to directly infuse if team is experienced in operating the device

**Over 30kg** – Use normally with 5ml/kg boluses

### 5. Hyperkalaemia

Treat with 0.2ml/kg Calcium Chloride followed by 0.1U/kg Insulin in 2ml/kg of 50% Dextrose IV over 10 minutes.

## Massive Transfusion Policy



### TREATMENT GOALS

#### First hour following injury

- Radial pulse (brachial in infants)
- improving physiology and clinical signs of perfusion

#### After first hour

- Restore normal physiological parameters
- Normal perfusion

#### Throughout


- Ionised calcium of > 1mmol/l
- Platelets >100
- Fibrinogen >1.5/l
- Normokalaemia



- Beware of over transfusion if using pressure devices
- Give platelets and cryoprecipitate through separate lines

\* **PRC** – Packed red cells      **FFP** – Fresh frozen plasma

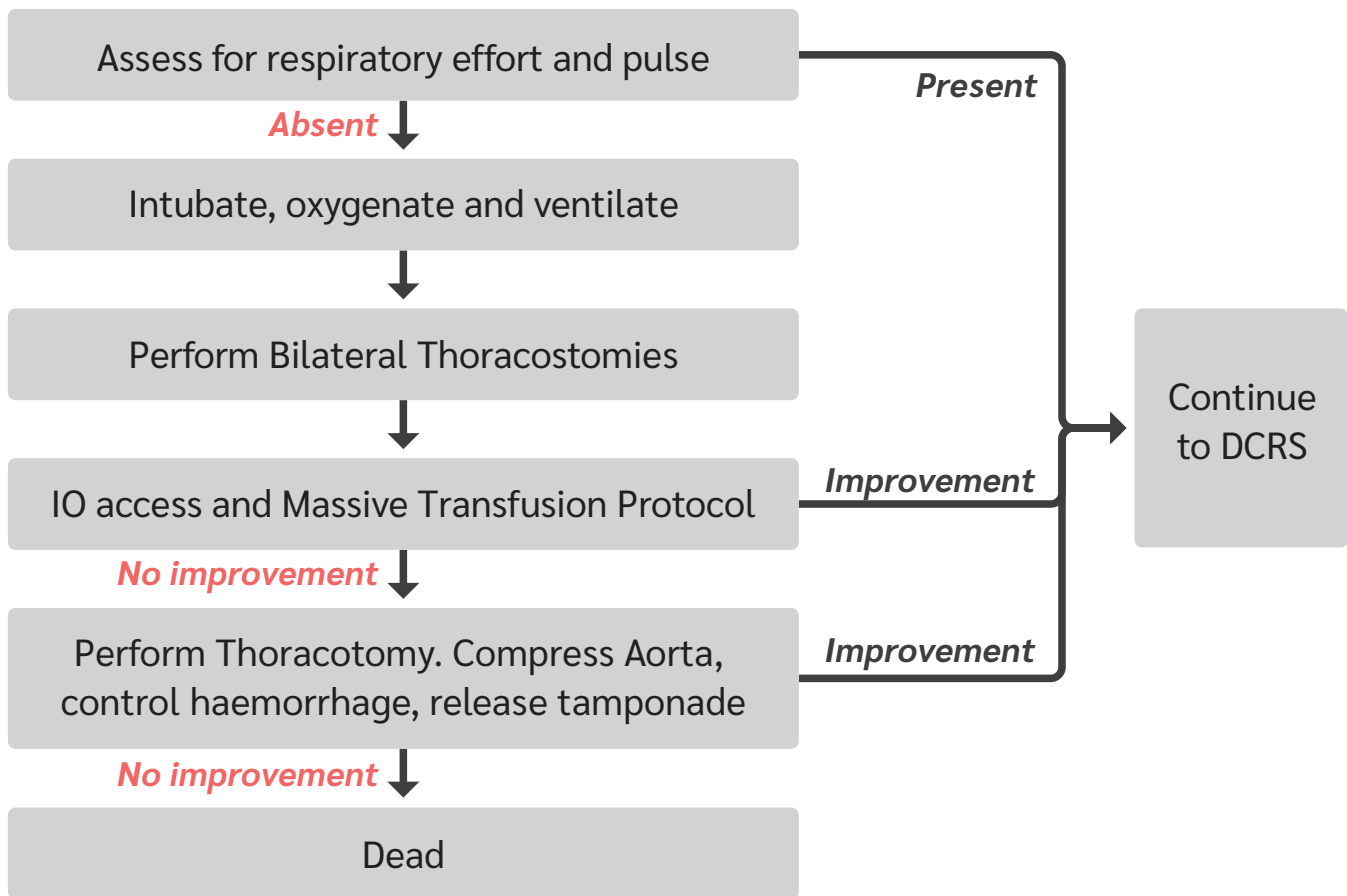
## Traumatic Cardio-Respiratory Arrest

- Traumatic Cardio-Respiratory Arrest (TCRA) is a survivable event in children 
- It requires rapid and aggressive treatment to reverse
- DO NOT FOLLOW MEDICAL ARREST GUIDELINES
- Adrenaline and cardiac massage are not indicated except in spinal shock
- Follow the TCRA Algorithm

### The reversible causes of TCRA and their treatment are:

Hypoxia	Intubate and oxygenate
Hypovolaemia	IV/IO access and transfusion of blood or blood products
Tension Pneumothorax	Bilateral finger thoracostomies
Cardiac Tamponade	Clamshell thoracotomy and pericardial release
Spinal Shock	Adrenaline and Advanced Paedatric Life Support if this is the sole cause of arrest

## Traumatic Cardio-Respiratory Arrest



If resources allow perform intubation, thoracostomy, and transfusion simultaneously then reassess before proceeding to thoracotomy

Cardiac compressions must not take place until the above steps have been completed

Vasopressors are not indicated in the initial management of trauma with the exception of spinal shock



## Notes on Blast Injury

Blast injury is not a single mechanism of injury. Children exposed to blast events will be injured via a number of mechanisms. Blast injury can be classified as follows.

### Primary

Injuries resulting from the effect of the blast pressure wave as it passes through tissues depositing energy. In particular where there is a gas-liquid interface. Effect most pronounced in the lungs and GI tract.

### Secondary

Penetrating and blunt injury as a result of bomb fragments and debris carried by the blast wind.

### Tertiary

Injuries resulting from the individual being thrown by the blast wind against objects. Predominantly blunt injury.

### Quaternary

All other blast related injuries not described above. Including burns, crush, inhalation, toxic effects and exacerbation of pre-existing medical conditions.

## Paediatric Blast Injury Characteristics

- **All cause in-hospital mortality of 8%**
- Multiple body region involvement in 65%
- Burns in 70%
- Penetrating injury in 80%
- Double (56%) the requirement for surgery vs non-blast paediatric trauma
- Principle cause of death is total body surface area burns exceeding 30%
- 30% with severe injury and 18% critically injured

### Typical Blast Injuries by System Condition

Auditory	Tympanic membrane rupture, ossicle disruption, cochlear injuries, foreign body
Eye, Orbit, Face	Globe perforation, foreign body penetration, air embolism, fractures
Respiratory	Blast lung, haemothorax, pneumothorax, pulmonary contusion and haemorrhage, A-V fistulas, thermal inhalation injury
GI	Ischaemia, bowel perforation and haemorrhage, ruptured liver or spleen,
Circulatory	Cardiac contusion, air embolism, shock, vasovagal hypotension, peripheral vascular injury
CNS injury	Concussion, closed and open brain injury, stroke, spinal cord injury
Renal Injury	Renal contusion, laceration, acute renal failure
Extremity injury	Traumatic amputation, fractures, crush injuries, compartment syndrome, burns, lacerations, acute arterial occlusion.

## Primary Blast Lung Injury

Blast lung injury is the commonest fatal injury following exposure to a blast wave. Pressure and volume trauma to the lung causes alveolar haemorrhage, pulmonary contusions, oedema and pneumothoraces. Signs and symptoms may take several hours to present with a clinical appearance similar to Acute Respiratory Distress Syndrome (ARDS) taking up to 48 hours to appear. Be suspicious of primary blast lung injury in children with any of the following :

Signs and Symptoms	Associated Features
<ul style="list-style-type: none"> <li>• Cough</li> <li>• Cough</li> <li>• Dyspnoea</li> <li>• Haemoptysis</li> <li>• Tachypnoea</li> <li>• Hypoxia</li> <li>• Cyanosis</li> </ul>	<ul style="list-style-type: none"> <li>• Pneumothorax</li> <li>• Haemothorax</li> <li>• Pneumomediastinum</li> <li>• Air embolus</li> </ul>

Treatment is supportive, up to 80% require respiratory support. If ventilated use a lung protective strategy to reduce lung injury (Paediatric Acute Lung Injury Consensus Conference, PALLIC Guidelines). Excessive fluids should be avoided

## Primary Blast GI Tract Injury

Compression-decompression injury to the bowel results in mucosal separation, haemorrhage and ischaemia. Again, presentation may take hours or days. Serial examination is required to identify ischaemia, perforation and peritonism.

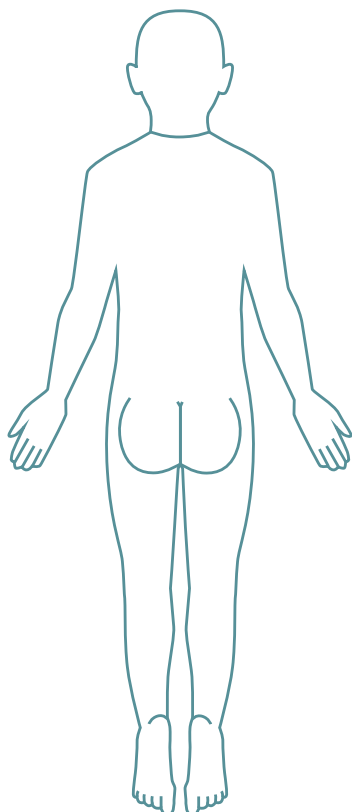
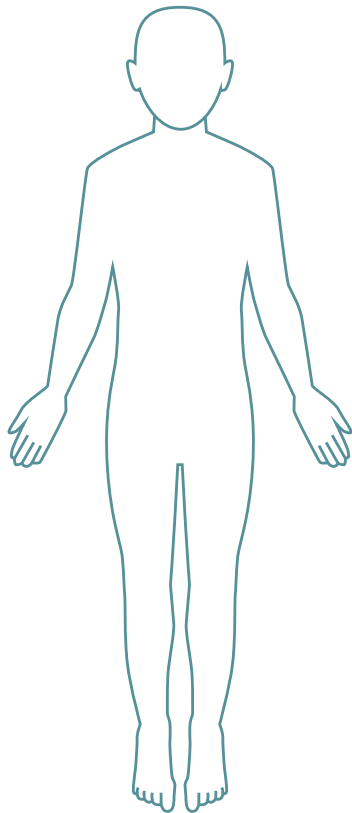
**Table: Aide Memoire Key Paediatric Differences**

Name	Key Differences	Relevance
Catastrophic Haemorrhage	Higher ml/kg blood volume	Rapid exanguination
	Smaller total circulating volume	
	Higher cardiac index	
Airway	Higher, more anterior larynx with floppy epiglottis	Miller laryngoscope blades and different technique
	Narrow airway	More rapid obstruction with oedema or swelling
	Soft neck/airway tissues	Easy to compress and occlude with handling or swelling
	Changing anatomy with age	Different positions of the open airway Changing equipment and technique requirements
Breathing	Compliant chest wall	Thoracic injury without external evidence or rib fracture
	High, anterior ribs	Diaphragmatic breathing No or less thoracic abdominal organ protection
	Diaphragmatic breathing	Respiratory failure when diaphragmatic movement is impaired by injury or gastric distension
	Lower functional residual capacity and high oxygen consumption	Rapid de-saturation following pre-oxygenation and reduced laryngoscopy time
	Changing respiratory rate with age	Failure to recognise the injured child

Name	Key Differences	Relevance
Circulation	Changing pulse rate and blood pressure with age	Failure to recognise the injured child
	Difficulty accessing veins	Reliance on alternative routes of drug and fluid delivery Task focus and scene delay
	Less stroke volume variation	High significance of tachycardia in response to hypovolaemia
	Increased cardiovascular compensation for hypovolaemia	Hypotension occurs later and considered a peri-arrest finding
Disability	Low glycogen stores and high metabolic rate	Propensity for hypoglycaemia
	More permeable blood brain barrier	Never use hypotonic/hyponatremic fluids for resuscitation, risk of cerebral oedema
Exposure	Higher surface body area to weight ratio	Propensity for hypothermia

<b>Patient Name</b>		<b>Patient Identifier</b>	
<b>Pre-alert info</b>			
<b>Team brief</b>			
<b>On arrival</b>	<b>Catastrophic haemorrhage</b>		<b>Airway obstruction</b>
	<b>Beathing problems</b>		<b>Shock</b>
	<b>Alert</b>	<b>Verbal</b>	<b>Pain      Unresponsive</b>
<b>Handover</b>	<b>Age</b> <b>Mechanism</b> <b>Injuries</b> <b>Signs</b> <b>Treatment</b>		
<b>Primary Survey</b>	<b>A – Airway</b>		
	<b>B – Chest &amp; Neck</b>		
	<b>C – Circulation, Abdo &amp; Pelvis</b>		
	<b>D – Disability</b>		
	<b>E – Exposure &amp; Extremities</b>		

Injuries identified:



Date

Time

<b>GCS</b>	Eyes (1-4)						
	Verbal (1-5)						
	Motor (1-6)						
	GCS Total (3-15)						
<b>Pupils</b>	R/L	Size					
	Reaction						
<b>Ventilation</b>	FiO2						
	ETCO2						
	SaO2						
	Resp-rate						
<b>Blood pressure and pulse rate</b>	190						
	180						
	170						
	160						
	150						
	140						
	130						
	120						
	110						
	100						
	90						
	80						
	70						
	60						
	50						
40							
30							
<b>Fluid Loss</b>	Blood loss						
	Urine						
	Chest drain						
<b>Temp, BM Pain</b>	Temperature						
	Glucose						
	Pain						
Record of drugs and fluids:							

# Paediatric Intensive Care

The purpose of paediatric intensive care in trauma is to:

- Provide organ system support to the patient with airway, breathing, circulation, neurological or other problems, who requires monitoring or interventions not available in a ward environment.
- Provide complex pain relief, e.g. infusions of opiates and other drugs, epidural anaesthesia etc. which are not available in a ward environment
- Monitor for signs of ongoing haemorrhage and to alert the surgical team if any concerns
- Monitor for signs of infection and treat with source control and antibiotics
- Prevent and treat the physiological abnormalities known to contribute to poor outcome in trauma – hypothermia, acidosis, coagulopathy

## ON ARRIVAL AT THE ICU

### History and handover

- **Stop** and **listen** to the handover from surgical team before connecting the patient to ICU equipment
- Mechanism of injury
- Primary and secondary survey
- Treatment so far including:
  - <C> ABC interventions
  - blood products
  - drugs (tranexamic acid? antibiotics?)
  - surgery and plan





## Checks after Handover:

- A: Tube size? Cuffed? Position?  
Review/arrange Chest x-ray to check position.
- B: Any difficulties with ventilation? Current settings?  
Review/repeat blood gas.  
Check any Drains.
- C: Circulatory assessment: heart rate, blood pressure, capillary refill.  
Is peripheral access adequate. Is central/arterial access needed?  
Take/review bloods.  
Has haemostasis been achieved? Is the patient coagulopathic?
- D: Any history of head injury? GCS prior intubation? Is C-spine protection necessary? Time/dose of last sedation/paralysis. Any current infusions?
- E: Core and peripheral temperature. Limb injuries/dressings.

## Immediately after handover

- Establish patient on ICU ventilator
- Commence/review infusions of sedative agents and iv fluids
- Admission bloods – FBC, coagulation screen, U&E, bone profile, CRP, blood cultures. Consider liver function, CK.

Thromboprophylaxis is rarely indicated in children < 16 years; consider in those with adult body habitus or high BMI after 1st 24 hours, once haemostasis achieved (discuss with surgeon).

# PAEDIATRIC VENTILATION

## Indications for ventilation include

- “Humanitarian” – e.g. multiple surgical or other procedures are imminent
- Reduced conscious level
- Airway problems
- Severe respiratory distress, progressive hypoxaemia or tiring
- Cardiovascular compromise

## Ventilator modes in paediatrics

The most commonly used modes of invasive ventilation in paediatrics are:

- Pressure control ventilation
- Bilevel Positive Airway Pressure
- Synchronised intermittent mandatory ventilation (SIMV)

Most ventilators deliver both pressure control ventilation modes as synchronised modes and spontaneous breaths can also be supported with pressure support ventilation (PSV) or pressure support (PS).

**Pressure modes are preferred in children.**

Suggested starting settings for children with normal lung compliance (Pressures may be much higher in ARDS)



Peak Insp Pressure	16 to 18 (Titrate to tidal volume of 6-8ml/kg).
Time (inspiration)	1.2 s (adolescent) down to 0.6 (term newborn).
Positive End Expiratory Pressure (PEEP)	4-6 (May need to be up to 15cm H <sub>2</sub> O in ARDS)
Rate	12 (adolescent) up to 30 (term newborn)
PSV	10 to 12

## Avoiding ventilator associated lung damage (VALI)

VALI may be limited by ensuring:

- Tidal volume limited to 6-8 ml/kg
- Peak Inspiratory Pressure < 35 cm H<sub>2</sub>O
- Permissive hypercapnia: aiming for an arterial pH of > 7.25 rather than a specific CO<sub>2</sub> target unless there are special circumstances (e.g. traumatic brain injury)
- FiO<sub>2</sub> should be titrated carefully to SpO<sub>2</sub>, aiming for SpO<sub>2</sub> of no higher than 92% unless there are special circumstances (e.g. traumatic brain injury)
- Judicious use of PEEP optimises alveolar recruitment and may result in lower FiO<sub>2</sub>

## Assessment for extubation

Does the patient meet all of the following criteria?

1. No further major surgical procedures planned
2. Adequate analgesia
3. Awake?
4. Gag/cough reflex – present?
5. No airway concerns (oedema/swelling)
6. Good gas exchange on minimal ventilator setting (e.g. CPAP/Pressure Support with PEEP 5 and Pressure Support 5-8)

# HAEMODYNAMIC MANAGEMENT OF THE CRITICALLY ILL CHILD

Normal ranges for physiological parameters are given on page 27.



In a child with evolving shock (tachycardia, hypotension, prolonged capillary refill, hyperlactataemia) check <C>ABC, ensure adequate IV access and consider the following causes:

- Ongoing bleeding – continue 1:1:1 red blood cells/plasma/platelets fluid resuscitation and arrange urgent surgical review
- Look for and treat other causes related to trauma:
  - Tension pneumothorax
  - Cardiac or abdominal tamponade
  - Spinal
- Sepsis – unlikely to present in first 24 hours of ICU admission. Beyond this time secondary sepsis is possible. Broad spectrum antibiotics and source control is essential
- Other:
  - Cardiogenic (including cardiac contusion)
  - Anaphylaxis

## General principles of management of the shocked child

- Look for and control any compressible haemorrhage (e.g. exsanguinating limb trauma)
- Ensure airway and breathing are adequately managed
- Commence volume expansion with boluses of blood products if trauma (5mg/kg), or crystalloid 10 ml/kg boluses if medical causes
- Patients should be reassessed after each fluid bolus to look for signs of improvement:
  - Fall in heart rate
  - Improvement in skin perfusion and urine output
  - Improved conscious level (if not sedated)
  - Increase in blood pressure and improvement in metabolic acidosis and lactate
  - Hourly urinary catheter output is an important marker of renal perfusion
- If haemostasis has been achieved and shock is fluid refractory, inotropic support may be commenced (*see table on next page*)
  - Initially this may be dopamine given via a peripheral intravenous catheter
  - In cold shock, when myocardial depression and vasoconstriction predominate, adrenaline (epinephrine) may be added if dopamine alone ineffective
  - In warm shock, when vasodilation is the predominant cardiovascular response, noradrenaline (norepinephrine) may be added.

**Table: Inotropes in paediatric critical care.**

Name	Mechanism	Action	Dose
Norepinephrine*	$\alpha$ adrenergic receptor agonist	Increases SVR	0.05-1.0 mcg/kg/min
Epinephrine*	$\alpha/\beta$ adrenergic receptor agonist	Increase HR, SVR, contractility	0.05-1.5 mcg/kg/min
Dopamine	DA, $\alpha/\beta$ adrenergic receptor agonist	<b>Low dose (2-5)</b> increases renal and splanchnic blood flow (DA) <b>Medium doses (5-12)</b> increases HR ( $\beta$ ) <b>Higher doses (12-20)</b> increase SVR ( $\alpha$ )	2-20 mcg/kg/min

**HR**=heart rate; **SVR**=systemic vascular resistance;  
**Target**=normal blood pressure for age.

\* Administer via central venous line if possible

## SEPSIS:

**In children, sepsis is the commonest medical cause of shock. If suspected, ideally take a blood culture and administer broad spectrum antibiotics immediately.**

- Antibiotic choice should be guided by local protocols and drug availability.
- In septic shock, fluid resuscitation, inotropes and vasopressors may all be needed to treat hypovolaemia, myocardial depression and inappropriate vasodilation respectively
- Generous fluid resuscitation may be necessary in the first 24-48 hours.

# INTRAVENOUS FLUID PRESCRIPTION IN CHILDREN

Consider:

## 1. Hydration status

## 2. Electrolytes

## 3. Ongoing losses, diarrhoea, stoma losses, vomiting etc.

## 4. Presence or risk of cerebral oedema

i.e. meningitis, traumatic brain injury, hypoxic ischaemic encephalopathy

## 5. Metabolic requirements

May have increased energy requirements e.g. burns, sepsis

## 6. Specific diagnosis with issues of increased insensible losses or risk of SIADH, i.e. meningitis, pneumonia, post operative

## Children should have fluids prescribed based on four age groups

### 1) Term neonates (under 4 weeks)

#### High fluid requirements up to 120 – 150ml/kg/day

Day 1 – 60ml/kg/day 10% glucose

Day 2 – 90ml/kg/day 10% glucose

Day 3 – 120ml/kg/day of 10% glucose, 0.45% saline\*

Day 4 onwards– 120-150ml/kg/day suggest 10% glucose, 0.45% saline\* but follow blood sugars and electrolytes carefully and adjust fluids accordingly.

#### To make 10% glucose

- 10ml 50% glucose
  - 40ml sterile water
- in a 50 ml syringe

#### \*To make 10% glucose with 0.45% NaCl

- 10ml 50% glucose
  - 25ml 0.9% NaCl
  - 15ml sterile water
- in a 50ml syringe



Usual daily electrolyte requirements (for guidance, add to total daily fluids if necessary)

- Sodium 2-4 mmol/kg/day
- Potassium 2 mmol/kg/day (2 mmol = 1.3 ml potassium chloride 20%)
- Calcium 0.45 mmol/kg/day (0.45 mmol = 2 ml calcium gluconate 10%)

## 2) Infants 1-12 months, approximately 100ml/kg/day

Recommended fluids in table (*on next page*)

## 3) Older children whose total daily requirement calculated by weight

- 100ml/kg/day first 10kg
- add 50ml/kg/day for all additional kg above 10kg
- add 20ml/kg/day for all additional kg above 20kg

Recommended fluids in table (*on next page*)

## 4) If the patient weighs > 50kg use 2-2.5 litres per day as “100%”

When prescribing fluids the **full calculation** should be written out on the prescription chart. For children under one prescriptions should be in **ml/kg/day**, for children over one they should be as a **percentage** of maintenance.

Fluid calculations should also include enteral feed and drugs. **Enteral route for fluids and nutrition is preferred when safe and clinically appropriate.**

The volumes of fluids above are only a guide to maintenance. True absolute maintenance may well be considerably less. Maintenance requirements may be increased in children with increased insensible losses such as pyrexia, excessive sweating or burns.

## Which fluid to prescribe beyond the neonatal period?

Fluid	Uses
0.9% NaCl, Plasmalyte, Hartmann's	Initial boluses Replacement of deficit Replacement of losses
0.9% NaCl with 5% Glucose or Plasmalyte	Maintenance

Premade 0.9% saline based solutions with potassium chloride 20mmol/L may be available and should be used unless there is hyperkalaemia, anuria or renal failure.

**DO NOT USE SODIUM CHLORIDE 0.18% + GLUCOSE 4% UNDER ANY CIRCUMSTANCES**

Examples:

- 5.2kg child aged 5 months prescribe 100ml/kg/day × 5.2kg = 520ml/day
- 80% fluids for a 23kg child prescribe 80% of 1560mls = 1248ml/day

### Special Considerations

- Risk of or established cerebral oedema – Use iso-osmolar fluid and restrict intake (likely to need only 60% maintenance)
- Post operatively – risk of SIADH. Fluids should be restricted to 60% on the first postoperative day, 80% on day 2 and liberalised to 100% on day 3

### Monitoring

Regular weighing is the most accurate way to assess hydration if practicable. **At least once daily electrolytes should be checked when on IV fluids.** If unstable, the patient may need electrolytes checking 4-6 hourly. Be prepared to change fluid prescriptions as frequently as necessary.

### Ongoing management

In case of difficulty, seek advice from Anaesthetist, ICU Consultant or Consultant or Nurse with specialist paediatric interest. Consider if child better managed on ICU if complex fluid needs. Revert to enteral feeds as soon as practicable.

## ENTERAL FEEDING

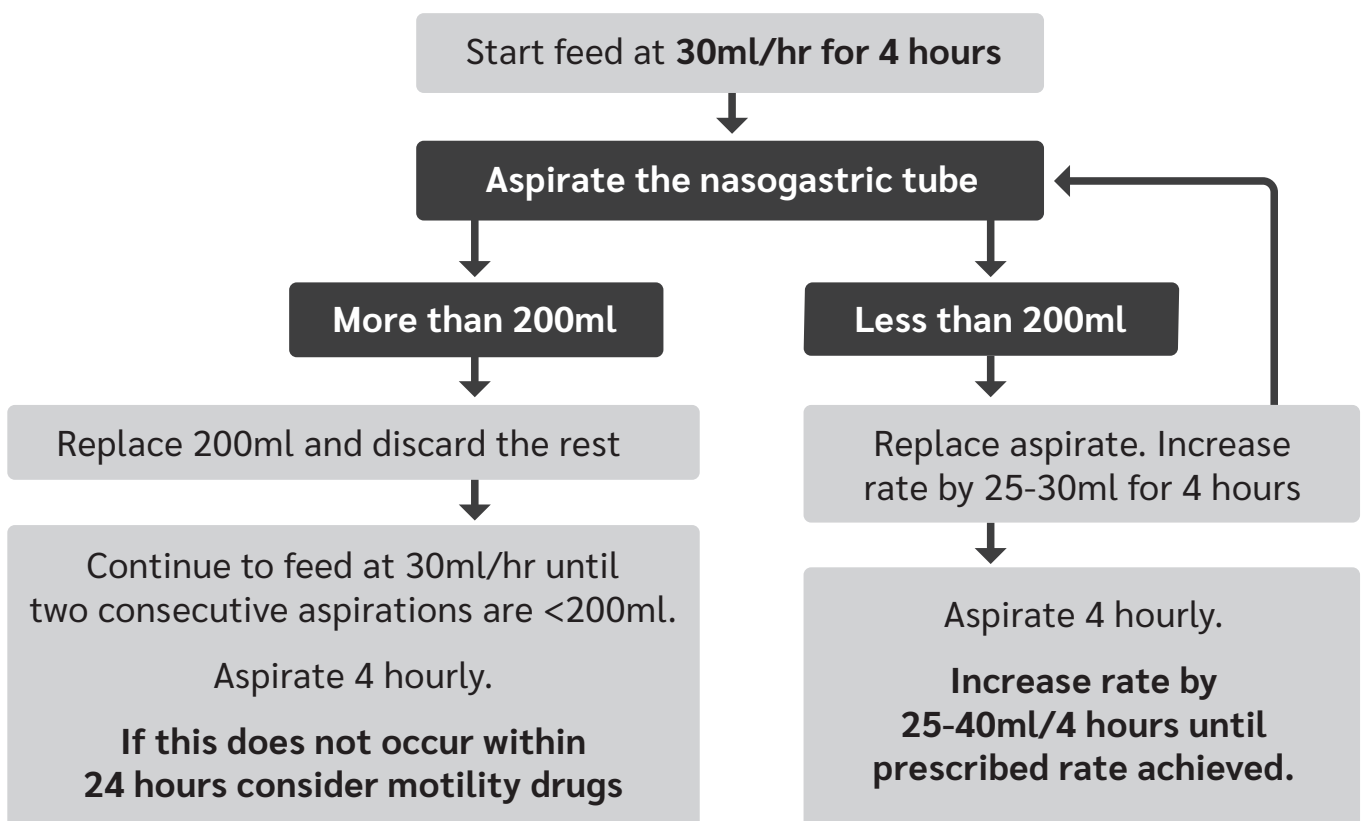
If not feeding, commence H<sub>2</sub> antagonist (i.e. ranitidine) IV; once feeds established, discontinue.

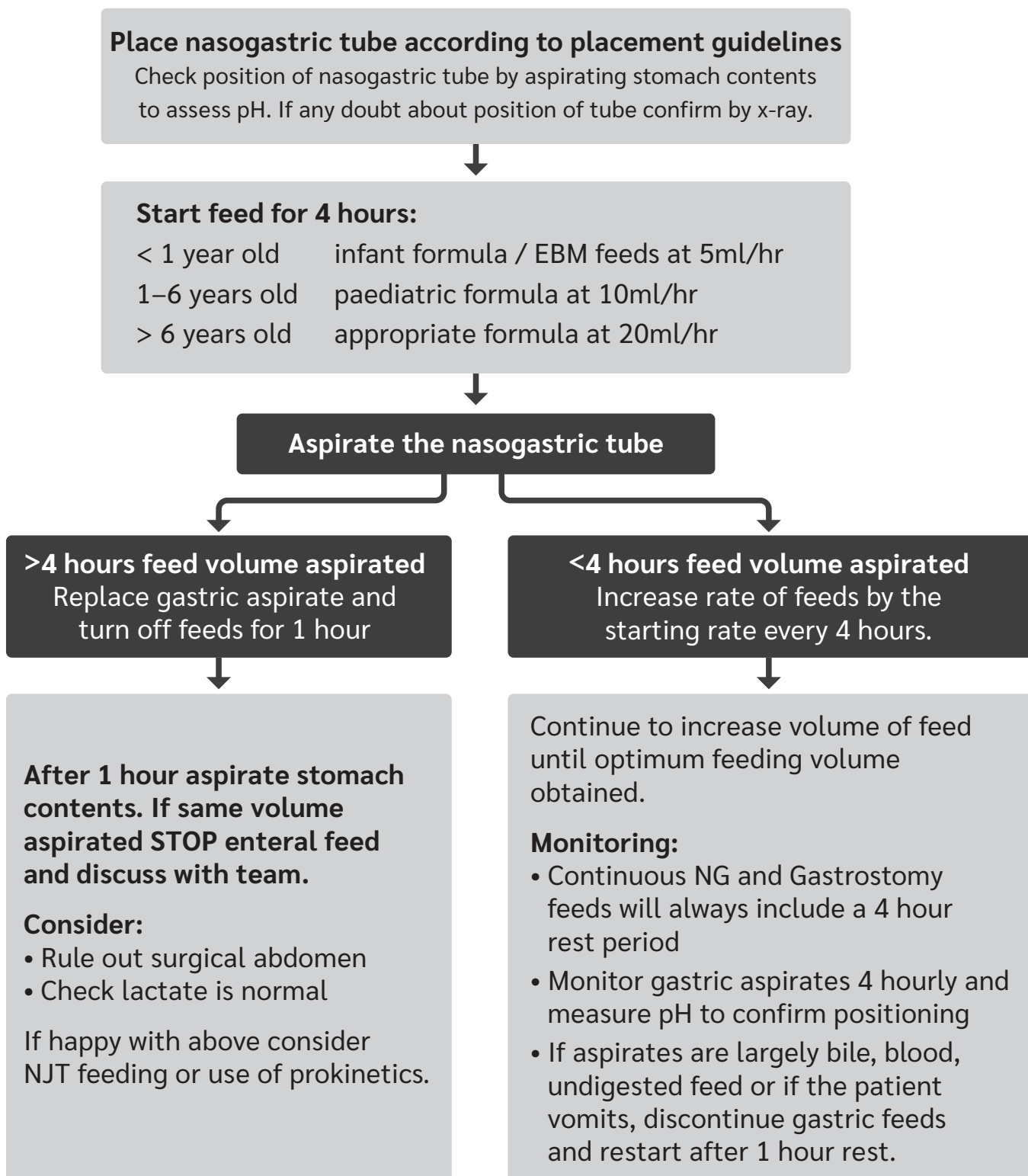
- Introduce feed gradually and according to flow diagram
- Once feeding is established, aspirate NGT minimum of once daily (usually 4-hourly)
- Critically ill patients should commence feeding as soon as possible once bowel in continuity (discuss with surgeon before commencing feed)
- Perform blood glucose monitoring 4-hourly
- Any drugs administered by NGT should be liquid and given separately from the feed with flushing before and after with water
- To minimise aspiration, patients should be fed sat at 30° or greater, if possible.

**Use a nasogastric feeding tube (NGT) when commencing enteral feeding according sizing below:**

< 1 year	6 Fr
1-6 years	8 Fr
Over 6 years	10 Fr

Over 40kg





# SEDATION AND ANALGESIA

## General Rules

- Propofol is not licensed for continuous sedation in children in PICU due to the risk of propofol infusion syndrome. In general, it should be avoided, though it may be reasonable to use for less than 24-48 hours if rapid weaning is anticipated. First line agents are morphine and midazolam.
- Always implement non-pharmacological interventions to reduce sedation and analgesia requirements.
- Introduce enteral sedation/analgesia early and start active weaning of intravenous drugs as early as first 24 hours of patient admission
- Before increasing or giving extra sedation, always rule out causes of pain and agitation like full bladder, hypoxia, hypercarbia, inadequate ventilator flow/ synchrony, uncomfortable bed position, sleep deprivation, etc.
- Sedation score (UMSS is validated 6 months – 12 years) should be used in every patient.
- Sedation goals, requirements and holiday should be considered on a daily basis.
- Implement nurse controlled analgesia or patient controlled analgesia in appropriate patients. Consider local anaesthetic for painful procedures.

### **Non-pharmacological Interventions:**

- Ensure patient comfort: any correctable environmental and physical factors which could cause discomfort should be fixed
- Normal pattern of sleep to be encouraged
- Minimise lights and noise
- Presence of parents and family. Communication and reassurance.
- Music/reading/entertainment depending on the child's conscious level and developmental stage

## REMEMBER THE DO'S AND DON'TS

### DO

#### Make contact

- Introduce yourself by name and explain who you are, and ask the child's name
- Ask the child their concerns and what they might need
- Communicate with children in ways they can understand (page 164)
- Stay calm and help parents to stay calm, and offer comfort and support
- Speak in your normal tone of voice and remain calm and reassuring

#### Support caregivers

- Make efforts to reunite young children with caregivers and keep them together. Make sure that caregivers stay with the child as much as possible and reassure them that they will not leave them alone
- It is important to keep caregivers at the forefront of care for children who have suffered a blast injury. This often means supporting caregivers to cope with their own distress in the situation, and providing them practical information and tips to help their child cope and recover
- Be sure to provide caregivers with information about what is going on, their child's condition and what they can expect. Respect their role as primary caretakers for children and involve them in decisions about care and treatment. Wherever possible and appropriate, speak first to parents and ask their permission before talking with their children

If possible, prepare and have available informational materials for parents and caregivers to help them understand the situation and know how best to support their children.

### DO NOT

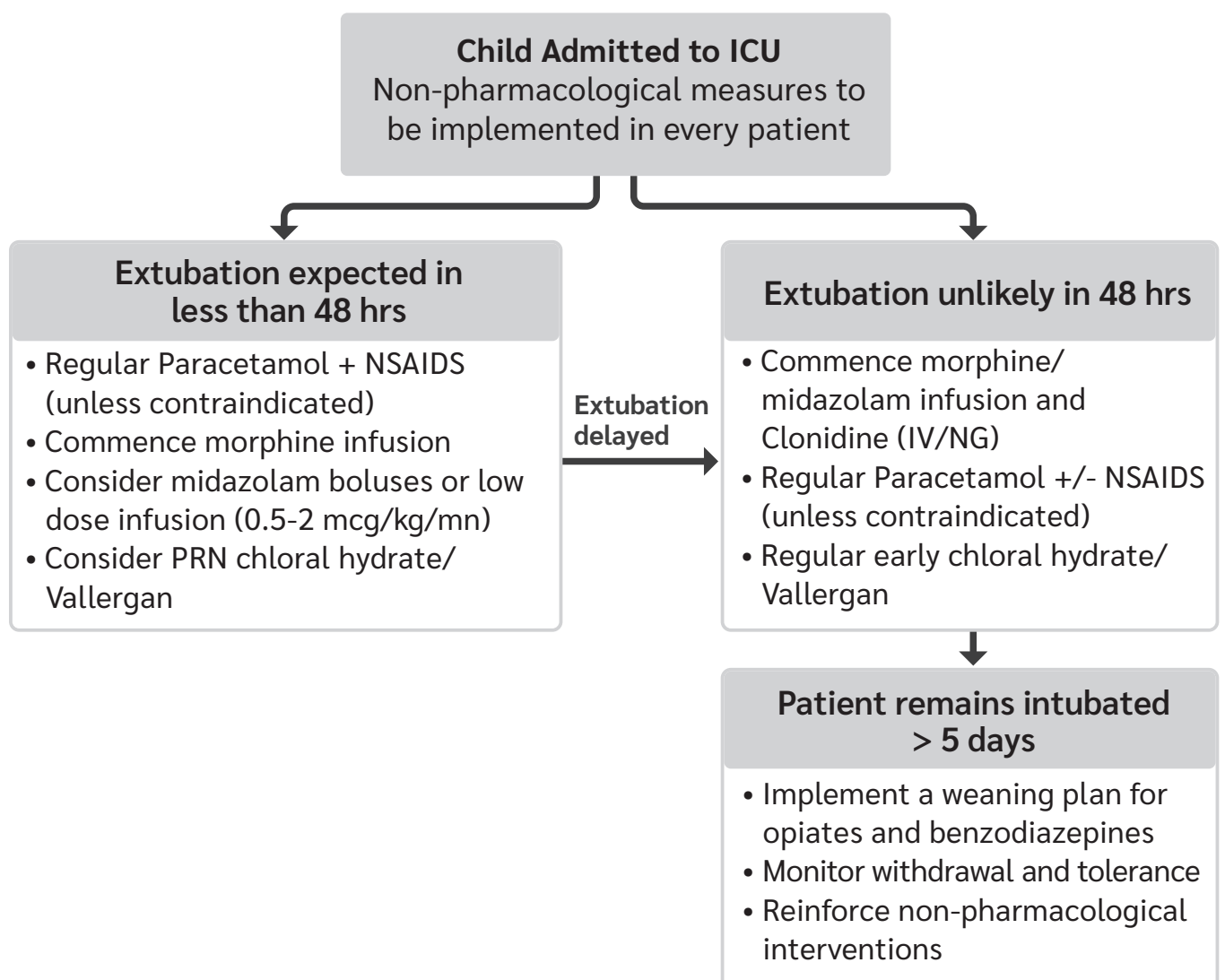
- Do not give children or their caregivers false reassurances or promises just to calm them down. Instead, give realistic reassurance and honest information
- Do not separate children from their caregivers
- Do not discuss procedures with other adults in front of little children
- Do not let children witness or hear other children receiving painful procedures (e.g., changing dressings in front of other children)
- Do not let children witness gruesome scenes in the medical facility (e.g., other people with acute, serious injuries)

## University of Michigan sedation score (UMSS)

– aim around 3 in intubated patients

Value	Patient state
1	Awake and alert
2	Minimally sedated: tired/sleepy, appropriate response to verbal conversation, and/or sound
3	Moderately sedated: somnolent/sleeping, easily aroused with light tactile stimulation or a simple verbal command
4	Deeply sedated: deep sleep, aroused only with significant physical stimulation
5	Unarousable

*Guidelines for sedation and analgesia for critically ill children.*



## Suggested drug combinations

Propofol / fentanyl (haemodynamically stable patient, < 48 hours ventilation anticipated)

Morphine / midazolam (haemodynamically unstable patient or > 48 hours ventilation anticipated)

Fentanyl / midazolam  
(if inadequate sedation achieved with morphine/midazolam)

### **Intubation >48 hours**

In children sedated for longer than 48 hours a daily sedation hold should be considered.

### **Long stay patient (> five days)**

- Beyond 5 days of sedation and analgesia, the symptoms of withdrawal are more likely; so an active weaning strategy is warranted.
- Closely monitor the sedation score.
- Ensure adequate doses of clonidine and enteral sedation to reduce the intravenous drugs.

### **Neuromuscular Blockade**

- Paralysis should be introduced only in selected patients (very high ventilatory pressures, neuroprotection etc.)
- Neuromuscular blockade should be stopped as soon as clinically stable.



## Drug Dosages

### **Morphine:** First line analgesic

	Start rate	Range	Bolus
Neonates	15 mcg/kg/hr	5-20 mcg/kg/hr	50 mcg/kg
Children <60 kg	20 mcg/kg/hr	10-60 mcg/kg/hr	50-200 mcg/kg
Children >60 kg	1.5 mg/hr	0.8-3.0 mg/hr	5-10 mg

Boluses of morphine are required to achieve effective plasma concentrations. If more than three boluses are required in one hour, increase the background rate by 20%. Occasional patient may need up to 60-80 mcg/kg/hr. Consider fentanyl in those who are resistant to morphine. Use lower doses for patients in hepatic or renal failure.

**Weaning:** After 7 days of continuous use, make a weaning plan for morphine, tapering it by 5-10% of the baseline dose either once or twice a day every day monitoring closely for signs of withdrawal.

### **Midazolam:** First line intravenous anxiolytic and sedative.

Can often be omitted in neonates.

	Start rate	Range	Bolus
Neonates	1 mcg/kg/min	0.25 – 2 mcg/kg/min	50 mcg/kg
Children <60 kg	1 mcg/kg/min	0.5 – 6 mcg/kg/min	50-200 mcg/kg
Children >60 kg	1 mcg/kg/min	5 – 15 mg/hr	2-5 mg

Midazolam should be titrated to UMSS score. Enteral sedation should be added as soon as possible to reduce the requirements for IV sedation. Use lower doses for patients in hepatic or renal failure and those with haemodynamic instability.

**Weaning:** After 7 days of continuous use, make a weaning plan for midazolam tapering it by 5-10% of the baseline dose either once or twice a day every day monitoring closely for signs of withdrawal.

## **Clonidine:**

Clonidine should be used for benzodiazepine and opiate sparing effect in all children who stay in ICU beyond 48 hours and should be started on admission when the expected stay is over 48 hours. It can be used on empty stomach unless there is a specific contraindication. It should be used cautiously in patients with cardiac impairment and hypotension. It should not be switched off abruptly due to risks of rebound hypertension.

	<b>Dose</b>	<b>Frequency</b>
Oral	1-5 mcg/kg (Test dose:1 mcg/kg, watch: hypotension for 2hrs)	3-4 times a day
Intravenous	1-2 mcg/kg Infusion: 0.25-2 mcg/kg/hr (↑0.1mcg/kg/hr till adequate sedation)	3-4 times a day

*Conversion from IV to oral: similar oral dose as intravenous dose.*

**Weaning: Wean opiates and benzodiazepines first and start weaning clonidine only after stopping these two).**

## Paracetamol/ NSAIDs:

Paracetamol should be introduced in every patient to enhance the analgesic effect of morphine unless there is specific contraindication.

Age	Dosages		
		Oral	Per-rectal
Neonates >32 wk (max 60 mg/kg/ day)	<b>BOLUS</b>	20 mg/kg	30 mg/kg
	<b>MAINTENANCE</b>	10-15 mg/kg q 6-8 hr	20 mg/kg q 8 hr
1 to 3 months (max 60 mg/kg/ day)	<b>BOLUS</b>	20-30 mg/kg	30 mg/kg
	<b>MAINTENANCE</b>	15-20 mg/kg q 6-8 hr	
3 months- 12 years (max 90 mg/kg/ day)	<b>BOLUS</b>	20-30 mg/kg	30-40 mg/kg
	<b>MAINTENANCE</b>	15-20 mg/kg q 6-8 hr	
> 12 years (max 4 g/day)	<b>MAINTENANCE</b>	1g q 4-6 hrs	

### Intravenous (infusion over 15 minutes)

Less than 10 kg	7.5 mg/kg q 4-6 hr (max 30 mg/kg/day)
10-50 kg	15 mg/kg q 4-6 hr (max 60 mg/kg/day)
>50 kg	1 g q 4-6 hr (max 4 g/day)

Other NSAIDs like ibuprofen and diclofenac should be considered to spare opiates unless contra-indicated.

## **Chloral Hydrate:**

Chloral hydrate may be added in patients more than one month old requiring IV sedation unless there is a specific contraindication, and IV sedation should be weaned. It can be given both orally and per-rectally. Lower doses should be started in patients with haemodynamic instability.

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**Dose: 30-50 mg/kg (max 1 g/dose) q 6 hours**

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## **Alimemazine/Trimeprazine (Vallergan)**

Vallergan should be considered in patients above 2 years on IV sedation to reduce the IV drug requirements.

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**Dose: 1-4 mg/kg q 6-8 hours**

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## **Other Intravenous sedation/analgesia**

<b>Agent</b>	<b>Dose</b>
Fentanyl	<ul style="list-style-type: none"><li>• 2-5 mcg/kg (intubation)</li><li>• 1-2 mcg/kg (procedures)</li><li>• 1-10 mcg/kg/hr (&lt;60kg) – (ICU sedation)</li><li>• 25-100 mcg/hr (&gt;60kg) – (ICU sedation)</li></ul>
Ketamine	<ul style="list-style-type: none"><li>• 2-3 mg/kg (intubation)</li><li>• 1-2 mg/kg (procedures)</li><li>• 10-45 mcg/kg/min (ICU sedation)</li></ul>
Propofol	<ul style="list-style-type: none"><li>• 1-4 mg/kg (intubation) – lower dose in hypotensive or obtunded patients</li><li>• 1-2 mg/kg (procedures)</li><li>• 1-4 mg/kg/hr (max 200 mg/h) (ICU sedation)</li></ul>

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**Muscle relaxation:**

Agent/ action	Dose
<b>Suxamethonium</b> Depolarising (NB. have Atropine ready)	1-2 mg/kg bolus for RSI (2mg/kg for neonates, and 1mg/kg children) Rpt 0.25-0.5mg/kg
<b>Rocuronium</b> Non-depolarising Recovery time ~ 40 minutes	0.6 mg/kg bolus 1.2 mg/kg bolus for modified RSI
<b>Atracurium</b> Non-depolarising Recovery time ~15-20 minutes	0.5 mg/kg bolus ivi 0.2-0.4mg/kg/h
<b>Vecuronium</b> Non-depolarising Recovery time ~ 20-30 minutes	0.2 mg/kg bolus ivi 1-6 mcg/kg/min

**Paediatric ICU – rehabilitation key points**

- Ensure adequate analgesia to enable good respiratory function and coincide medication with rehab
- If the child is sedated, ensure upper and lower limb range of motion is maintained through the use of positioning and gentle passive exercises
- Ensure that the child is turned 2 hourly if they are sedated to prevent pressure ulcers and contractures
- For the ventilated child combining positioning with manual hyperinflation and manual techniques (for example vibrations and/or percussion, if trained to perform) may help with sputum clearance
- If sputum clearance is difficult, ensure that the child is sufficiently hydrated and consider using a mucolytic nebuliser
- If suction is required, ensure the correct catheter size and suction pressures are used in order to clear secretions.

Age	Suction pressure	
	mmHg	Kpa
<3 years	75-90	10-12
3-13	90-150	12-20
3 +	150	20

# Anaesthetics and Pain Control

## PREPARATION

Prior preparation is essential to commencing anaesthesia.

With an accurate measured weight:

- Prepare anaesthetic and drug charts
- Calculate fluid maintenance volume and drug doses
- Calculate resuscitation fluid bolus volume and emergency drug doses
- Prepare and check the correctly sized equipment

Using the child's age be aware of the normal reference range for vital signs (see page 27).

Prior to arrival of the child brief the team and ensure the room is warmed.

## COMMENCING ANAESTHESIA

Establish one point of secure venous access for induction and fluids. Subsequent access can be done once anaesthetised. Use of a topical dermal anaesthetic cream is recommended prior to cannulation.

**Allow parents/carers to stay until induction to keep the child calm.**

## VENOUS ACCESS

**Remember:** Intraosseus access may be quickest and most appropriate route. Consider as first option.

### Peripheral access

#### Cannula size

- Infants: 24g
- Over 1 year: 22g

#### Sites

- Dorsum of hand
- Ante-cubital fossa
- Dorso-lateral foot
- Saphenous vein

#### Difficult access?

- Neonates: scalp vein
- Infants: palmar aspect of wrist
- Older children: external jugular

### Central access

Use single lumen where available to improve flow: 4-6F

#### Multi-lumen lines

- Infants: 3F
- 1-2 years: 4 to 5F
- Over 2 years: 5F

#### Insertion length

- Infants: 5cm
- 1-2 years: 8cm
- Over 2 years: 10-12cm

Use ultrasound guidance if available.  
Needle through cannula technique under 10kg

## INDUCTION

Calculate all drugs in advance



Anaesthesia should be conducted as deemed appropriate by the anaesthetic practitioner responsible and in line with their experience. Be aware however that propofol and barbituate inductions often cause significant hypotension in children with hypovolaemia or sepsis or children on inotropic support. Ketamine induction offers the most stable induction.

Pre-medication can be used as follows

- Oral midazolam 0.25mg to 0.5mg/kg (maximum 15mg) given in 20mg/kg of paracetamol syrup
- Give 30 minutes prior to surgery

This pre-medication is also suitable for use prior to ketamine sedation.

## Endotracheal Intubation

- Gastric distension secondary to bag mask ventilation is common. Pass a nasogastric or orogastric tube following induction
- Children desaturate more quickly than adults
- Beware of endobronchial intubation, listen at both axillae and check position of tube Every time the child is moved
- Do not over inflate the cuff



Gentle hand squeeze ventilation with frequent breaths is all that is required before intubation.

Excessive or vigorous bag mask ventilation must be avoided as this will inflate the stomach and splint the diaphragm making ventilation more difficult and create a cycle of over vigorous inflation attempts, increasing diaphragmatic splinting and increases the risk of aspiration and can lead to respiratory arrest.

Use a straight blade laryngoscope in under two year olds

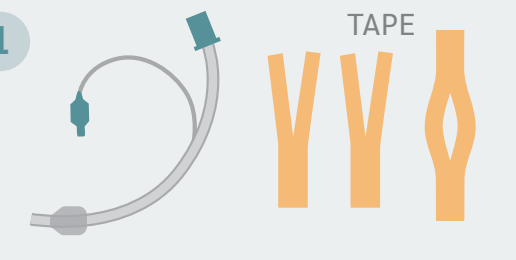
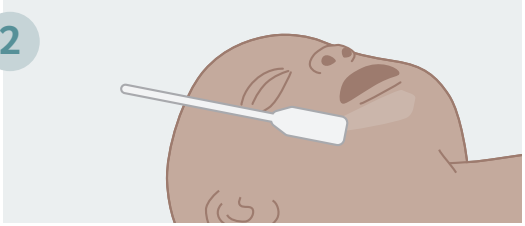

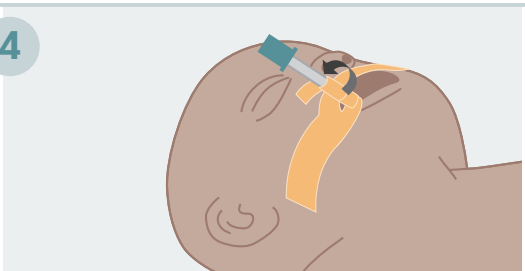
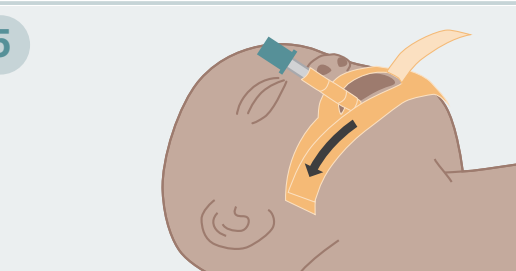
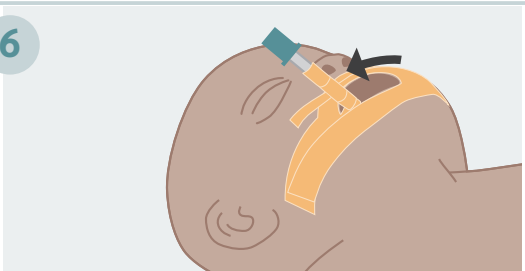
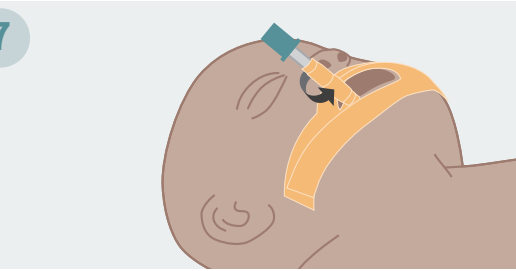
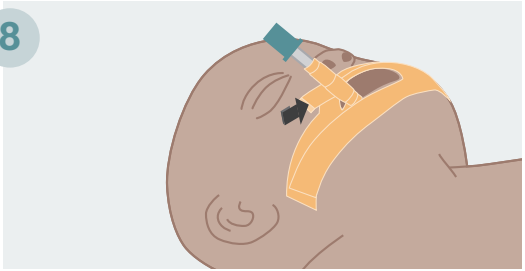
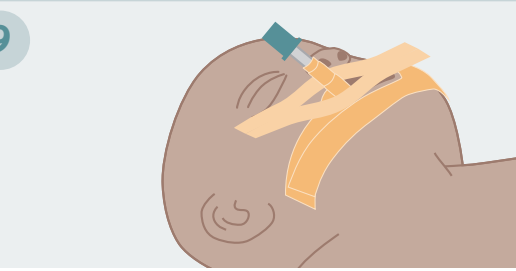
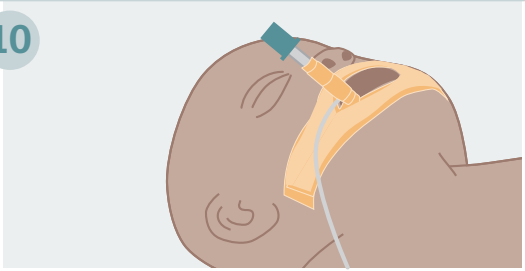
Tracheal tube size should be based on

- Age
- Estimated from diameter of nostril or 5th finger

Use a cuffed tube where possible. A slight leak at 20cm H<sub>2</sub>O indicated a good fit. If there is no leak downsize, if there is a large leak, upsize or add a moist throat pack. Secure the tube with tape trouser legs. (See below). A oropharyngeal airway will prevent lateral movement of the tube.



## Guide for securing an oral endotracheal tube

<p>1</p>  <p>Assemble equipment</p>	<p>2</p>  <p>Apply thin layer of barrier cream around lips and cheeks</p>
<p>3</p>  <p>Place the V at angle of mouth. The upper part of the trouser leg is then fixed along the upper lip.</p>	<p>4</p>  <p>The lower part of the trouser leg is then turned back to wind around the ETT in an upward spiral</p>
<p>5</p>  <p>Using the second trouser leg, place the V at the opposite angle of the mouth. The lower part of the trouser leg is then fixed below the bottom lip</p>	<p>6</p>  <p>The upper part of the trouser leg is then fixed above the upper lip</p>
<p>7</p>  <p>The free end of the trouser leg is then wound over the ETT in a downward spiral</p>	<p>8</p>  <p>Fold the last part of the trouser leg back on itself to make a small flap to facilitate tape removal/replacement</p>
<p>9</p>  <p>The third piece of tape has a central slip through which the ETT connector is passed</p>	<p>10</p>  <p>This is then applied above and below the lips</p>

## ESTABLISH MAINTENANCE OF ANAESTHESIA

Volatile agent technique with air/oxygen mix

Or intermittent Ketamine or Ketamine Propofol mix (PK – Ketafol) if no volatile agent available

Long term post op Propofol infusion is not to be used in children but can be used for surgical procedures.

---

Rough guide in absence of advanced pumps (guided by clinical signs)

---

10mg/kg/hr	first 10 minutes
8mg/kg/hr	next 10 minutes
6mg/kg/hr	subsequent maintenance

---

Ideally, ECG, Pulse Oximetry, capnography, end tidal volatile, blood pressure, temperature and respiratory volumes, pressure and rate.

### Arterial Access

Consider invasive blood pressure monitoring in cases where cardiovascular instability may be predicted or large volume replacement may be required.

#### ARTERIAL ACCESS

##### Under 5 years

###### Femoral artery

- Route of choice in under 5 year olds unless not accessible or operator has specialist experience
- **Under 1 year olds:**  
Catheter over needle technique
- **Over 1 year olds:**  
Seldinger (wire through needle technique)

##### 5 years and over

###### Radial artery

- Catheter over needle technique
- Transfix vessel then withdraw and advance with syringe attached

###### Cannula size

- Neonates: 24g
- Under 1 year old: 22g
- Over 1 year old: 22g to 20g

## FLUID MANAGEMENT

Children will require maintenance fluids during their procedure.  
The fluid requirement per hour can be calculated using the **4-2-1 rule**

1st 10kg body weight = 4ml/kg/hr  
2nd 10kg body weight = 2 ml/kg/hr  
For every kg thereafter = 1ml/kg/hr



- Neonates: 10% dextrose + 0.45% NaCl
- Infants: 5% dextrose + 0.9% NaCl
- Monitor blood sugars closely
- Use pumps or burette – never have fluids on free flow

Consider using 20mmol/l KCL if the child has been on IV fluids for greater than 24 hours

If catheterised maintain 1ml/kg/hour urine output

Never use hypotonic/hyponatremic fluids in resuscitation



## Thermoregulation

Children are more prone to hypothermia which can increase mortality.  
Therefore:

- Monitor temperature and aggressively maintain normothermia
- Warm all fluids
- Cover head
- Use insulation beneath the child or active warming if available
- Keep exposure to a minimum
- Warm room

## POST OP

- Extubate when warm, well filled, with adequate analgesia and all invasive procedures are complete
- Pain relief is essential but challenging in the very young who cannot articulate their pain scores adequately. Consider appropriate nerve block techniques.
- Complete drug chart with regular and as required analgesia and clear post anaesthetic instructions

## PAIN MANAGEMENT IN CHILDREN

- Excellent pain control is a basic humanitarian standard in the management of injured children.
- Control pain as soon as possible
- Analgesia will reduce tachycardia and bleeding
- Analgesia will reduce psychological stress and will calm the child, parent and carer
- Essential steps in achieving pain control are anticipation and recognition



### Assessment

Anticipate pain in injured children. Remember that the expression of pain is different in various cultures, a quiet child is not necessarily a pain free child. All children require documented pain scores at regular intervals, both pre and post analgesia.

Pain scores can be subjectively assessed in older children using a 0-3 scale

Some children may be able to use a 0-10 scale:

- 0 – no pain at all
- 10- worst pain ever

<b>0</b>	No pain
<b>1</b>	Mild pain
<b>2</b>	Moderate pain
<b>3</b>	Worst pain/severe pain

Younger children will require objective pain assessment using The Alder Hey Triage Pain Score.

## The Alder Hey Triage Pain Score: reference scoring chart

Response	Score 0	Score 1	Score 2
Cry/voice	No complaint/cry	Consolable	Inconsolable
	Normal conversation	Not talking negative	Complaining of pain
Facial expression	Normal	Short grimace <50% time	Long grimace >50% time
Posture	Normal	Touching/rubbing/sparing	Defensive/tense
Movement	Normal	Reduced or restless	Immobile or thrashing
Colour	Normal	Pale	Very pale/'green'

*For any score of 1 give mild to moderate analgesia.*

*For any score of 2 give strong analgesia.*

### Assess pain severity

- Use splints/slings/dressings etc
- Consider other causes of distress
- For procedures consider regional blocks and conscious sedation

**Mild pain** Oral/rectal paracetamol 20mg/kg loading dose, then 15mg/kg, 4–6 hourly  
Oral ibuprofen 10mg/kg 6–8 hourly  
No more than 30mg/kg per day of Ibuprofen

**Moderate pain** As for mild pain plus:

- Oral/rectal diclofenac 1mg/kg 8 hourly (unless already had ibuprofen) *and/or*
- Oral codeine phosphate\*\* 1mg/kg 4-6 hourly (over 12 years) or Oral morphine 0.2–0.5mg/kg stat

**Severe pain**

- Consider Entonox as holding measure
- Intranasal diamorphine – see page 90
- IV morphine 0.1–0.2mg/kg

Supplemented by oral analgesics

# ANALGESIA

## Non-Pharmacological

Never underestimate the powers of the 'magic bandage'. Children in pain need reassurance and comfort, be nice. Dressing wounds will reduce pain in particular burns

Covering wounds will reduce the psychological impact of the appearance, helping to calm the patient.

Extremity wounds should be immobilised and elevated or placed in a sling.

Infants can be kept comfortable in a variety of ways including

- Breastfeeding or non-nutritive sucking using a dummy if is a normal part of the infant's care, and if the infant is able to suck.
- Full or partial swaddling to minimise limb flailing and support containment
- Reduction in noxious stimuli and over stimulation e.g. noise and lighting
- Holding and cuddling with a parent or carer
- Infants >6 months supported upright position as appropriate
- Distraction for older infants e.g. sight/sound toys, bubbles or singing

### **REMEMBER:**

- Relate to children according to their age and developmental stage.
- Avoid separation of children from their caregivers
- Show children respect
- Support caregivers to care for their children.

## Oral analgesia

Where possible all children should receive oral analgesia when in pain even if parenteral routes have been used. They are extremely effective and given early will establish some longer acting analgesia once parenteral agents are wearing off and the child is packaged. Oral analgesics include paracetamol, ibuprofen and opioids.

## Rectal analgesia

This is a useful route in distressed or vomiting infants. Both paracetamol and diclofenac can be administered via the rectal route.

## Intravenous

Titrated intravenous opiates remain the gold standard for the control of severe pain. However intravenous access can be difficult to achieve and cause distress for the child. It can also be a cause of unacceptable scene delay.

## Intramuscular

Intramuscular ketamine is a rapid and effective route to deliver good pain control. It is particularly useful in burns where the patient is both very distressed and is difficult to cannulate.

## Intranasal

This is a particularly useful route to achieve effective and rapid analgesia. Ketamine, fentanyl and diamorphine are all well absorbed through the nasal mucosa.

The drugs need to be in a low volume, and volumes above 0.4 ml should be divided between nostrils. At above 0.4 ml efficacy may be lost as more of the drug is swallowed rather than absorbed via the mucosa.

The drugs should be administered using a 1 ml syringe and a mucosal atomiser device (MAD) if available. Doses for intranasal drugs are detailed on the next page.

## Peripheral Nerve Blocks

Particularly useful in limb injury It is advisable to practice ultrasound guided rather than blind techniques where possible. Practitioners must be trained and experienced in any peripheral nerve block they wish to use.

## Drug Doses

Drug	Route**	Dose	Cautions
Paracetamol	Oral	15 mg/kg (max 1g) QDS	Always check if paracetamol has been administered by carers.
	Rectal	15 mg/kg (max 1g) QDS	
	Intravenous	<b>Over 10 kg</b> 15 mg/kg (max 1g) QDS <b>Under 10kg</b> 7.5 mg/kg QDS (max 30 mg/kg/day)	
Ibuprofen	Oral only	5 mg/kg (maximum 400 mg) TDS	May exacerbate asthma. Avoid in renal disease, gastric ulceration and bleeding disorders
Diclofenac	Oral	1 mg/kg (max 50 mg) TDS	May exacerbate asthma. Avoid in renal disease, gastric ulceration and bleeding disorders
	Rectal	1 mg/kg (max 50 mg) TDS	
Codeine*	Oral only	1 mg/kg (max 60 mg) QDS	Contraindications below
Tramadol	Oral	1 mg/Kg (max 50 mg) QDS	Serotonergic side effects
	Intravenous	1 mg/Kg (max 50 mg) QDS	



Drug	Route**	Dose	Cautions
Oramorph	Oral only	<b>1-3 months</b> 50-100 mcg/kg 4 hourly	Respiratory and CNS depression. Nausea and vomiting
		<b>3-6 months</b> 100-150 mcg/kg 4 hourly	
		<b>6-12 months</b> 100-200 mcg/kg 4 hourly	
		<b>Over one year</b> 200-300 mcg/kg 4 hourly	
Morphine	Intravenous only	50 mcg/kg boluses up to 200 mcg/kg titrated to pain	Respiratory and CNS depression. Nausea and vomiting
Fentanyl	Intravenous	0.25 mcg/kg in boluses up to 1 mcg/kg titrated to pain	Respiratory and CNS depression. Nausea and vomiting
	Intranasal	1 mcg/kg atomised into nostril(s)	If >0.4 ml, divide between nostrils
Diamorphine	Intranasal	<i>See next table</i>	Respiratory and CNS depression. Nausea and vomiting
Ketamine (sedation and analgesia)	Intravenous	0.25-0.5 mg/kg	Dysphoria
	Intramuscular	2-4 mg/kg	Consider small dose of benzodiazepine
	Intranasal	3 mg/kg	

\* Codeine should be used with caution due to risk of respiratory depression in all children less than 12 years of age and children 12 to 18 years of age who have undergone airway procedure or with a history of sleep apnoea. Alternatives to codeine are dihydrocodeine, oral morphine solution and tramadol.

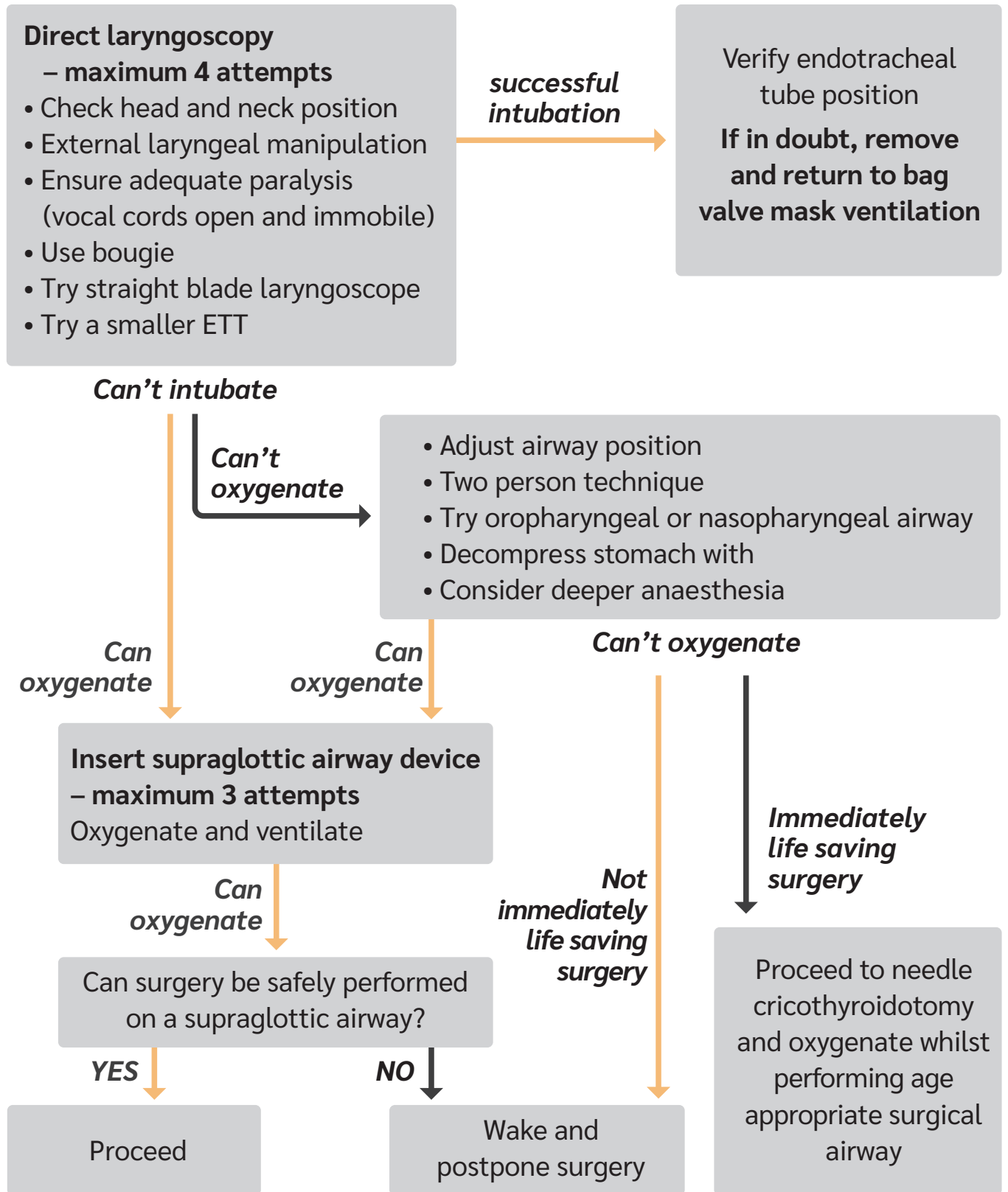
\*\*IV doses apply to intraosseous route also

## Intranasal Diamorphine Dosing Table (Using 10mg vial of diamorphine)


Weight/kg	Volume Saline Added/ml	Notes
15	1.3	1. Estimate weight or weigh to nearest 5 kg
20	1.0	
25	0.8	2. Add weight specific volume of 0.9% Sodium Chloride
30	0.7	
35	0.6	3. Draw up 0.2ml of the solution
40	0.5	
50	0.4	
60	0.3	

*Once drawn up administer into nostril using a mucosal atomiser device. This will deliver 0.1 mg/kg of diamorphine.*

Unanticipated Difficult Airway



# Thoraco-Abdominal Surgery

- In general, the same principles that govern surgical management of adult abdominal trauma hold true for children in the austere environment 
- Vital structures are covered by less tissue and are more easily injured by energised fragments or missiles. Children are more likely to present with multiple injuries
- Do not use the absence of rib fracture as reassurance of absence of intrathoracic injury
- Pedicled abdominal organ systems are mobile and are injured by deceleration or acceleration during bodily displacement
- Air containing viscera may be damaged from the coupling of the blast wave with tissue

**5 questions should be uppermost in the mind of the treating surgeon during assessment of the child. Answering these will develop the management plan.**

1) Is there an abdominal injury?

(Breach of peritoneum, rupture of hollow viscus, bleeding solid organ).

- What is the patient history and mechanism/timing of injury ?
- What are the physical findings?
- What are the results of special investigations?

2) Is there significant compromise of the child?

- What is the physiology, and the trends in physiology?  
(Heart Rate, BP, Respiratory rate, Mentation, Urine Output)

3) How urgently does the child require intervention?

- How compromised is the patient, what is the risk of decompensation?
- What are the other injuries that may require attention?
- What are the competing cases that may require attention?

- 4) What is the best management strategy for the likely injury?
- Is conservative management a possibility?
  - If surgery is required, must it happen now or can it be delayed?
  - If surgery is required is it damage control or definitive?

5) Where is the child's next place of care?

- Is this a bigger or more resourced hospital?
- How will the child get there?
- What action can be taken now to set the scene for ongoing successful care in that medical treatment facility?

## MANAGEMENT

### Conservative management of abdominal solid organ injury

- Bleeding from solid abdominal organs (liver, spleen, kidney) is often self-limiting and can be managed by resuscitation and close observation. Thus, the finding of blood in the peritoneal cavity alone is not a reason alone to operate
- This strategy relies on the ability to closely monitor the patients for clinical deterioration

### Surgical management of suspected intra-abdominal injury

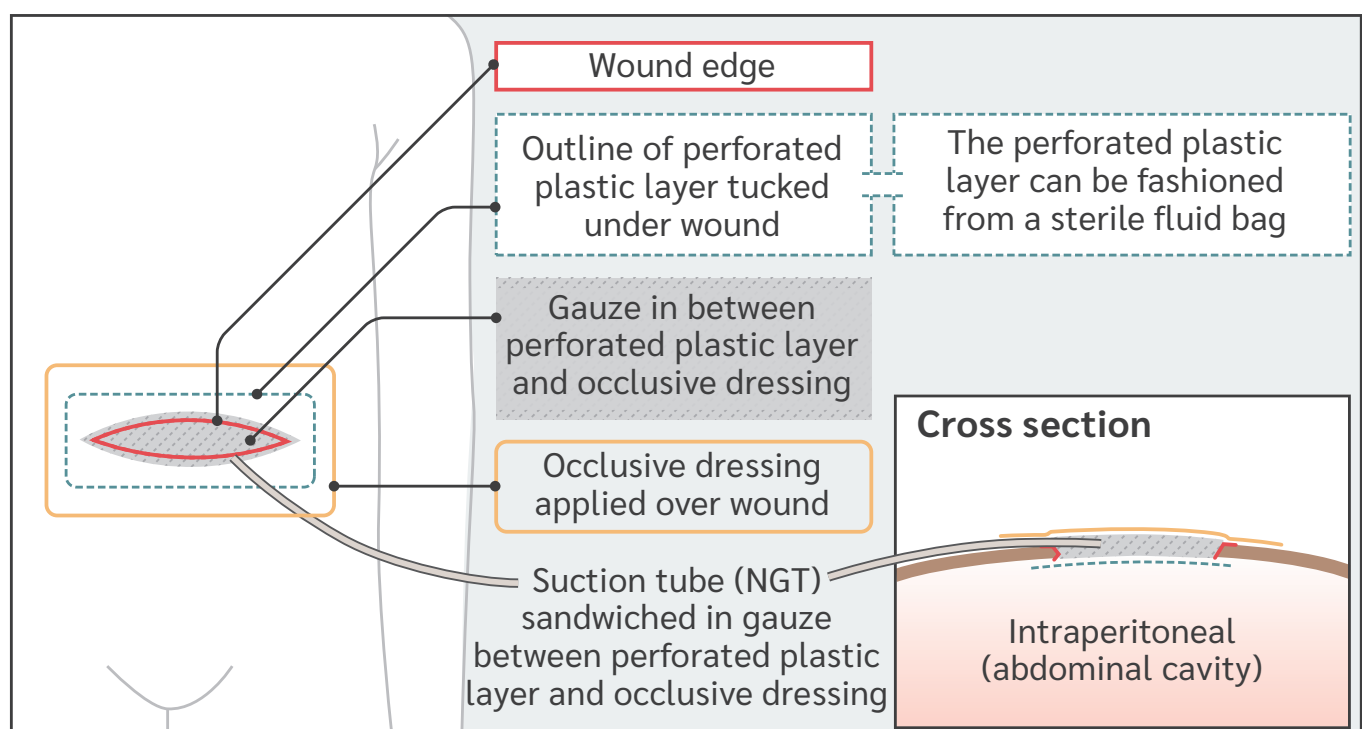
#### Preparation

- Shock, compensated shock, evidence of peritoneal or retroperitoneal breach, evisceration, and peritonitis mandate surgery
- If in doubt, use time and frequent reassessment to govern your choice. If there no time or space to assess trends in the child's condition, operate.
- Liaise closely with the anaesthesia provider
- Liaise closely with your surgical assistant and assess available equipment, sutures and packs
- Perform a comprehensive brief to your team (e.g. WHO Surgical Safety Checklist, page 100). Explain what the goal is, the risks and the plan to deal with complications.

## Abdominal injuries

- Shocked children with penetrating wounds should be managed by DCS.
- Solid organ injuries secondary to blunt injury can be treated conservatively if the child is haemodynamically stable after initial resuscitation and there are no other intra-abdominal injuries. This strategy relies on sufficient resources to closely observe the child for a prolonged period. These may not be available, therefore laparotomy may be an appropriate resource based decision.
- Consider splenic preservation if possible because of the long term risks of infection after splenectomy – especially in countries where vaccination and antibiotics are scarce.
- The omentum can be used as a haemostatic patch to help control bleeding from lacerations in the liver or spleen.
- Bowel anastomoses should be as per in adults.
  - Once the child is no longer acidotic,
  - Once the child is off inotropes and haemodynamically stable.
- The second look laparotomy after initial damage control surgery is the perfect time to attempt this.
- Temporary abdominal integrity can be achieved with an occlusive vacuum dressing. It is very tempting for a surgeon to close the thin and complaint abdomen of a child under tension. **Do not do this.**

### Occlusive Negative Pressure Dressing



- Distal stomas (i.e. terminal ileostomy or colostomy) are well tolerated by children but do impose a significant burden on the family long term.
- Proximal stomas are poorly tolerated because of the fluid and electrolyte losses and malabsorption mean the child is unlikely to thrive. Avoid them by either doing damage control surgery procedure followed by delayed primary anastomosis at the second look or schedule early stoma closure before the child leaves hospital.
- Consider passing a nasojejun tube in theatre at the second look laparotomy to allow early feeding.
- In penetrating trauma, match the external entry/exit wounds to the organ injuries you have found in order to build up a trajectory of the missile's path. Make sure that this is understood before completing the laparotomy.
- Copious irrigation of the peritoneum with warmed sterile fluid, debridement of all unviable soft tissue along the line of any missile track and planning for subsequent relook procedures are vital elements to prevent subsequent infection, and are more important than peri-operative antibiotic cover.

## Vascular Injury

- Injury pattern and careful assessment remain the key to identifying vascular injuries.
- Doppler ultrasound is the best way of identifying the anatomy but an on-table angiogram may also be valuable if achievable.
- Before exploring an injured vessel the surgeon should have both proximal and distal vascular control.
- Shunting of major vessels in damage control situations maybe life and limb saving but often the vessels of children and the intense vasoconstriction of the arteries can make this technically difficult.
- Children often do not have the same development of collateral circulation as adults and are at increased risk of distal ischemia if vessels are interrupted.
- Fasciotomies are just as relevant for children as they would be for adults with similar injuries.

## Thoracic injury

- Most thoracic injuries can be managed by chest drainage alone.
- Blunt chest injury rarely causes rib fractures in children but does often lead to significant pulmonary contusion. These can be managed conservatively with good pain relief and assisted ventilation.
- Due to the mobility of the pediatric mediastinum, pneumothorax can progress rapidly to tension physiology. All children with suspected trauma to the chest should have a Chest x-ray performed.
- If chest drains are required for significant pneumo- or haemothorax then these are inserted in the usual way but a finger sweep once into the pleural space is difficult.
- Thoracotomy is useful for control of bleeding, compression of the descending aorta for any distal haemorrhage.
- A clam shell incision should be used for most injuries. Access in anterior lateral left sided thoracotomy is usually inadequate. A median sternotomy takes longer to perform but gives better access for proximal control of the root of the neck vessels and the arch of the aorta.
- Non-anatomical lung resections or tractotomy either with stapling devices or by direct suture work well for lung injury with significant bleeding or air leak.
- Pneumonectomy is very poorly tolerated in young people.

## Concise guidance on definitive repair

<b>Stomach</b>	Repair in 2 layers; absorbable suture (always review the lesser sac for perforation).
<b>Duodenum</b>	Kocherise; repair small holes in 2 layers with absorbable suture; repair larger holes similarly but consider gastrojejunostomy to protect repair;
<b>Small/large bowel</b>	Repair in single or two layers with absorbable suture.
<b>Rectal perforation</b>	Simple repair if small. If complex – consider diverting stoma.
<b>Liver</b>	Packing is mainstay of haemostasis with later pack removal. Avoid liver sutures (risk of necrosis/sepsis).
<b>Spleen</b>	Packing with later pack removal or splenectomy.



<b>Pancreas</b>	Stop bleeding with haemostatic sutures; drainage. Distal pancreatectomy if tail/body injury with >50% of width transected.
<b>Kidney</b>	Manage conservatively unless expanding haematoma. Mobilise and perform buttressed repair of polar injuries with absorbable suture.
<b>Ureter</b>	Repair over suitable stent (paediatric feeding tube or similar) across the lesion (introduced via ureteral orifice)
<b>Bladder</b>	Repair in two layers with absorbable sutures. Per urethral catheter drainage for 10 days.
<b>Diaphragm</b>	Repair with interrupted non-absorbable sutures.

### Consent



Parental consent for surgery should be sought as a matter of routine. Older children need explanation and reassurance.

## Documentation

The operative note must be very clear, with an explicit description of what was done, why it was done, what remains to be done and when it should be done. The number and position of intra-abdominal swabs must be unequivocally recorded. The note should anticipate potential complications and record the courses of action that should be taken in the event that these arise. The operating surgeon must write the operative note such that any other surgeon receiving the child at the next place of care should be left in no doubt as to the management plan. See Annex 8A.

## Operative note template

<b>Patient Name</b>	<b>Age</b>
<b>Patient Identifier</b>	
<b>Name</b>	
<b>Registration number</b>	
<b>Surgeon</b>	
<b>Assistant</b>	
<b>Scrub</b>	
<b>Anaesthetist</b>	
<b>Preparation</b>	
<b>Indication</b>	
<b>Findings</b>	

## Procedure

## In situ packs

## Closure

Parameters	Op time
Blood loss	Blood product
Worst Base Excess	Worst Temp

## Post Op Plan

## WHO Surgical Safety Checklist

### 1. Before induction of anaesthesia (with at least nurse and anaesthetist)

Patient has confirmed his/her identity, site, procedure, and consent?

---

Is the site marked?

Yes

Not applicable

---

Anaesthesia machine and medication check complete?

---

Pulse oximeter on the patient and functioning?

---

Does the patient have a:

Known allergy?

No

Yes

---

Difficult airway or aspiration risk?

No

Yes, and equipment/assistance available

---

Risk of >500ml blood loss (7ml/kg in children)?

No

Yes, and two IVs/central access and fluids planned

This checklist is not intended to be comprehensive.  
Additions and modifications to fit local practice are encouraged.

## 2. Before skin incision (with nurse, anaesthetist, surgeon)

Confirm all team members have introduced themselves by name and role.

---

Confirm the patient's name, procedure, and where the incision will be made.

---

Has antibiotic prophylaxis been given within the last 60 minutes?

Yes

Not applicable

---

### Anticipated Critical Events

To Surgeon:

What are the critical or non-routine steps?

How long will the case take?

What is the anticipated blood loss?

To Anaesthetist:

Are there any patient-specific concerns?

To Nursing Team:

Has sterility (including indicator results) been confirmed?

Are there equipment issues or any concerns?

---

### Is essential imaging displayed?

Yes

Not applicable

## 3. Before patient leaves operating room (with nurse, anaesthetist, surgeon)

### Nurse Verbally Confirms:

The name of the procedure

Completion of instrument, sponge and needle counts

Specimen labelling  
(read specimen labels aloud, including patient name)

Whether there are any equipment problems to be addressed


---

### To Surgeon, Anaesthetist and Nurse:

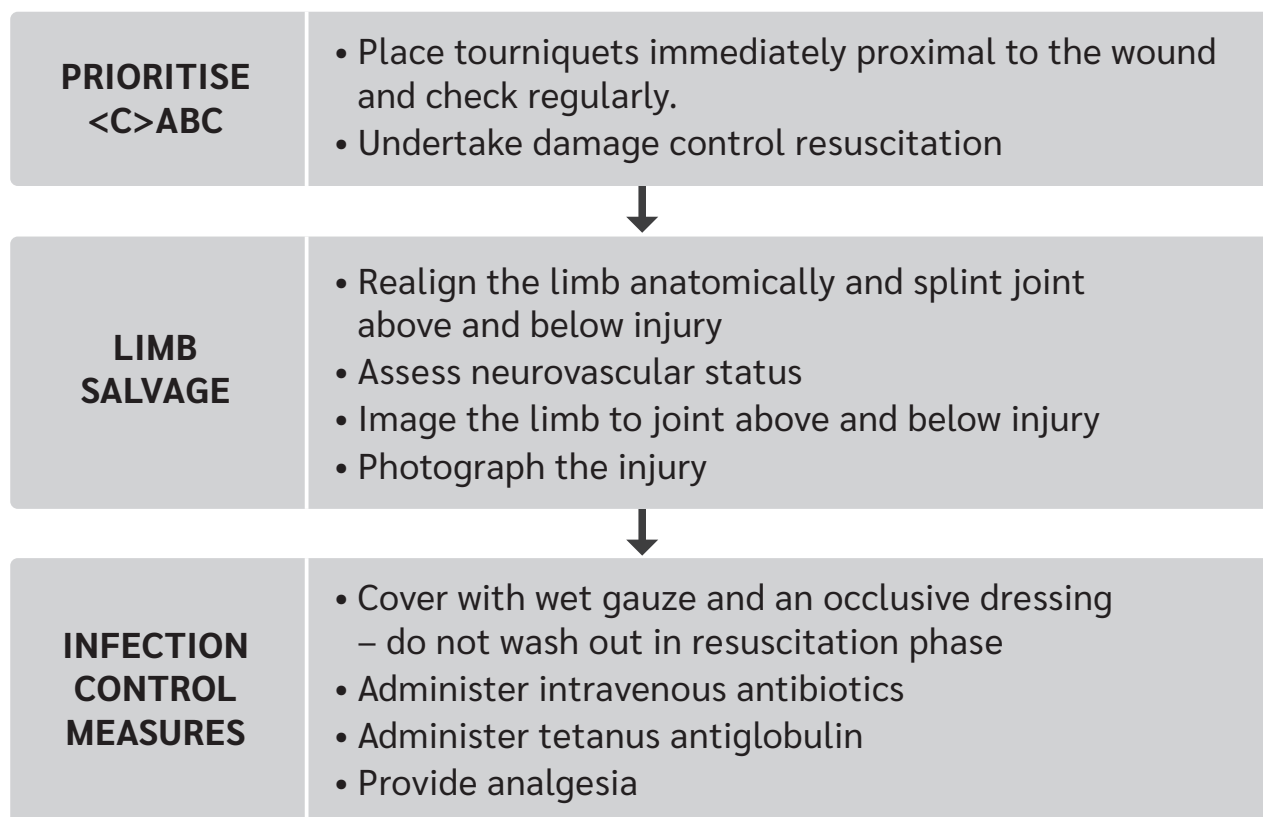
What are the key concerns for recovery and management of this patient?

# Limb injury management

This section will cover the immediate and early management of limb blast injury.

- Limb and tissue salvage begins at the point of injury and continues throughout the care pathway 
- The order of priority remains <C>ABCDE
- Early debridement to reduce contamination
- Regularly reassess neurovascular status and for sign of compartment syndrome
- Remove tourniquets as soon as safe to do so

## IMMEDIATE MANAGEMENT



## Neurovascular assessment and stabilisation

- Use hard signs to assess for vascular injury and not capillary refill or doppler Pulse oximetry is a helpful adjunct
- Realign and immobilise the limb, immobilise the joint above and below the injury
- Always image the limb including joint above and below
- Re-examine the limb after every procedure

### Hard signs of vascular injury are:



- Absent pulses
- Active/pulsatile haemorrhage
- Bruit or thrill
- Expanding haematoma

## Infection Control and Prevention

- Co-amoxiclav
  - 1-2 months 30mg/kg every 12 hours
  - >2 months 30mg/kg every 8 hours (max 1.2g single dose)
- Clindamycin
  - 3-6 mg/kg every 6 hours (max 450mg per dose)
- Tetanus immunoglobulin

## INITIAL OPERATIVE DEBRIDEMENT

Plan debridement during the command huddle. This is a priority for the first operative period and ideally done within the first hour, do not delay as these injuries are highly contaminated.

Do not attempt primary closure of blast and penetrating wounds



- Scrub with soapy aqueous chlorhexidine to remove surface contamination
- Use a tourniquet if wound distribution permits
- Clean skin using alcohol containing preparations
- Extend wounds along fasciotomy lines in the tibia
- Extensile incisions should consider and facilitate future amputation
- Use logical “Clock Face” approach working around the wound from superficial to deep
- “Create a tunnel not a funnel” by maintaining a broad front with the your wound debridement
- Irrigate wounds with copious (5-9 litres) of low pressure normal saline, use potable water in austere or restricted resource circumstances)
- Debride to viable tissue however if there is doubt leave the tissue and check again at 48 hours. Children have excellent blood supply and tissue preservation is vital for future definitive repair and rehabilitation

### Remember: do not



- **Do not** separate children from their caregivers
- **Do not** discuss procedures with other adults in front of little children



## SECOND LOOK OPERATIVE MANAGEMENT

- Generally at 36- 48 hours but debride earlier if concerned the blast wound is in evolution or signs of sepsis
- Sepsis & fungal infection should be considered in acute deterioration of the blast wound (see Sepsis algorithm page 151)
- Do not begin reconstruction until surgical control of the wound is definitively achieved

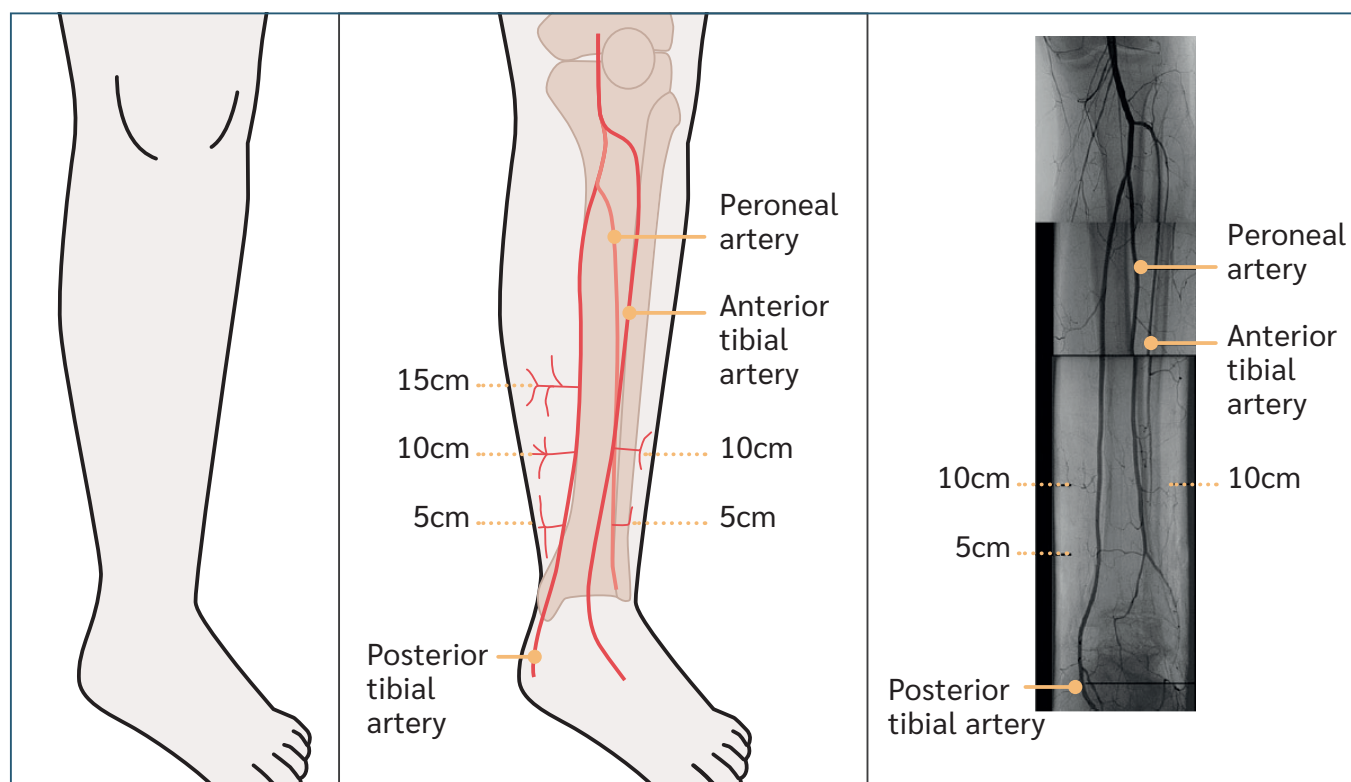
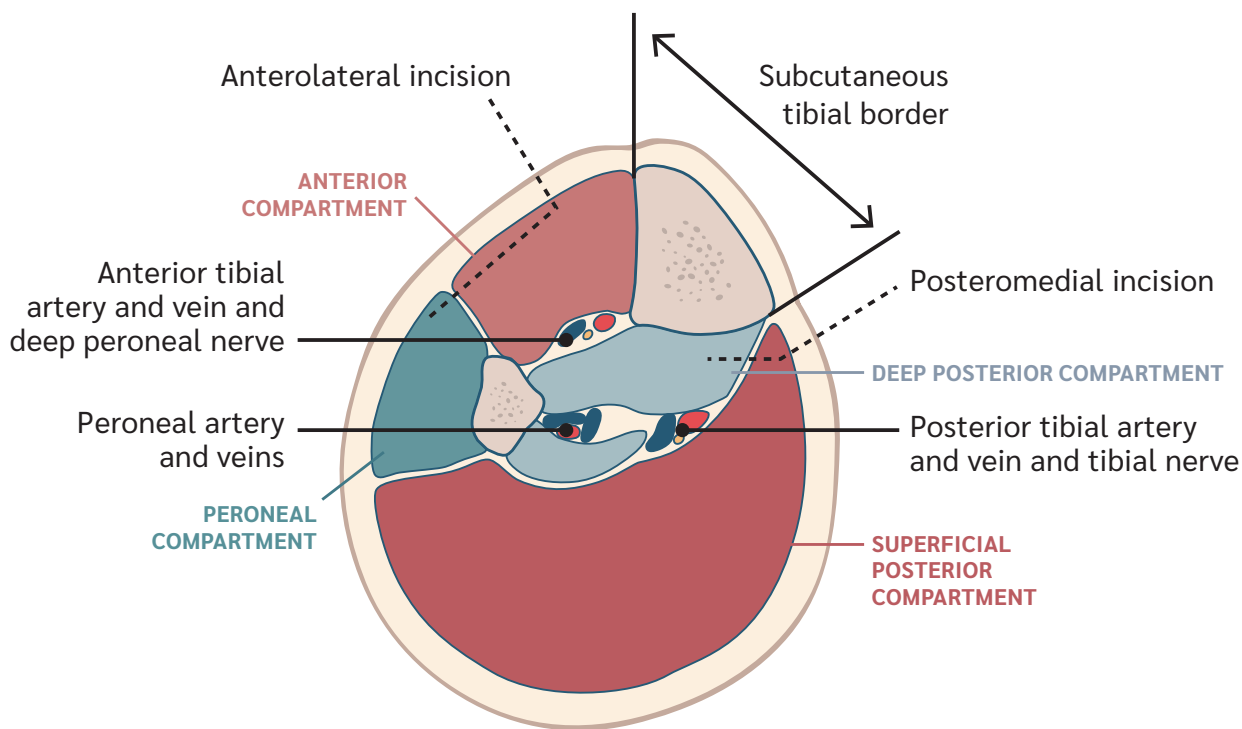
## COMPARTMENT SYNDROME

### Signs of Compartment Syndrome

- Pain out of proportion to the injury
- Pain on passive movement of a muscle traversing the involved compartment
- Altered sensation in the distribution of nerves traversing the involved compartment
- Absent sensation and absent pulses are late signs and indicative of a poor outcome
- Requires regular monitoring and prompt fasciotomy to save life and limb

# Fasciotomy

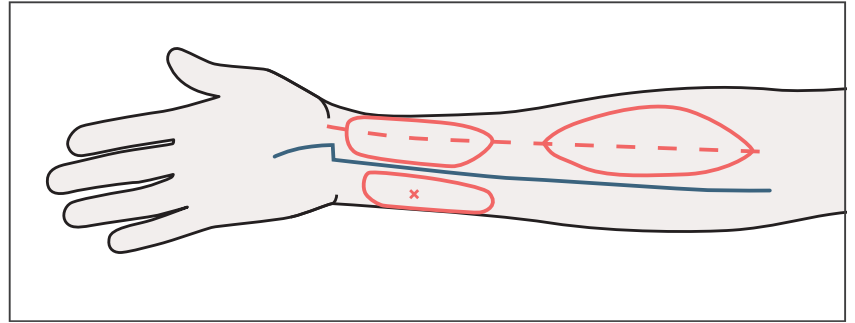
## Lower Limb



In the lower limb four compartments accessed through two full length incisions. Care to preserve the posterior tibial artery perforators medially. Access the peroneal compartment sub-fascially via the anterior compartment.

## Upper Limb

Open carpal tunnel with incision from Caplan's cardinal line to wrist crease based on radial border of ring finger. Cross the wrist in an ulna direction to a line from the ulna aspect of the ring finger. Decompress the forearm in a straight line to the antecubital fossa to the midpoint of the ulna half of the antecubital fossa. Decompress extensor compartment and mobile wad via a separate dorsal incision



### Rhabdomyolysis



- Children with massive soft tissue injury are at risk of rhabdomyolysis, in particular in compartment syndrome
- Monitor and maintain hydration
- Monitor and maintain urine output  $>1\text{ml/kg/hr}$

### Indications for emergency amputation

#### The indications for emergency amputation are the three D's



- **Deadly:** the limb is the source of life-threatening haemorrhage or sepsis
- **Dead useless:** whilst technically salvageable attempted salvage poses a risk to the patient for negligible gain.
- **Dead loss:** the limb is deemed unsalvageable ideally by two surgeons

## FURTHER GUIDANCE

### Fat

- Fat is not resistant to blast forces and high energy transfer and needs debridement

### Fascia

- Extensile exposure of the fascia (raised with the skin) in the long axis of the limb

### Muscle

- Assess using the 4 Cs: Colour/Consistency/contractility/capacity to bleed

### Bone

- Bone fragments with minimal soft-tissue attachments are at risk of infection and should be removed
- Privileged fragments (intra-articular) are taken at risk
- Debride to bleeding bone
- Where possible preserve the growth plates of the bones to maintain future development

### Nerves

- Do not tag
- Repair when the wound can be closed or repair covered with soft tissue

### Degloving

- Document degloving and the planes involved
- Reliable local flaps cannot be raised in degloved skin
- Raise all skin flaps in a fasciocutaneous plane

# LIMB REHABILITATION

## Amputation

- Where possible, ensure that prosthetic considerations are part of surgical level selection. Growing children will require regular refitting for prosthetics, and risk bony overgrowth that will make prosthetic fitting challenging.
- Educate the patient and their family regarding phantom sensation (continuing to feel the presence of the limb – normal, expected) and phantom pain (continuing to feel pain in abnormal limb – abnormal) in an age appropriate way. This can happen before or after surgery. Phantom pain or sensations can be incredibly distressing if not understood.
- Encourage independence as early as possible. Mobilise using crutches or a wheelchair as soon as medically able. Teach safe transfers, including, for bilateral amputees how to get up from the floor if they fall. Children may be able to mobilise very quickly post operatively with crutches but take care to keep them safe to avoid falls onto their stump.
- If possible, link children with amputations to other children with the same condition for peer support.
- Teach the child or their family members to apply stump bandaging for oedema control in consultation with the medical team.
- Contractures can develop quickly and prevent or delay the possibility of prosthetic use. Hip Flexion contractures are a risk in above knee amputation. Encourage the child to spend time each day in prone lying with hip extension. For below knee amputations, ensure that knee extension is maintained by encouraging long sitting (with the knee fully extended) and avoiding the use of pillows under the knee in lying or sitting.

- The mechanism of blast injury can increase the risk of complications. Monitor/Check For: Infection, heterotrophic ossification, neuroma, phantom pain, bone spur/overgrowth. Report any new or increased pain, increased swelling, wound discharge, or unexplained joint stiffness to the medical team.
- Refer to a prosthetic or rehab provider for follow up at the earliest possible opportunity. If no provider is available, record patient details in a central list so that they can be followed up appropriately later.
- For upper limb amputations, the same basic principles of rehabilitation apply. Teach the child to avoid postural deviations. Hand dominance is key – they will need encouragement and support to learn how to carry out tasks independently. Encourage early independence, rather than reliance on family members, where possible.

## Other limb injury:

- Paediatric fracture rehabilitation does not differ significantly from adult fracture rehabilitation, so long as general paediatric rehabilitation principles (Section 13) are adhered to.
- Be aware that complications such as nerve injuries (causing weakness or numbness) or additional fractures (with bony tenderness or causing limited function) may have been missed during emergency surgical management of an injured child and are often identified later by the rehabilitation professional.
- Ensure that post operative weight bearing status is defined by the surgeon, along with any other restrictions of range of movement.
- Mobilise as early as medical/surgical advice will allow. If at all possible, carry a stock of paediatric crutches and wheelchairs. Check and double check that the child can follow weight bearing instructions if there are restrictions.
- Teach the patient to maintain gentle range of movement and strength above and below the level of injury. DO NOT use passive movement to maintain or restore range in an acute setting. If permitted by the surgeon, use simple active exercise, as pain allows.
- Report any new or increased pain, increased swelling, wound discharge, unexplained weakness or new deformity to the medical team.
- Where nerve injuries are present, be sure that the team assesses the severity of the injury as educating the family about the chance (and timeframe) for recovery is essential.
- Also educate the child and their family about protecting and keeping the limb warm if it has a loss of sensation, and protecting range of movement if there is weakness.
- Upper blast limb injuries are complex and their effects are long lasting. Rehabilitation plans should be developed in partnership with the surgical team. **Specialist upper limb rehab referral should be made as early as possible.**

# Management of Burns

This section will cover the management of paediatric burn casualties. The management of burns begins at the point of injury and first response.

- The management of burns begins with the first response
- Intravenous fluids in burns within the first hour increases survival
- Burns management is resource intensive
- Analgesia is difficult but vital, consider all routes
- Burn patients are trauma patients, hypovolaemia in the first hour must be assumed to be blood loss and not burns fluid loss
- Where possible burn injuries should be transferred to a specialist multidisciplinary team



## INTRODUCTION

Burns injuries are common in blast trauma and are frequently accompanied by multiple other injuries which must not be overlooked in the effort to treat the burn.

Burn injury can be life threatening in isolation and will add to the morbidity and mortality of the trauma patient.

Burns are extremely painful and can lead to life long scarring and psychological sequelae. Good, early management of pain is critical to enable calm and effective management and prevent distress and psychological sequelae for the child. Intramuscular ketamine is extremely effective and is particularly useful when IV access is difficult. See section 7 for dosing.

Burn care requires an inordinate amount of hospital resources and the availability of on going care and the resources of the local healthcare system should be considered when deciding to begin care.

Mortality and the risk of complications rises with increasing burn surface area and lower age.




## Immediate care

- **Perform <C>ABCDE/Damage Control Resuscitation and stop the burning process. Do not be distracted by the burn. Patients may have lifethreatening injuries other than burns.**
- If not already done, continue to cool the burn for up to 30 minutes using ambient temperature clean water
- Protect from hypothermia – **Cool the burn, warm the patient**
- Loosely cover the burn with clean material or plastic food-wrap. Does not have to be sterile but must not constrict
- Give strong analgesia
- If a delay to hospital of over one hour is anticipated encourage the patient to drink small but frequent amounts of fluid or begin intravenous fluids

## <C>ABCDE IN BURNS

### Airway:

- Assess carefully for likelihood of inhalation injury
- Prolonged exposure in an enclosed space
- Facial or intra-oral burns
- Stridor, wheeze or hoarse voice
- Soot in airway or sputum
- Singed nostrils
- Any history of reduced consciousness

- Consider early pre-emptive intubation if there are any signs of airway burns 
- Airway burns cause progressive, potentially rapid upper airway occlusion that will prevent successful intubation of the child
- Do not cut the endotracheal tube, leave at full length
- Monitor cuff pressure and be aware of head and neck swelling leading to tightening of tube fixation

## Breathing:

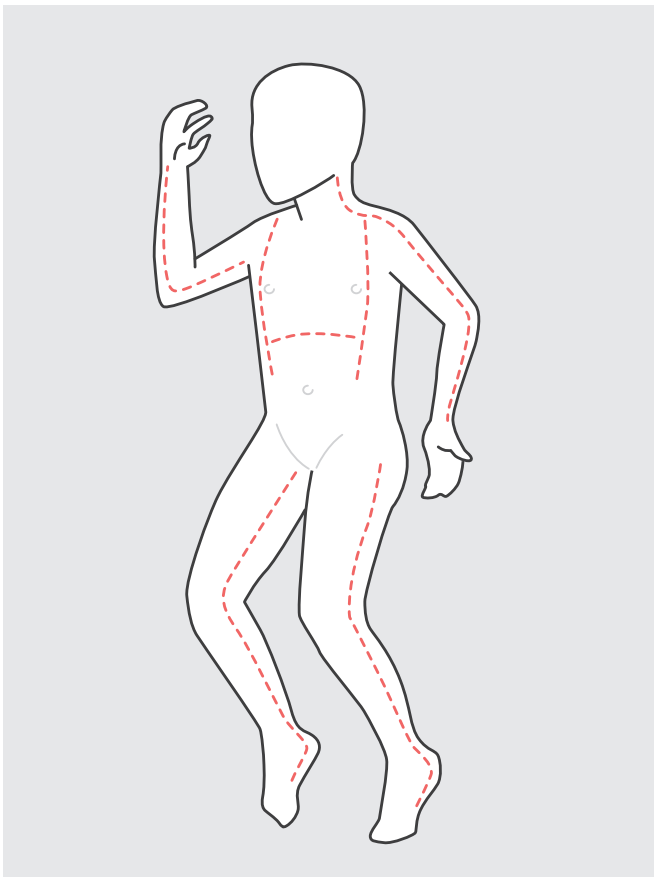
- Assess for restriction of chest movement by full thickness burns. If present perform escharotomy to allow adequate chest wall movement for effective ventilation
- Pulmonary failure characterised inadequate by gas exchange may indicate pulmonary injury secondary to toxic inhalation. This requires a ventilation strategy as used for acute respiratory distress syndrome (ARDS) and carries a high mortality. Features of pulmonary injury are usually delayed by several hours.

## Circulation:

Assess neurovascular status of limbs distal to deep circumferential burns. If there is compromise, perform escharotomy and be prepared to manage bleeding

- Hypovolaemia and shock in the first hour is unusual in an apparently isolated burn. If present, exclude other causes of haemorrhage and treat according to the shock protocol

### *Lines for escharotomies*



- For burns of greater than 20% TBSA are fluids should be started in the first hour or as soon as possible
- Fluids given for initial resuscitation are in addition to the burns fluids
- Warm all fluids
- Hypovolaemia should prompt reassessment and resuscitation



## Fluid Management:

Children with a total body surface area burnt (TBSA) of greater than 20% require intravenous fluid administration and careful fluid balance management

To calculate the first 24 hours fluid volume requirement for burns over 20% TBSA the recommended formula is:

---

$$\text{Patient weight (kg)} \times 2 \times \% \text{TBSA} = \text{Volume in millilitres}$$

---

Give **50%** of this volume over the first 8 hours (from the time of injury)

Give the remaining volume over the next 16 hours and

- Monitor urine output hourly, preferably using a urinary catheter
- Aiming for 0.5ml -1ml per/hour (1ml per hour in infants)

Use Ringer's Lactate or equivalent.  
Never use hypotonic/hyponatremic solutions



Slowly increase infusion rate if urine output falls below 0.5ml/kg (1ml/kg in infants)

Over administration of fluids is potentially harmful. If urine output is greater than 2ml/hour, reduce infusion rate gradually until rate falls to less than 2ml/hr

For injuries less than 20%TBSA oral fluid intake will suffice in most cases. Use standard oral rehydration solution encouraging small amounts frequently. Monitor intake and urine output. If there are signs of dehydration or poor urine output add intravenous maintenance fluids.

## Disability:

In altered consciousness consider:

- Toxic gas inhalation (including carbon monoxide and cyanide gas)
- Head injury
- Hypoglycaemia
- Hypoxia

## Exposure:

- Children with burns are particularly prone to hypothermia, keep as warm as possible
- Ensure that a thorough secondary survey is performed
- Give adequate analgesia as early as possible, intramuscular ketamine is particularly effective.

## INITIAL WOUND CARE

- The initial priority in wound care is to clean, assess and cover the wound
- Apart from small burns, cleaning and assessment under general anaesthetic in an operating theatre is preferable



Following <C>ABCDE perform the following

Thoroughly clean the burn and remove all blisters, soot and burnt clothing using warm antiseptic soapy solution. Water safe enough to drink is acceptable if cleaning solution is not available

Burn wounds must be cleaned thoroughly before any dressing is applied.

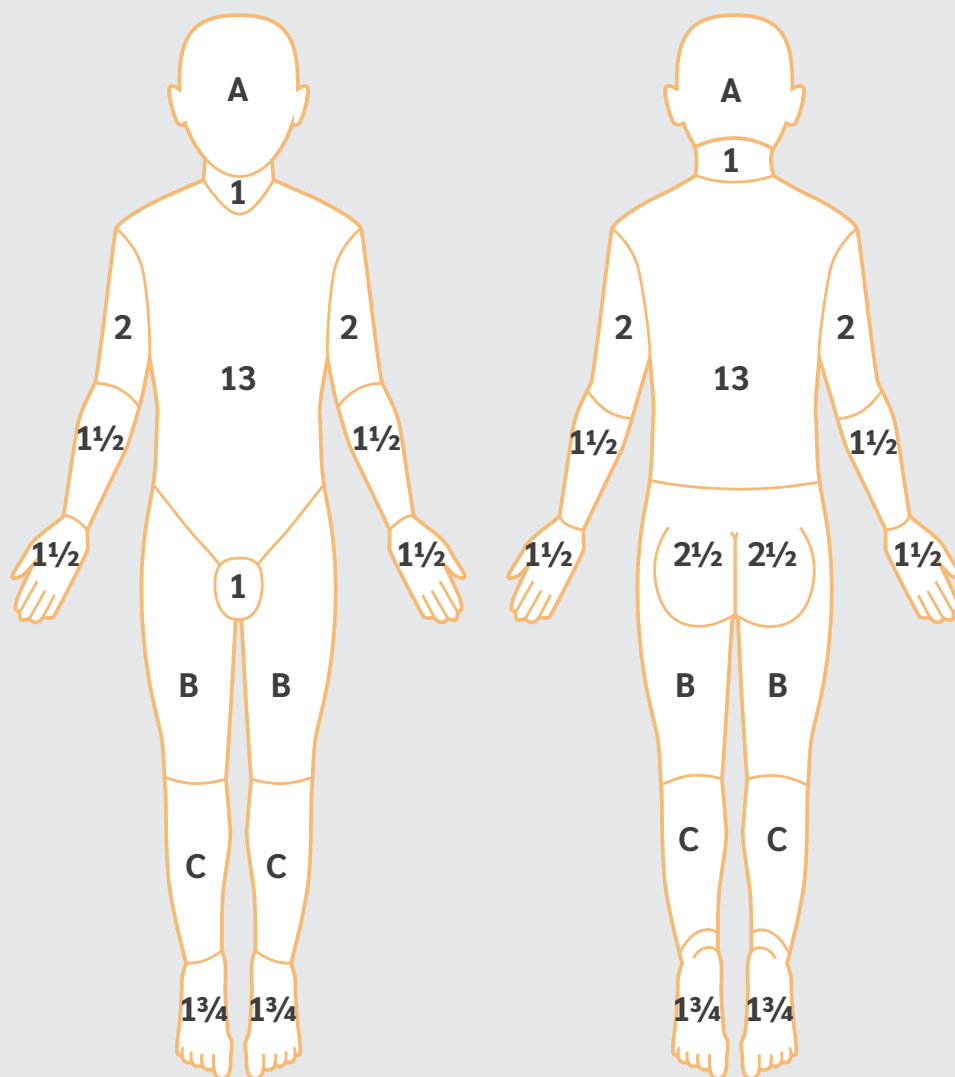
- Prophylactic systemic antibiotics in isolated burn injury are not routinely required
- If there is concomitant penetrating injury administer antibiotics as per normal
- Administer appropriate anti-tetanus prophylaxis
- Apply a classical burn dressing will consist of
  - An interface layer of a non-adherent dressing
  - An antiseptic layer
  - An outer absorbent layer
- Burn wounds will be highly exudative for the first couple of days.
- Change the outer layer when it gets soaked through but leave the interface layer
- At 48 hrs, remove all dressings and re-evaluate the burn.

## BURN SIZE ASSESSMENT

Establish the size of the burn and describe it as the percentage of the total body surface area that is burnt- %TBSAB. This will guide fluid management and potentially futility decisions.



- The 'rule of nines' is not accurate in children, use a Lund and Browder chart (*next page*)
- Skin erythema without blistering is not counted in %TBSAB
- The palmar surface of the whole hand including fingers is about 1% TBSA
- Burn depth evaluation can be difficult. It is easiest to divide into:
  - Superficial; where dermal capillary refill can be demonstrated
  - Deep, where there is no dermal capillary flow
- Do not rely on initial assessment of depth if the patient is hypovolaemic or hypothermic, reassess once resuscitated
- Be aware, burns may evolve and %TBSAB increase as a result.



**Relative percentage of areas affected by growth**

Age in years	0	1	5	10	15	Adult
A – 1/2 of head	9 1/2	8 1/2	6 1/2	5 1/2	4 1/2	3 1/2
B – 1/2 of one thigh	2 3/4	3 1/4	4	4 1/4	4 1/2	4 3/4
C – 1/2 of one leg	2 1/2	2 1/2	2 3/4	3	3 1/4	3 1/2

## ON-GOING CARE

Burns patients will require daily review as a minimum and vigilance for signs of sepsis.

- Maintain gut function and protect from stress ulceration by feeding from day 1
- An effective analgesia regime is essential
- In large burns, (greater than 30%TBSAB, a systemic inflammatory response will be triggered). This will require high dependency care.
- A systemic inflammatory response will result in tachycardia and fever making the diagnosis of infection difficult
- Dressings should be changed when soaked through or there are suspicions of burn wound infection
- Treat definite evidence of burn wound infection with systemic antibiotics
- High protein, high calorie nutritional support is highly desirable
- A combination of splinting and physiotherapy should be started early to counter the tendency for burn contractures
- Regularly review fluid requirements and transfer to oral fluids as soon as possible.

## BURN WOUND CLOSURE

- Burns that heal in less than three weeks have significantly less scarring
- Superficial burns, if dressed appropriately, will heal in this timeframe
- Deeper burns require surgical excision and skin grafting and the best outcomes are achieved if this is performed very early
- If the capability to perform early excision and grafting is not available, it is better to apply dressings for two weeks and then graft what has not healed
- During surgery for excision and grafting, minimise blood loss by liberal use of topical weak epinephrine solution (1:1,000,000)
- If the %TBSA requiring grafting is over 40% it will be exceptionally difficult to find enough autologous skin graft. In low resource environments this may indicate futility in beginning burn care.

## DELAYED BURNS PRESENTATION

- Patients with burns >20% TBSAB are highly likely to require fluids resuscitation
- Shock may be due to fluid loss, sepsis or haemorrhage
- The likelihood of sepsis increases with the time from injury
- Never use suxamethonium during anaesthetic induction it is likely to cause hyperkalaemia and cardiac arrest

## SPECIAL BURNS

### Electrical:

- Anticipate deeper damage than suggested by the surface wound
- May require fasciotomy as well as escharotomy
- Deeper necrosis may be progressive; be cautious with early grafting.

### Chemical:

- Wear appropriate personal protective equipment
- Prolonged decontamination with copious volumes of water is essential
- Brush off powder chemicals before irrigating
- Tissue necrosis may be progressive; be cautious with early grafting.

### Phosphorous burns:

- Wear appropriate personal protective equipment
- Phosphorous will not burn under water; keep unbridged wounds soaking wet
- Surgically excise the burn wound with a wide margin as an emergency
- Copper Sulphate is toxic; do not use.

### Vesicant agents:

- Wear appropriate personal protective equipment
- Decontamination must be thorough. Removed clothing will remain a hazard.
- Blister fluid does not contain active agent
- Fluid loss is lower than for thermal burns
- Healing is normally spontaneous but slow; skin grafting is not advised.



## BURNS REHABILITATION CONSIDERATIONS


- A comprehensive assessment of the patient must be prioritised. This should include the burnt area but also consider the child more holistically including pre-existing conditions and subjective information to help you tailor your treatment plan to the individual child. Consider what sports they like, do they have siblings that can help to engage them in therapy?
- Before beginning any therapeutic intervention, the child's pain must be managed to minimise distress. This should include a combination of age appropriate distraction techniques, relaxation and analgesia as part of an agreed medical team plan.
- It is important to answer any questions that the caregivers and child have about the therapy plan, functional impact and appearance of the burns injury honestly and with an aim to empower them to take part in therapy and to build trust.
- Positioning the child's affected limbs into 'anti-contracture' positions will help to maintain soft tissue length and minimise complications. A positioning chart can be used to act as a memory prompt.
- Splinting can be used to reduce swelling, maintain soft tissue length and minimise joint contracture. It is important to pay close attention to small joints such as in the hands and to design a clear regime that is both understood and agreed with the primary care giver.
- A series of exercises and movements should start immediately to move the affected limb through its full range of motion (where surgical precautions allow). This can take the form of play, dance or sports skills dependant on the interest of the child.
- Play should be encouraged and tailored to the individual child. Play should be age specific, culturally sensitive and mirror the movement that is limited I.e. above head games/ tasks for axilla burns

- Passive stretches of the affected limb are an important part of therapy but involve trust and patience as they can be painful. Techniques such as safe words (‘stop’) for older children can allow them to retain a sense of control over the limit of the stretch.
- Scars can take between 18 months and 2 years to mature. During this time the child will need ongoing therapy in the form of advice, exercises, moisturising of any scar with a non-perfumed and non-irritating cream and where available the use of pressure garments.
- Reconstructive surgery could be necessary and as such should be considered in onward referral– this need may manifest after the scar maturation period due to the growth of the child.

# Neurological Injury

## HEAD INJURY

- Head injury is common in paediatric blast patients with patients under seven years old twice as likely to present with head injury than those over seven years.
- Blast induced traumatic brain injury (as opposed to blunt or penetrating trauma) is also common, particularly under ten years of age.
- Intracranial injury is particularly challenging in low or limited resource setting where access to neurological intensive care may not be possible. It is important therefore to consider whether desired goals are achievable early in the child's care.

- Regardless of mechanism the goal of head injury management is to prevent secondary injury following the irreversible primary insult. 
- Prompt and good resuscitation is vital in improving outcomes
- Early futility discussions are particularly important in low resource environments (see Futility, page 171)

## ASSESSMENT

- Following <C>ABC, D – Disability is assessed. The AVPU scale can be used initially along with assessment of pupil size and reactivity.
- If the child scores V or P then a Paediatric Glasgow Coma Score should be assessed.

<b>A</b>	Alert
<b>V</b>	Responds to Voice
<b>P</b>	Responds only to Pain
<b>U</b>	Unresponsive to all stimuli

## Pediatric Glasgow Coma Scale (PGCS)

	<1 year	> 1 year	Score	
<b>Eye opening</b>	Spontaneously	Spontaneously	4	
	To shout	To verbal command	3	
	To pain	To pain	2	
	No response	No response	1	
<b>Motor response</b>	Spontaneous	Obeys	6	
	Localises pain	Localises pain	5	
	Flexion-withdrawal	Flexion-withdrawal	4	
	Flexion-abnormal (decorticate rigidity)	Flexion-abnormal (decorticate rigidity)	3	
	Extension (decerebrate rigidity)	Extension (decerebrate rigidity)	2	
	No response	No response	1	
<b>Verbal response</b>	<b>0-23 months</b>	<b>2-5 years</b>	<b>&gt;5 years</b>	
	Smiles/coos appropriately	Appropriate words/phrases	Oriented	5
	Cries and is consolable	Persistent cries and screams	Disoriented/confused	4
	Persistent inappropriate crying and screams and/or screaming	Persistent cries	Inappropriate words	3
	Grunts, agitated, and restless	Grunts	Incomprehensible sounds	2
	No response	No response	No response	1
<b>Total Pediatric Glasgow Coma score (3-15)</b>				

- A full neurological assessment should occur as soon as possible with sensory and motor deficits documented.
- Record regular neurological observations to identify any deterioration.

## PREVENTION OF SECONDARY INJURY

Cause	Prevention/treatment
Ischaemia secondary to expanding intracranial haematoma	Evacuation of haematoma
Ischaemia secondary to cerebral oedema	Intravenous Hypertonic Fluid Mannitol 0.25-0.5g/kg 2.7% Sodium Chloride 3ml/kg
Ischaemia secondary to hypotension and or anaemia	Damage control resuscitation and surgery Vasopressors in isolated head injury (see Section 6)
Hypoxia	Airway management Delivery of high flow/concentration oxygen to maintain normal oxygen concentration/ $\text{PaO}_2$
Hypercapnia/ hypocapnia	Support ventilatory failure Monitor end tidal $\text{CO}_2$ (the 2 being superscript) and correlate with arterial blood gas Avoid hyperventilation
Hypoglycaemia	Check whole blood glucose levels hourly and correct hypoglycaemia with 2ml/kg 10% Glucose bolus and add glucose to maintenance fluids to make 5% or 10% solution if necessary
Hyperglycaemia	Insulin sliding scale (See annex to this chapter)
Fever	Antipyretics – paracetamol and or ibuprofen in analgesic doses (see section 7) Cool patient
Seizure	Load with phenytoin (20mg/kg over one hour) or Levetiracetam (20mg/kg over one hour) (For seizure prophylaxis) Rapidly terminate seizures with IV benzodiazepine or anaesthesia

## **Other basic measures to reduce intracranial pressure include**

- Keep head in the midline and ensure there is no obstruction to jugular venous return such as tight endotracheal tube tapes
- Nurse at 20-30 Degrees head up position
- Good analgesia
- Good sedation and paralysis
- Stool softeners

## **Surgical management**

Limited surgical management may be available but should be limited in the DCRS phase to debridement of penetrating wounds and evacuation of haematoma causing raised intra-cranial pressure or mass effect. Surgery beyond this will require specialist input. The availability of such input may determine whether or not futility is an issue.

## SPINAL INJURY



- Do not try to restrain a combative child
- Rigid cervical collars are no longer routinely advised in children, immobilisation, if required should be with blocks and tape
- Remove children from rigid boards as soon as possible
- Spinal immobilisation should never interfere with the delivery of immediate life- saving interventions.

All blast injured children should be suspected of having a spinal injury. Immobilisation of children is difficult as they are less likely to cooperate with restrictive measures and attempts to implement them may endanger the child further.

Spinal immobilisation should be considered in a cooperative child if there is mechanism consistent with injury and

- Neck pain, or
- Reduced range of movement, or
- Injury above the clavicle, or
- Peripheral neurological deficit.

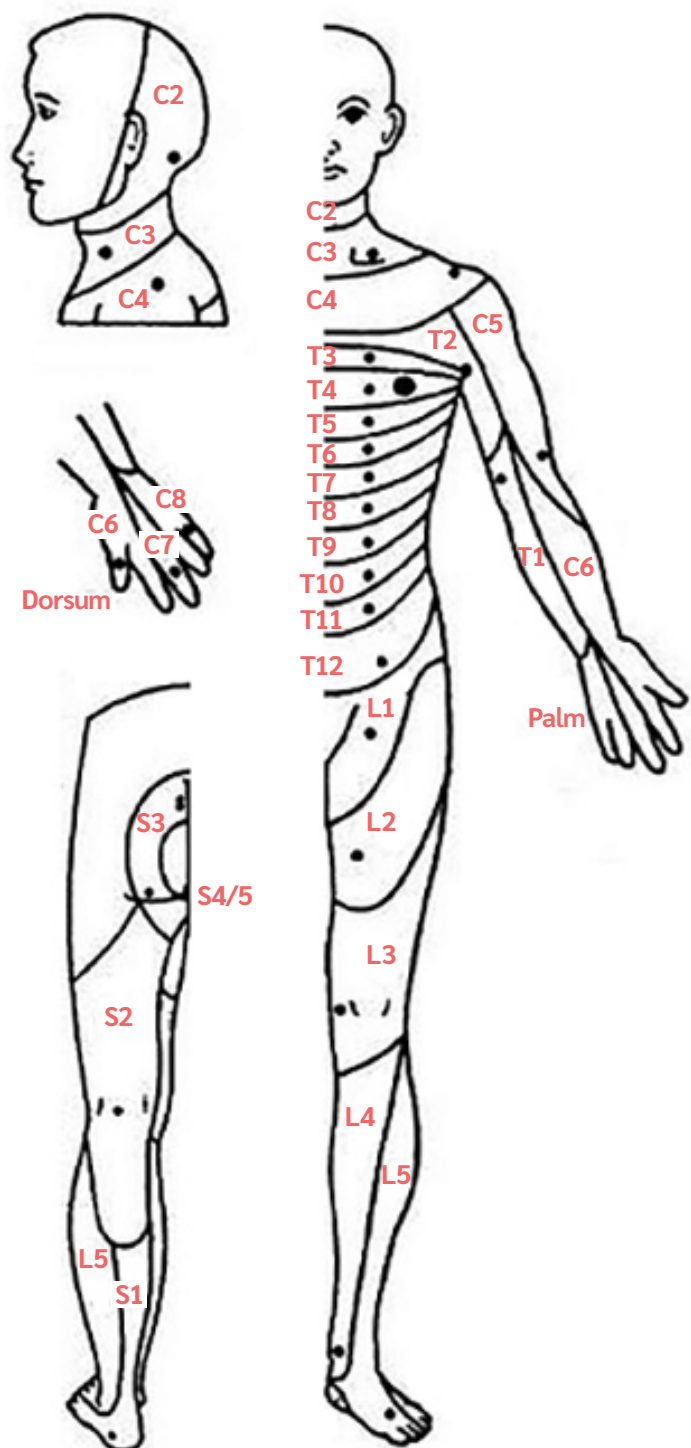
The majority of spinal injuries in children are cervical, commonly in the upper third. However, the use of cervical spine collars is no longer advocated in children. If immobilisation is assessed as required, then manual in- line stabilisation should be initially provided. If cooperative, blocks and tape should be applied. Immobilisation should not be forced upon the child; fully conscious children are likely to be able to protect their own cervical spine during transfer.

- Transport should be in either a vacuum mattress or scoop stretcher and never on a spinal board – these are for extraction only
- Antiemetics should be considered for all supine and immobilised children
- In the occurrence of penetrating cervical injury, immobilisation is not indicated
- Spinal shock is an indication for vasopressors in injured children.

All injured children should have a full neurological assessment at the first opportunity as part of the secondary survey. Deficit may be secondary to brain injury or spinal cord injury. It should include

- Pupils
- Cranial nerve assessment as able
- Ears. Nose and throat examination
- Respiratory pattern and effort
- Motor levels
- Sensory levels
- Bladder and bowel function assessment

### Sensory Level Map



Elbow Flexors	C5
Wrist Extensors	C6
Elbow Extensors	C7
Finger Flexors	C8
Finger Abductors	T1
Hip Flexors	L2
Knee Extensors	L3
Ankle Dorsiflexors	L4
Long Toe Extensors	L5
Ankle Plantar Flexors	S1
Anal Contraction	S4/5



Treatment of spinal injuries is challenging the resource limited environment. In principle they should be nursed flat and moved using the log roll technique as required for spinal precautions. For larger children this may be the same as an adult with 4 people. In smaller children 3 people will be sufficient. Semi-rigid c-spine collars should be used in unstable cervical spine injury. In addition undertake the following.

- Regular respiratory function assessment using spirometry if available but also observation of effort and cough strength
- Chest physiotherapy if any respiratory motor compromise
- Vigilance for autonomic dysreflexia (rise above baseline of 15mmHg under 13 years old and 20 above 13 years old)

## WARD AND REHABILITATION

- If there is any suspicion of SCI, monitoring of respiratory function is vital. Measure via spirometry if possible. Also monitor cough strength and ability to clear secretions. Children with SCI will generally have normal lungs but their ability to inhale/ exhale and cough may be neurologically impaired. They may require manual assisted coughs and respiratory training.
- Avoid sudden drops in BP through medication, abdominal binders and anti-embolism stockings/ compression garments. The child's normal BP values in different postures should be known so that changes can be noted.
- A dual diagnosis should be considered when a child with an Acquired Brain Injury also has unexplained progressive neurological symptoms, persistent low back pain, respiratory deterioration and/ or urinary retention.
- Be aware that untreated autonomic dysreflexia (AD) can lead to stroke or cardiac arrest and therefore must be dealt with as an emergency. An unusually grizzly and irritable young child with SCI should also be considered as potentially suffering from AD and appropriate checks made. A rise in BP of 15 mmHg above the baseline for a child with SCI under 13 years old or 20 mmHg in the SCI child over 13 years may be a sign of AD.
- For the management of an unstable spine, use full spinal precautions for turning and positioning.
- Children with SCI are at risk of pressure ulcers. Alternate position every 2 hours to prevent the development of pressure ulcers. Teach the child

or family to implement a program of skin checks, twice daily, normally on dressing/undressing to monitor areas at risk.

- When managing increased tone, the goal is to improve function, prevent complications and alleviate pain. Conservative management is preferred in paediatrics e.g. weight bearing, stretches and reciprocal limb activities where possible. If insufficient or unable to do this, medication can be considered.
- Patient and family education are vital. Key topics to cover include skin care, bladder, bowel, and posture, and the family need to be have an awareness of the complications of SCI, especially autonomic dysreflexia and when seeking emergency assistance is indicated. It is important to discuss realistic long term outcomes with the family, and to encourage them to support their child to achieve their maximum potential. Linking a child to a peer with a spinal injury at the earliest possible opportunity can be of great benefit, as can linking to local disabled peoples organisations.
- Following definitive management (or once the injury is judged to be stable) a child with an SCI will require intensive rehabilitation post injury to achieve their maximum potential. A regular standing programme is key to reducing the risk of deformity caused by prolonged sitting. A standing orthosis or frame that supports both the trunk and lower limbs is recommended in the absence of sufficient neurology to maintain posture, especially if injured pre-adolescence. Abdominal bracing is indicated for reduced neurology in the trunk and commenced when upright sitting starts (prior to deformity manifestation).
- The younger the child is and the more asymmetrical their neurological presentation the greater their potential for deformity and contracture. Limitations of as little as 5° will magnify enormously with growth. In order to prevent hip dislocation, subluxation and contractures establish a regular standing programme, soft tissue stretching, control of spasticity, prophylactic hip abduction and sleeping prone as able to (this may be restricted by spinal or post-operative precautions).

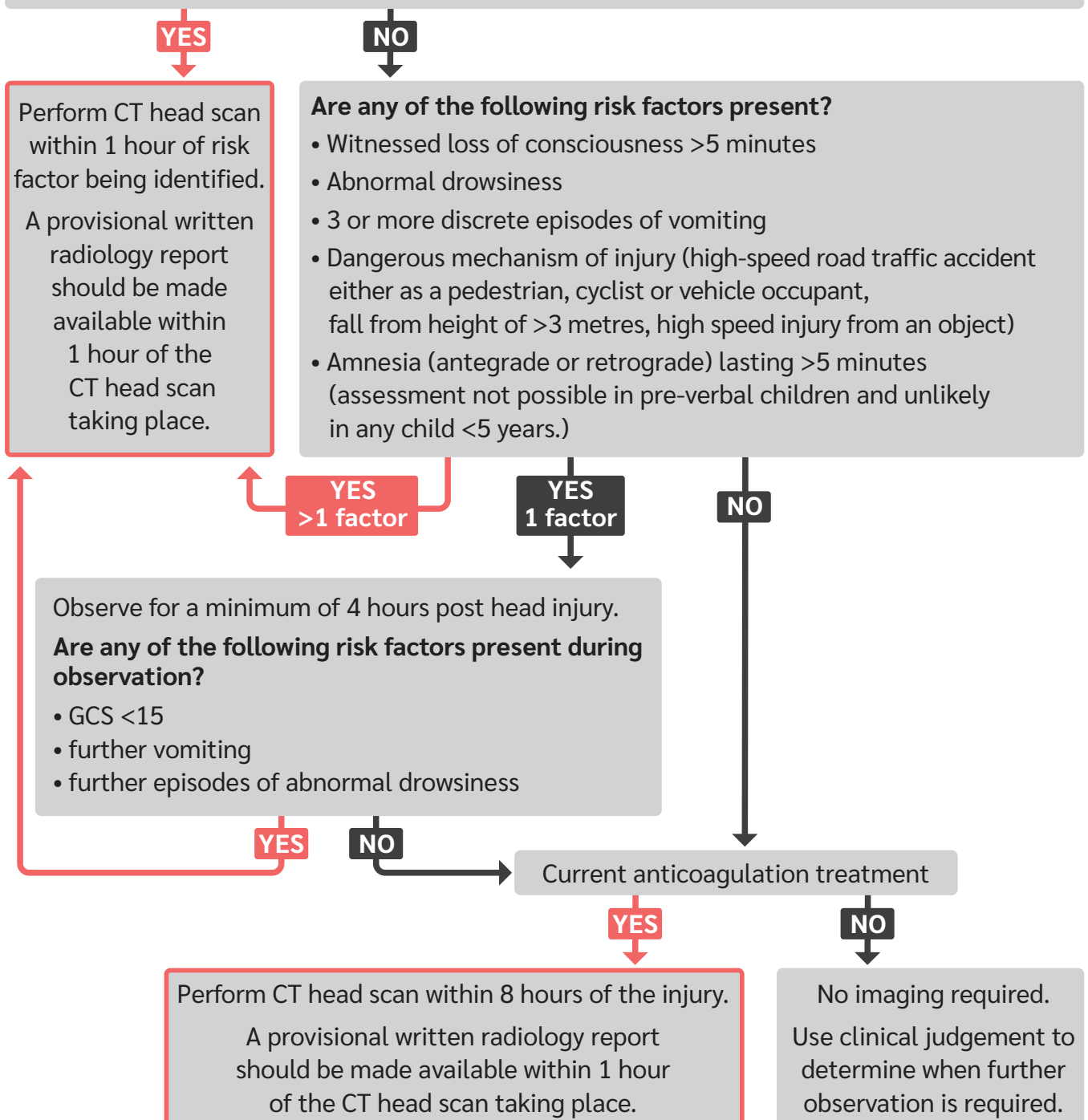
## ONGOING CARE

Ongoing care of neurological injury in children following DCRS is extremely challenging in the low resource setting. Patients with neurological injury should be transferred to specialist care when it is safe to do so. Family education will be vital.

**Children presenting to the emergency department who have sustained a head injury**


**Are any of the following risk factors present?**

- Suspicion of non-accidental injury
- Post-traumatic seizure, but no history of epilepsy
- On initial assessment GCS <14, or for children under 1 year GCS (paediatric) <15
- At 2 hours after the injury GCS <15
- Suspected open or depressed skull injury or tense fontanelle
- Any sign of basal skull fracture (hemotympanum ‘panda’ eyes, cerebrospinal fluid leakage from the ear or nose, Battle’s sign)
- Focal neurological deficit
- For children under 1 year, presence of bruise, swelling or laceration of more than 5cm on the head



# Paediatric Ward Care

This section will cover the key essentials of providing safe paediatric ward care. Care may be given by untrained personnel such as parents but it must be overseen by trained personnel.

- The key priorities of ward care are pain control, mobilization, wound care, nutrition and hydration, infection control, tissue viability and psychosocial care 
- Children should be reviewed daily as a minimum in all the key priorities
- The structure and tempo of the 'ward day' should be organised around these priorities
- Communication on discharge should be simple but sufficient to enable ongoing care and follow up

High quality care is achievable in the absence of a paediatric specialist but it requires some organisation, coordination and meticulous attention to the child's needs. The clinician of whichever specialty, most experienced in the delivery of paediatric care should adopt an oversight role and act as point of contact for all paediatric issues. They should ensure that all children are reviewed at least daily.

## WARD PRIORITIES

There are 7 key ward care priorities which should underpin the daily routine and key activities on the ward for a child following blast injuries and surgery.

- 1 Provide adequate pain control
- 2 Encourage early mobilization
- 3 Attention to wound care and dressings
- 4 Ensure adequate nutrition and hydration
- 5 Prevention/treatment of infection
- 6 Prevent skin breakdown and pressure sores
- 7 Support psychological and emotional wellbeing

## PAIN MANAGEMENT

It is important to remember that there are many elements that can contribute to a child's pain and distress including fear of the unfamiliar environment, parental distress, fear of strangers, needle phobia, fear of injury severity etc. These should be addressed non-pharmacologically where possible, including the use of parents, family members, play therapy and distraction techniques. Pain should be assessed regularly using objective and subjective scoring. Regular analgesia should be prescribed along with as required strong analgesia for breakthrough pain.

Full details on pain management are in Section 7.

### Procedural Pain Management

Children undergoing regular procedures such as burns dressing changes may require procedural sedation. Very short procedures may be tolerated using a nitrous oxide/oxygen mix but longer procedures not requiring general anaesthesia may be possible using sedation. This should be performed by a clinician with advanced paediatric airway management skills and sedation experience. Repeated procedures are far better tolerated if there is no anticipation of pain.

## ENCOURAGE EARLY MOBILISATION

Whilst bed rest and avoiding exertion can form an important part of recovery and rehabilitation, appropriate early mobilisation is often a more important part of the recovery process.

### Examples of early mobilisation support include:

- Deep breathing and coughing
- Active daily exercise
- Joint range of motion
- Muscular strengthening
- Make walking aids such as walkers and crutches available

For examples of Rehab-based age appropriate play activities see Rehabilitation section, page 158.

# WOUND MANAGEMENT

When managing wounds in children either from the injury itself or from subsequent surgery it can be important to think about the phases and mechanisms of wound healing.

## Phases of Wound Healing to consider

Phase of wound healing	Description
<b>1 Inflammatory phase</b> 0-3 days	<ul style="list-style-type: none"><li>• Normal response to injury</li><li>• Increased blood flow causing heat, redness, pain, swelling</li><li>• Wound ooze is a normal body response</li></ul>
<b>2 Proliferative phase</b> 3-24 days	<ul style="list-style-type: none"><li>• Wound is healing (reconstruction and epithelialisation)</li><li>• Body makes new blood vessels covering the surface of the wound</li><li>• Wound will become smaller as it heals</li></ul>
<b>3 Maturation phase</b> 24-365 days	<ul style="list-style-type: none"><li>• Final phase of healing</li><li>• Scar tissue is formed</li><li>• Wound is still at risk and should be protected where possible</li></ul>

## Mechanisms of wound healing to consider

Mechanisms of wound healing	Description
<b>Primary intention</b>	<ul style="list-style-type: none"><li>• Most wounds are managed by primary closure</li><li>• Wound edges approximated with steri strips, suture, staples</li><li>• Minimal loss of tissue and scarring</li></ul>
<b>Delayed primary intention</b>	<ul style="list-style-type: none"><li>• Surgical closure of a wound 3-5 days after cleansing or debridement</li><li>• Used for traumatic and contaminated surgical wounds</li></ul>
<b>Skin graft</b>	<ul style="list-style-type: none"><li>• Removal of partial or full thickness segment of epidermis and dermis from its blood supply</li><li>• Transplanting to another site to speed healing and reduce infection</li></ul>
<b>Flap</b>	<ul style="list-style-type: none"><li>• Surgical relocation of skin and underlying structures to repair a wound</li></ul>

## Wound cleansing

Requires the application of fluid to clean the wound and optimise the healing environment.

The goal of wound cleansing is to:

- Remove visible debris and devitalised tissue
- Remove dressing residue
- Remove excessive or dry crusting exudates

### How to cleanse a wound properly:

Irrigation is the preferred method for cleansing open wounds. This may be carried out using a syringe in order to produce gentle pressure and in order to loosen debris. Gauze and cotton wool should be used with caution as can cause mechanical damage to new tissue and the shedding of fibres from gauze swabs/cotton wool delays healing.

- Use aseptic procedure
- Antiseptics are not routinely recommended for cleansing (only for infected wounds)
- Don't try to remove 'normal' exudate
- Minimises trauma to the wound
- Use sterile isotonic saline or water (ideally warmed to 37°C)
- Skin and wound cleansers should have a neutral pH and be non-toxic
- Avoid agent such as alcohol or acetone as tissue can be degraded by these

## Choice of dressing

A wound will require different management and treatment at various stages of healing. No dressing is suitable for all wounds; therefore frequent assessment of the wound is required.

### Considerations when choosing dressing products:

- Sterile/clean
- Maintain a moist environment at the wound/dressing interface
- Be able to control (remove) excess exudates
- Not adhesive (i.e. does not stick to the wound)
- Protect the wound from the outside environment – bacterial barrier



## NUTRITION

Good nutrition is vital in following injury particularly in children who have an already high metabolic rate. Following major trauma children will experience a catabolic state, which can slow recovery, and inadequate nutrition can increase morbidity, mortality and length of hospital stay. Early feeding is beneficial. If the gut works, use it.

The basic energy and protein needs of healthy children are summarized below. Estimating protein and energy needs from standard references and monitoring the patient's progress over time is acceptable. But remember that nutritional demands following trauma and surgery are increased.

### Normal Daily Recommendations for Energy and Protein

Nutrient	Neonates / Infants	Children 2-12 years	Adolescents
Energy (cal/kg/day)	80-100	60-80	30-40
Protein (g/kg/day)	1.2-1.8	1	0.8

Children also need vitamins, essential fatty acids, minerals and trace elements and whilst previously healthy children can do without these nutrients for days, children who have been chronically malnourished, have abnormal GI losses, or require prolonged nutritional support may already have or may develop critical nutritional deficits.

Children can develop a profound ileus after almost any form of severe stress or sepsis even if it does not directly affect the abdomen; the signs of an ileus are of thick bilious dark green aspirates from the NG tube, abdominal distension and failure to pass flatus. However, unlike intestinal obstruction it will be painless and there will be no bowel sounds on auscultation.

Attempts at feeding during an ileus tends to make the child distended and vomit which is distressing and makes the fluid balance more complicated.

If the child is thirsty clear fluids can be allowed while the NG tube is left on free drainage.

Enteral nutrition via NG or NJ tube should be started as soon as the ileus starts to resolve and should be continued until the child is feeding well orally.

Infants in general should only be given breast milk or infant formula rather than cow's milk due to immaturity of the gut.

In children over the age of 1 year, adult tube feeding formulas may be used if they are all that is available. They will have protein concentrations generally 1-2 times what is needed for children. If needed, additional non-protein calories can be given in the form of vegetable oil (6.6 kcal/ml) or dextrose (3.4 kcal/ml).

## Worms

Infestation with worms is almost universal in some parts of the world and can lead to a serious delay in wound healing due to poor nutrition.

*Ascaris Lumbricoides* (common round worm), *Tania solium* (tapeworm), threadworm (*enterobius vermicularis*) are the commonest forms encountered.

Hookworm (*ancylostomiasis*) live in the upper small intestines and may lead to an iron deficiency anaemia.

Treatment of worms with a single dose of mebendazole is good practice in these patients. Tapeworm need treatment with niclosamide.

## HYDRATION


Maintaining adequate hydration is important. Infusions in the ward environment following surgery can be life saving. Postoperative failure to address fluid or blood loss through lack of recognition, or IV insertion site malfunction can lead to significant morbidity or mortality in children. Infusions to correct any deficit and for maintenance will nearly always be essential for children following major surgery.

Ensuring correct and secure siting of an intravenous cannula is vital:

- Use a vein in a position that will last a long time in the wards
- Secure the cannula and giving set carefully
- Use a tape or dressing that sticks to the skin and use the wings or other large part of the IV cannula for attachment but beware of damaging fragile skin


Fluid Balance should be watched and recorded carefully (24 hour in-out balance accounting for losses through urine, surgical drains, nasogastric tubes as well as insensible losses)

### Maintenance fluids

- All fluids administered to children should be calculated their weight and clearly prescribed. Do not guess 
- Where possible use pumps or a buvette to administer fluids and never have fluids on free flow.
- Do not use 5% glucose for maintenance fluid
- Never use hypotonic or hyponatremic fluids in the resuscitation of a child

#### What volume?

Maintenance fluid volume administration to children can be calculated using an hourly rate based on weight. Children will generally require:

- 4ml/kg per hour for the 1st 10kg 
- 2ml/kg per hour for the 2nd 10kg
- 1ml/kg per hour for every additional kg

Therefore a;

- 10kg child will require  $(10 \times 4\text{ml}) = 40\text{ml/hr}$
- 20kg child will require  $(10 \times 4\text{ml}) + (10 \times 2\text{ml}) = 60\text{ml/hr}$
- 30kg child will require  $(10 \times 4\text{ml}) + (10 \times 2\text{ml}) + (10 \times 1\text{ml}) = 70\text{ml/hr}$

Fluid replacement should be titrated to urine output and adjusted to account for other losses such as nasogastric and wound drains.

### What Type?

The following fluids are appropriate for maintenance in children with normal body electrolyte:

- 0.9% Sodium Chloride with 5% dextrose
- Plasmalyte
- Hartmann's solution (Ringer's lactate)

0.45% Sodium Chloride with 5% glucose can be used for maintenance but it must be kept away from resuscitation fluids and areas where resuscitation performed. 5% Dextrose is not suitable fluid for maintenance.

Infants (under one year old) are at increased risk of hypoglycaemia therefore use 10% dextrose + 0.45% Sodium Chloride and check.

All NG losses should be replaced with normal sodium chloride (0.9%) with 20mmol/l Potassium Chloride.

### Electrolytes

- Never allow a child to become hyponatremic
- Maintain plasma sodium at 135-145 mmol/l
- Maintain plasma potassium at 3.5 – 5.0 mmol/l



Children on fluids should have potassium, sodium, urea and creatinine measured daily if possible.

Added potassium chloride is not generally required the first 24 hours but after that it is given at 20 mmol/l This should be adjusted to electrolyte results.

In children, plasma Sodium should be maintained at 135–145 mmol/litre and plasma Potassium at 3.5–5.5 mmol/litre



## Example of a paediatric fluid prescription chart

Date	Type of Stock IV fluid	Volume	Time to be infused	Additive Name and dose	Prescribers' signature	Pharmacist signature	Batch / bottle number	Time	Signature /Witness	Volume infused	Date and time Dripset changed IV set changed
				Electrolyte Drug				Start End			
				Electrolyte Drug				Start End			
				Electrolyte Drug				Start End			
				Electrolyte Drug				Start End			
				Electrolyte Drug				Start End			
				Electrolyte Drug				Start End			
				Electrolyte Drug				Start End			
				Electrolyte Drug				Start End			
				Electrolyte Drug				Start End			
				Electrolyte Drug				Start End			

## INFECTION CONTROL

Blast injured patients will mount a brisk inflammatory response and so inevitably have pyrexia and a high CRP. If WCC is rising assess carefully for infection. If resources allow it is worth considering monitoring Procalcitonin (PCT) every other day to differentiate infection from an inflammatory response linked to Systemic Inflammatory Response Syndrome (SIRS) or trauma. Practitioners should at least look for trends of increasing heart rate and respiratory rate and spiking temperature as signs of potential evolving infection.

There are number of sites that may provide a focus for infection. The following should be checked daily for evidence of infection

- All wounds
- Cannulas and central lines\*
- Wound and chest drains

\*Central lines should be removed in any child with and unexplained fever. They should not be routinely left in situ for more than 10 days and never beyond 14.

Remove all vascular access, urinary catheters and wound drains as soon as they are no longer required.

If a child mounts a fever consider the following sources

- Chest – perform a chest radiograph if there is evidence of respiratory distress
- Urine – in particular if catheterised
- All wounds, drains and lines
- Central nervous system if any breaches of meninges
- Intrathoracic/abdominal sepsis
- Musculoskeletal

In children under three months with a fever of 38°C give antibiotics and screen for sepsis



All blast victims with injuries must have their tetanus immunisation status checked and treated according to the advice on management of patients with tetanus prone wounds.

Best practice guidance on the appropriate post-exposure infection prophylaxis of blood-borne viruses following a blast injury where contaminated fragments are created from either a suicide attack or multiple casualties is as follows:

- 
- 1 All patients who sustained injuries that breached the skin as a result of a bomb injury must receive an accelerated course of hepatitis B vaccination (0, 1, and 2 months, or day 0, day 7, day 21, and at 12 months)

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  - 2 Patients who are discharged from inpatient care before completion of an accelerated hepatitis B vaccination course should receive their remaining doses of vaccine either at out-patient follow-up, or by arrangement with their GP

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  - 3 All patients should be tested at 3 months to determine their hepatitis B vaccine response and at 3 months and 6 months to determine their hepatitis C and HIV status

---

  - 4 Post exposure prophylaxis for HIV should not be normally given
- 

Give antibiotics as per local policy or advice. In the absence of this co-amoxiclav is suitable for blast injury. Children with bowel perforation will require metronidazole.

## TISSUE VIABILITY

For children who are immobilized for prolonged periods or for whom early mobilization is not possible it is vital to ensure that skin breakdown and pressure sores are avoided.

## **Psychosocial support**

Children (and their families) who have undergone significant trauma are very likely to require significant psychological support in the days, weeks, months and even years after the event. On the ward it may be important to engage the help of psychologists and/or social workers and other healthcare staff, where possible, who can work with the child and family on the psychological and emotional impact of the event. Close family and friends can be helpful in providing support but there is a clear role for more formal rehabilitation and counselling where this is available. In addition to this, the safeguarding needs of the child also need to be considered with respect to the child's safety, especially looking towards discharge.

## **DISCHARGE PROCESS**

On discharging the patient from the ward, record in the notes:

- Diagnosis on admission and discharge
- Summary of course in hospital
- Instructions about further management, including drugs prescribed. It is vital to ensure that a copy of this information is given to the patient, together with details of any follow-up appointment and that the required care following discharge is properly understood by the family.

See the discharge summary template in the Annex 12D on page 156.



# Paediatric Early Warning Score

- Decompensation in children is late and catastrophic. The early signs are often missed
- Routine use of a vital sign scoring system will help the clinician recognise deterioration.



Children should have their vital signs recorded and documented regularly on a chart to illustrate the physiological trends. A common failing in paediatric care is the failure to recognise the deteriorating child leading to catastrophic collapse. Routine use of a vital sign scoring system will enable the early recognition of a deteriorating child and the necessary intervention. The following frequency of observations are recommended.

In emergency setting a minimum of every 15 minutes but increased as dictated by the lead clinician.

Post operatively

- Hourly for first four hours
- Four hourly for first 48 hours thereafter
- As dictated by Paediatric Early Warning Score (PEWS) and lead clinician there after

## Paediatric Early Warning Score (PEWS)

PEWS is a vital signs scoring tool that highlights to those caring for children the signs of deterioration in a child and when to escalate to the clinician in charge of that child's care. It can be calculated using the age specific tables below each time a set of vital signs are taken. The score then indicates what action to take next (see actions table). Those caring for children should also escalate their concern based on clinical judgement regardless of the patients PEWS.

## PEWS action table

PEWS	Action
0	<ul style="list-style-type: none"> <li>• Continue routine vital sign recording as requested</li> <li>• Request review if concerned despite low score</li> </ul>
1-2	<ul style="list-style-type: none"> <li>• Treat as prescribed</li> <li>• Repeat vital signs hourly</li> <li>• Request review and escalate to review within 15 minutes if not improving</li> </ul>
3-4 or Red (3) in any one parameter	<ul style="list-style-type: none"> <li>• Review within 15 minutes</li> <li>• Vital signs every 15 minutes or continuous monitoring</li> <li>• Start prescribed emergency treatment</li> <li>• Escalate for immediate review if not improving within 15 minutes</li> </ul>
5 or more	<ul style="list-style-type: none"> <li>• Start emergency treatment</li> <li>• Immediate review</li> </ul>
Bradycardia / Cardiac arrest	<ul style="list-style-type: none"> <li>• Cardiac arrest response</li> </ul>

Regardless of PEWS always escalate if you are concerned about a patient's condition, for example:

- Clinical acumen
- Looks unwell
- Airway obstruction/  
threat
- Seizures
- Confusion or  
irritability
- Hypoglycaemia
- Suspicion of sepsis
- Pallor
- Mottling
- Cyanosis

PEWS Calculation Table Aged 0-12 months

	3	2	1	0	1	2	3	Score
Resp Rate per minute	>80	60-80	50-60	30-50	20-30		<20	
% O <sub>2</sub> Saturations				>94	92-94		<92	
Inspired O <sub>2</sub>				Air	<35%	35% or greater		
Respiratory Distress				None	Mild	Moderate	Severe	
Heart Rate per minute	>180	170-180	150-170	120-150	110-120	100-110	<100	
Systolic Blood Pressure mmHg	>110	90-110	80-90	70-80	60-70		<60	
Capillary Refil Time Seconds				<2		2-3	>3	
Temperature	<35°C						>40°C	
AVPU				A		V	P/U	
Pain Score				0	1	2	3	
Total:								

## PEWS Calculation Table Aged 1-4 years

	3	2	1	0	1	2	3	Score
Resp Rate per minute	>50	40-50	30-39	25-29	20-24	15-19	<15	
% O <sub>2</sub> Saturations				>94	92-94		<92	
Inspired O <sub>2</sub>				Air	<35%	35% or greater		
Respiratory Distress				None	Mild	Moderate	Severe	
Heart Rate per minute	>170	150-170	130-150	90-140	80-90	70-80	<70	
Systolic Blood Pressure mmHg	>130	120-130	100-120	70-100	70-80		<70	
Capillary Refil Time Seconds				<2		2-3	>3	
Temperature	<35°C						>40°C	
AVPU				A		V	P/U	
Pain Score				0	1	2	3	
Total:								

## PEWS Calculation Table Aged 5-11

	3	2	1	0	1	2	3	Score
Resp Rate per minute	>50	40-50	30-39	20-29	15-20	10-14	<10	
% O <sub>2</sub> Saturations				>94	92-94		<92	
Inspired O <sub>2</sub>				Air	<35%	35% or greater		
Respiratory Distress				None	Mild	Moderate	Severe	
Heart Rate per minute	>150	130-150	120-130	80-120	70-80	60-70	<60	
Systolic Blood Pressure mmHg	>130	120-130	110-120	70-110	80-90		<80	
Capillary Refil Time Seconds				<2		2-3	>3	
Temperature	<35°C						>40°C	
AVPU				A		V	P/U	
Pain Score				0	1	2	3	
Total:								

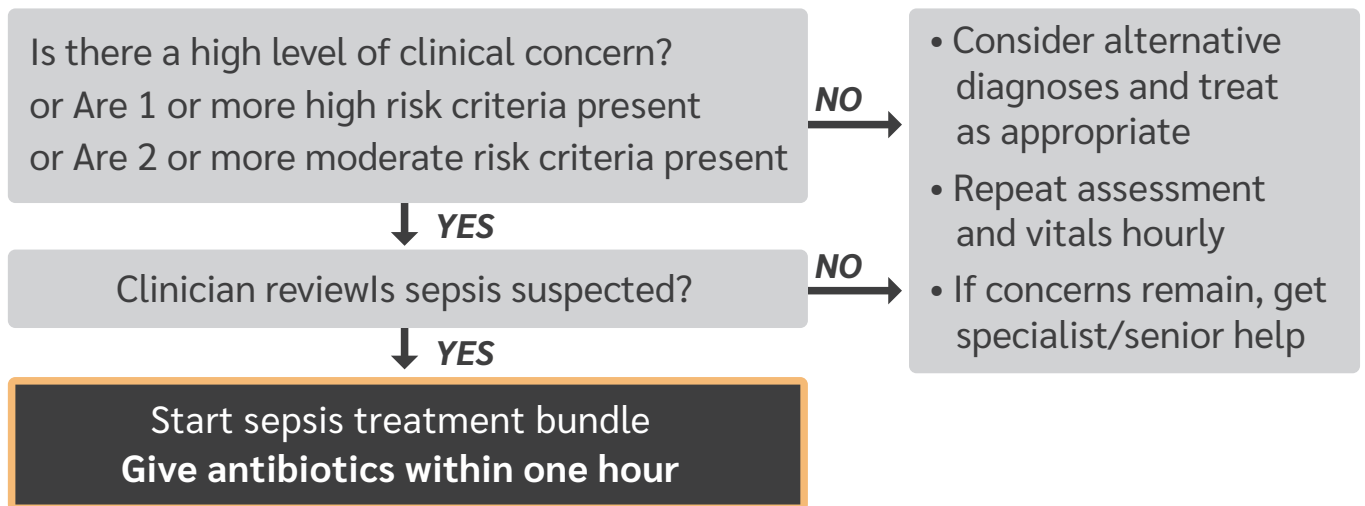
## PEWS Calculation Table 12 and over

	3	2	1	0	1	2	3	Score
Resp Rate per minute	>35	30-35	25-30	15-25	10-15		<10	
% O <sub>2</sub> Saturations				>94	92-94		<92	
Inspired O <sub>2</sub>				Air	<35%	35% or greater		
Respiratory Distress				None	Mild	Moderate	Severe	
Heart Rate per minute	>130	120-130	100-120	70-100	60-70	50-60	<50	
Systolic Blood Pressure mmHg	>150	140-150	130-140	100-130	90-100		<90	
Capillary Refil Time Seconds				<2		2-3	>3	
Temperature	<35°C						>40°C	
AVPU				A		V	P/U	
Pain Score				0	1	2	3	
Total:								

## Sepsis

In children with abnormal vital signs (page 27), consider sepsis and treat early if suspected.

### Suspected Sepsis Pathway



#### Moderate Risk Criteria

Age (years)	Heart rate	Resp Rate
<1	>160	>60
1-2	>150	>50
3-4	>140	>40
5	>130	>27
6-7	>120	>27
8-11	>115	>25
>12	>100	>25
Any age	< 60	

#### Perfusion

- Reduced urine output
- Capillary refill time of >3 seconds
- Pale/flushed
- Cold peripheries

#### Other

- Temp >39°C aged >3 months
- Leg pain without injury
- Abnormal social response
- Lethargy
- Floppy
- Carer concern
- Drowsy

#### High Risk Criteria

- Appears ill to healthcare worker
- Not responding socially
- Does not wake or stay a wake with stimulation
- Weak, high pitched or continuous cry
- Grunting
- Apnoea or bradypnoea
- Oxygen saturations of <90%
- Mottled or ashen
- Cyanosis
- Non-blanching rash
- Temperature <36°C or aged <3 months and >38°C
- Anuria
- Hypotension:

#### Systolic Hypotension by age

<1 year	<70mmHg
1-5 years	<80mmHg
5-12 years	<90mmHg

Paediatric Sepsis Bundle









## As Required Drug Prescription

<b>As Required Drug Prescription</b>		<b>Date</b>																				
<b>Drug</b>		<b>Time to be given</b>																				
<b>Dose</b>	<b>Route</b>																					
<b>Start Date</b>	<b>Stop Date</b>																					
<b>Frequency: Maximum number of doses in 24 hours</b>																						
<b>Prescriber</b>																						
<b>Role</b>																						
<b>Signature</b>																						

## Paediatric Discharge Summary Template

<b>Patient Name</b>		<b>Age</b>
<b>Patient Identifier</b>		
<b>Date of Admission:</b>	<b>Date of Discharge:</b>	
<b>Attending Physician:</b>		
<b>Hospital/Ward:</b>		
<p><b>Admission Diagnosis:</b> This should be the reason for admission (e.g. dehydration, respiratory distress, hypoxia, abdominal pain), <b>not</b> the discharge diagnosis.</p>		
<b>Discharge Diagnosis:</b>		
<p><b>Secondary Diagnoses:</b> Additional diagnoses other than the main discharge diagnosis including chronic medical conditions and diagnosis from the admission that are resolved</p>		
<b>Procedures:</b>		

**Brief Hospital Course:** This should be a brief, problem-based summary of the admission. Include all pertinent lab values and radiology studies here.

**Pending Lab or Test Results:**

**Immunizations Given During Admission:**

**Diet:** If applicable. Include feeding regimen if child is on tube feeds, or include if there has been a formula change. Otherwise, you can skip this.

**Discharge Medications:** Include medication name, dose, route, frequency, duration

**Discharge Instructions:**

**Follow-up Appointments:** Include clinic/physician, date, time, location, phone number if known.

# Rehabilitation

Blast injuries in children frequently result in trauma that requires extensive rehabilitation, which if not implemented from an early stage in their recovery can severely limit the outcome of any medical or surgical intervention. Ensuring early, appropriate and ongoing rehabilitation in areas that are experiencing conflict can be hugely challenging. Common issues include:

- Blast injuries most frequently result in poly trauma, making early rehabilitation more complex. Younger children in particular are more likely to present with associated head and thoracic injuries, while the presence of certain explosive remnants of war (such as cluster munitions) can increase the likelihood of upper limb injuries in children by being mistaken for toys or objects of interest.
- Children are typically injured alongside family members or friends. This has serious psychological and safeguarding implications, which must be addressed concurrently with medical care and rehabilitation. Managing an injured child's distress should be a priority.
- Conflict can displace populations while blasts can destroy homes, meaning patients may be being discharged into an uncertain environment, with limited access to resources. Knowing where a child is likely to go on leaving the facility, and how they will access follow up, are vital.
- High patient numbers or security concerns can mean that length of stay in hospitals in areas of active conflict is often reduced, while follow up can be difficult. Ongoing rehabilitation providers may be scarce. In the absence of any follow up, maintain lists of patients that may need input so that you can track them down later.

- Children require a different general approach to rehabilitation compared to adults, while there are some paediatric specific clinical considerations for different types of injury. Some basic points for paediatric rehabilitation are included in chapters.
- Access to paediatric specific equipment (such as wheelchairs, crutches, orthotics and prosthetics) is often limited. Where children require assistive devices these need to be re-fitted regularly while the child is still growing. Having a stock of paediatric equipment, or linking to organisations that do, can be vital.
- In some contexts, children with impairments may be socially disadvantaged as a result of their injury, resulting in them not attending school, being kept at home, or being perceived as being unable to work or marry later in life. Early education with family members, and links to peer support, can help mitigate this.

### **Recommended team approaches to the rehabilitation of children with blast injuries:**

- Where possible, integrate rehabilitation professionals into the acute care setting. This, together with regular clinical communication meetings, will enable the clinical team to work effectively to plan the child's care.
- Map available rehabilitation services in your area and establish direct means of referral to these.
- Try to hold a small stock of essential paediatric equipment like crutches and wheelchairs. Being able to make or refer for individual splints and orthotics is advantageous.

### **Recommended approaches for the rehabilitation provider:**

- Rehabilitation should start as soon as possible, and should include the family or caregiver where possible and appropriate.
- The pattern and impact of a blast injury will be unique to each child. A comprehensive assessment of the child must therefore be prioritised. A thorough subjective assessment will support treatment and discharge planning, and should focus on the

child's situation, including what they enjoy doing, whether they are at school, who in the family is around to support them, and whether they have anywhere to go when they leave the hospital. Document as much information as possible to avoid the child or family having to undergo repeated questioning. Work with the medical team to understand the full medical history, and any restrictions and precautions that are in place.

- General objective assessment must include pain, oedema, range of movement, and function.
- Before beginning any therapeutic intervention, the child's pain must be managed to minimise distress. This should include a combination of age appropriate distraction techniques, relaxation and analgesia as part of an agreed medical team plan.
- It is important to answer any questions that the care givers and child have honestly and with an aim to empower them to take part in therapy and to build trust.
- Make sure that treatment is age appropriate and functional in nature, and based around the child's interests. Fun, play based, culturally appropriate activities should be used as much as possible.
- Use distraction techniques for children in pain or distress. Simple things like bubbles, toys, or movies or games played on mobiles phones or tablets can be really helpful.
- Make sure your treatment area is child friendly, with access to toys, books etc.
- Where possible, treat similarly aged children simultaneously using games and activities, and use other children to provide peer support to each other.
- Spend time educating the child's caregivers about their injuries so that they can communicate appropriate messages to the child.
- Work closely with the child and their caregivers to set realistic joint goals together that they can work towards.
- Try to be honest with the family about the realistic outcomes of rehabilitation.



- Refer patients as early as possible for follow up if required but also provide instructions to the child’s caregivers which they can take to any follow up service. Prior to discharge, ensure that a robust plan is in place for ongoing care. If this is not possible, bring the child back to your hospital for follow up and advice on a regular basis.
- Maintain lists of paediatric patients needing long term follow up along with contact details to enable other actors to support follow up. While services may not be available in the midst of a conflict, they may develop rapidly once the fighting subsides. In the absence of national facilities, common INGO providers may include Humanity and Inclusion, ICRC and CBM.

### Rehab-based age appropriate play activities

	Type of play	Example	In rehab
6-18 months	Exploratory	Pushing buttons, making noise with instruments	Use toys that make sounds or actions to encourage movements. Engage with things like bubbles or music.
18 months – 3 yrs	Active	Running, jumping, building	Build treatment around fun basic fine and gross motor activities, like building blocks or imitating actions.
3-6 years	Imaginative	Playing doctor, dress up, doing art activities	Get the child to also play doctor or nurse and help out, or build fine motor activities around art or basic puzzles
6-9 years	Challenging	Puzzles and games that challenge motor skills	Use local puzzles or popular sports that will challenge the child's skills. Use group activities
9-14 years	Team and individual	Team sports, but also individual interests or hobbies	Use sports or other appropriate play, based on the child’s interests.

# Mental Health and Psychosocial Support Considerations

This chapter aims to provide guidance for medical staff on what to say and do to help children and caregivers, and what NOT to say and do in order to avoid causing further harm. Topics covered include:

- Basic principles of working with children of different ages, safely and supportively.
- Common stress responses and support strategies for children of different ages
- Tips to give caregivers and families in supporting a child impacted by blast injury.
- How to create a child-friendly, supportive environment in medical facilities.
- The critical importance of self and team care for frontline medical staff.
- For the ways to assist children during painful procedures please refer to the “Pain Management” section.

- Blast injury and treatment will be stressful to the child and caregiver
- Physical injury and intense fear will lead to psychosocial impact
- Negative psychosocial can be mitigated at every stage of the care pathway
- Do not separate children from parents or guardians unless unavoidable
- Support caregivers in their care of children

## INTRODUCTION

A blast injury and its treatment can be a very stressful and frightening experience for a child and their caregivers. In addition to physical impacts, children and their caregivers can suffer intense fear during the event and its aftermath, as well as anxiety, sadness and grief. How a child reacts to such a distressing event depends upon many factors, including their age and developmental stage. It also depends upon the support they have from the adults around them.

Frontline medical staff play an important role not only in life-saving measures and critical treatment for children who suffer blast injuries, but also in reducing further psychological harm to children and in promoting their coping, healing and recovery.

The way in which medical staff communicate with children and their caregivers and the supportive environment they create can make a big difference to how the child experiences a blast injury and adapts both physically and emotionally to the after-effects. You can help the children you treat to feel supported throughout their experience, and to develop effective coping strategies in the short and long-term as they recover.

## PRINCIPLES OF WORKING WITH CHILDREN

Keep in mind the following principles in working with children, and in particular those who have experienced a distressing event such as a blast injury:

- Relate to children according to their age and developmental stage
- Avoid separation of children from their caregivers
- Show children respect
- Support caregivers to care for their children
- Create a child friendly and healing environment in the hospital
- Take care of yourself in order to best care for children and their caregivers.

## COMMON STRESS RESPONSES AND SUPPORT STRATEGIES FOR CHILDREN OF DIFFERENT AGES

Children who have suffered blast injuries, whatever their age, might show a range of emotions including fear that the event may take place again, that they or their loved ones may be hurt, or that they may be separated from them. They can also experience anger, self-blame, shame, disbelief or anxiety. Common stress reactions that you can see depend on the age of the child, but could include being clingy; having sleep and eating difficulties; becoming withdrawn, unable to concentrate or confused; and becoming irritable and aggressive. It is also important to remember that a child's injury and hospitalization is also very challenging for their parents who may feel helpless and unable to support their child. Therefore, it is vital to not only support the child's coping, but also to help parents to support their children.

### **Below are some support strategies**

**- what to say and do – when working with children of specific ages.**

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#### **Young children (age 0-6)**

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##### **What they might think/feel:**

- Might think that the injury and the treatment is a punishment for something they've done wrong
- Their reactions depend on how their parents/caregivers react
- Sensitive to how others react

##### **What medical staff can do:**

- Ensure the child can stay close to their caregivers whenever possible
  - Be aware that the child is listening when discussing any procedures, they may have to have – be sensitive to their feelings and try not to frighten them
  - When possible, tell the child about any procedures in a very simple way and try to be reassuring (but do not lie)
  - Ask caregivers to bring familiar things from home if possible (blanket/toys/pictures)
  - Encourage medical play. Allow them to play with the stethoscope, new syringes without needles)
  - Read books with pictures that can explain the procedure and equipment etc. through pictures
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## School-aged children (age 7-13)

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### What they might think/feel:

- Strong fear of needles and pain
- Talks about the event in a repetitive manner
- Difficulties with memory, concentration and attention
- Somatic (physical) complaints related to emotional stress (e.g., headaches, belly aches)
- May experience guilt, self-blame and shame

### What medical staff can do:

- Explain the procedure in advance avoiding words like “cutting”, “making a hole” etc.
  - Try to explain how their body works and explain why they need the surgery/ procedure without going into too much detail
  - Encourage the child to ask questions and try not to leave any “gaps” in the information. This might lead to the child filling this in with fantasies that may be frightening.
  - Encourage them to express their feelings, both verbally and through drawing and play
  - All of the above can also be done by the caregivers
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## Adolescents (age 13-18)

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### What they might think/feel:

- Worry more about their change in the appearance after the injury
- Worry about their relationship with peers
- Worry about loss of independence and control
- Intense grief
- Self-consciousness, guilt or shame
- May become self-absorbed and feel self-pity

### What medical staff can do:

- Explain any procedures in detail
  - Involve the child in making as many decisions as possible
  - Encourage the child to ask questions
  - Try to allow adolescents as much privacy as possible
  - Include the child in every conversation about their treatment
  - Encourage them to express their concerns and take time to listen to them and discuss
-

# THINGS CAREGIVERS CAN DO TO HELP CHILDREN

## Infants

- Keep them warm and safe
- Keep them away from loud noises and chaos
- Give cuddles and hugs
- Keep a regular feeding and sleeping schedule, if possible
- Speak in a calm, soft voice

## Young children

- Give them extra time and attention
- Remind them often that they are safe
- Explain to them that they are not to blame for what happened
- Avoid separating young children from caregivers
- Keep to regular routines and schedules as much as possible
- Give simple answers about what happened to them without scary details
- Allow them to stay close to you if they are fearful or clingy
- Be patient with children who start demonstrating behaviours they did when they were younger, such as sucking their thumb or wetting the bed
- Provide a chance to play and relax, if possible

## Older children and adolescents

- Give them your time and attention
- Help them to keep regular routines
- Provide facts about what happened and explain what is going on now
- Allow them to be sad. Don't expect them to be tough
- Listen to their thoughts and fears without being judgemental
- Set clear rules and expectations
- Ask them about the dangers they face, support them and discuss how they can best avoid being harmed
- Encourage and allow opportunities for them to be helpful

## DO

### Make contact

- Introduce yourself by name and explain who you are, and ask the child's name
- Ask the child their concerns and what they might need
- Communicate with children in ways they can understand
- Stay calm and help parents to stay calm, and offer comfort and support
- Speak in your normal tone of voice and remain calm and reassuring

### Support caregivers

- Make efforts to reunite young children with caregivers and keep them together. Make sure that caregivers stay with the child as much as possible and reassure them that they will not leave them alone.
- It is important to keep caregivers at the forefront of care for children who have suffered a blast injury. This often means supporting caregivers to cope with their own distress in the situation, and providing them practical information and tips to help their child cope and recover.
- Be sure to provide caregivers with information about what is going on, their child's condition and what they can expect. Respect their role as primary caretakers for children and involve them in decisions about care and treatment. Wherever possible and appropriate, speak first to parents and ask their permission before talking with their children.
- If possible, prepare and have available informational materials for parents and caregivers to help them understand the situation and know how best to support their children. This may include information about:
  - Blast injury effects, care and treatment and what to expect in the short and long-term
  - Contact information for available medical, rehabilitation and other services (e.g., social and legal services)
  - How children react to distressing events according to their age and developmental stage and how caregivers can best support them
  - Positive strategies to help caregivers cope, including contact information for support groups or other types of available psychosocial care.

## Respect children's dignity, rights and strengths

- It is critical to safeguard the dignity of children at all times and to respect their rights. Be sure never to shame a child for how they feel or things they say or do. Be honest when speaking to children and help them to cope in adaptive ways to the challenges they face after a blast injury.
- Also, remember that children have strengths and helping them to regain control over their functioning, life and decisions will also promote their healing and recovery. Involve children appropriately and whenever possible in decisions that affect them during their treatment and recovery from a blast injury.
- Help the child to cope with the situation by offering them strategies for calming themselves, and finding out what kind of coping strategies usually work for them
- Take consent from child (adolescent) and from parents (for infants and toddlers) when possible
- Do explain in simple language what will happen and allow them to ask questions

## Create a supportive and comfortable environment

- Provide a child-friendly environment. This may include age-appropriate and safe toys for children (soft stuffed animals, books for children of different ages and reading abilities), cheerful colours in recovery areas, and child-friendly informational materials.
- Make sure that there is a play area and some materials for children to play with. It will not only help them to distract from the treatment but also allow to express themselves and cope better with challenges of treatment.
- If possible, provide medical toys or safe-to-use medical equipment (e.g. stethoscope, new syringes without needles) so children can become more comfortable with the treatment. You might use medical play for explaining future procedures to younger children.
- Help them access basic needs – this can include food, water, or a quiet and comfortable place to rest.
- Offer practical comfort, such as a stuffed animal to hold, a blanket, food or water.



## DO NOT

- **Do not** give children or their caregivers false reassurances or promises just to calm them down. Instead, give realistic reassurance and honest information.
- **Do not** separate children from their caregivers.
- **Do not** discuss procedures with other adults in front of little children.
- **Do not** let children witness or hear other children receiving painful procedures (e.g., changing dressings in front of other children).
- **Do not** let children witness gruesome scenes in the medical facility (e.g., other people with acute, serious injuries).

## SELF AND TEAM CARE FOR MEDICAL STAFF

The lifesaving treatment you offer to children and other patients can bring special meaning to your life. But witnessing others suffer pain, distress, grief and loss – often in difficult work conditions – can also cause distress for you and your colleagues. Difficult work such as this over a period of time can also lead to burnout – a condition where helpers may feel tired, depressed, unmotivated, overwhelmed, cynical and pessimistic.

Taking care of yourself in these situations is not only a vital element for successful treatment of children and their caregivers, it is also vital for preserving your own health and wellbeing and that of your colleagues. Here are few tips for self-care:

- Exercise
- Socialize and connect with people that you enjoy their company
- Take breaks even for a quick stretch or fresh air
- Eat regularly and make healthy food
- Get enough sleep
- Enjoy cultural, spiritual and social activities
- Know your limits
- Create a balanced schedule (e.g., don't work too many hours in a day, or too many days in a row without rest)
- Try to keep a sense of humour
- Write down three positive things that happened during the day.

In addition to the ways in which we take care of ourselves, it is important that colleagues work well together and support each other.

The following are key elements of peer support:

- concern, empathy, respect and trust
- effective listening and communication
- clear roles
- team work, cooperation and problem-solving
- discussing work experiences and the impacts of the job.

# Ethics and Safeguarding

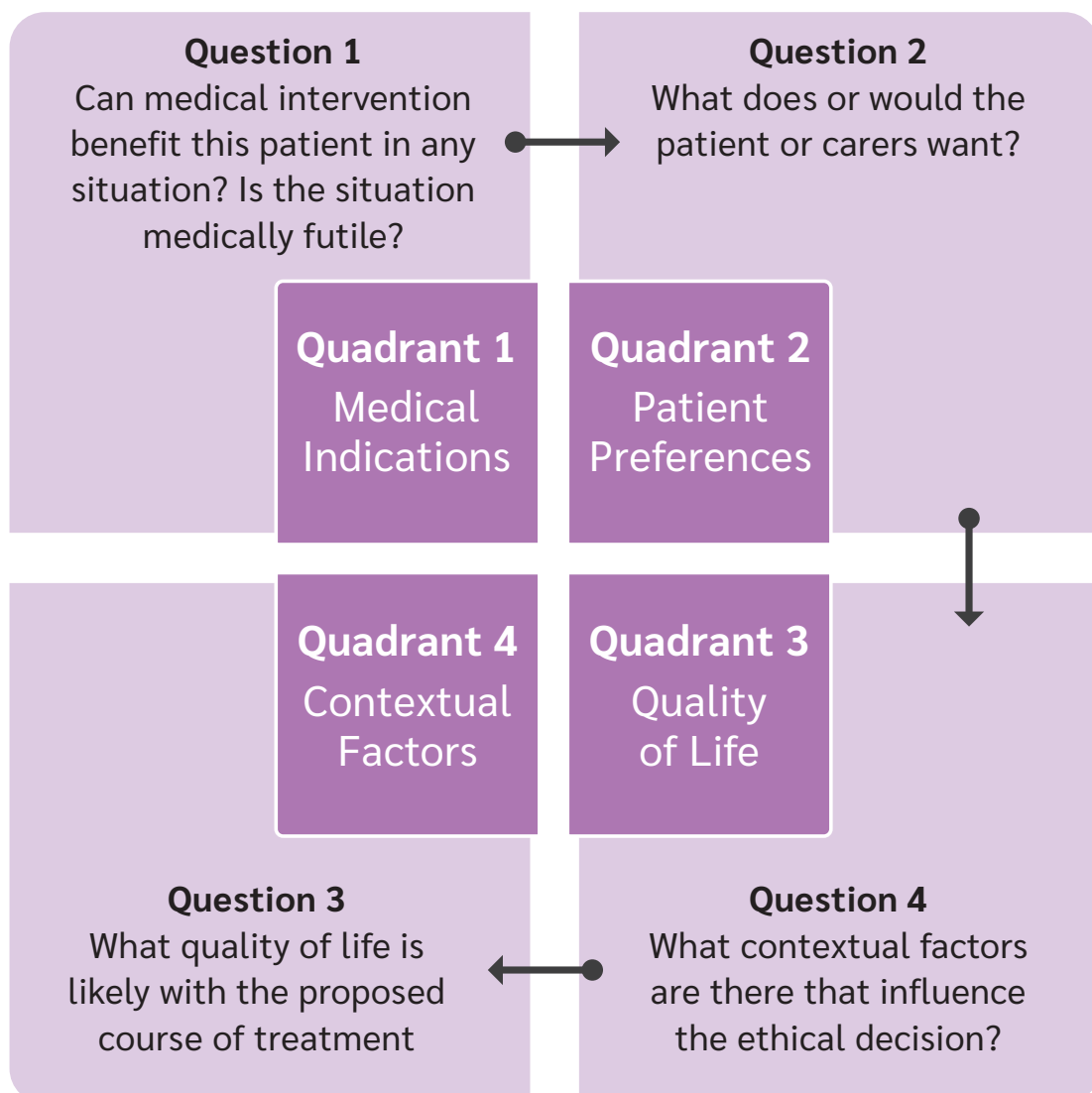
## FUTILITY AND ETHICAL DECISION MAKING

In any medical facility there will be a patient for whom no care will deliver the desired positive outcome. The point at which care is judged futile is determined by a number of factors that are in turn adjusted by many time, place, patient and culture specific influences.

There are three steps in judging futility

1. Identification of the moral issue.
2. Structured ethical assessment
3. Make moral recommendation and enact

*A tool that can be used to structure the futility decision is the Ethical Quadrant*



## Quadrant 1: Medical Indications and their risks, and benefits

### Can medical intervention benefit this patient in any situation? Is the situation medically futile?

It is key that the team establishes:

- Severity of injury
- Prognosis
- Is it reversible
- Treatment options and their risks, and benefits
- Likelihood of success

**Physiological** – Based on the physiological status of the patient, it is judged that there is no chance of the desired medical outcomes being met.

**Quantitative** – There is very little chance of achieving the desired medical outcome

**Qualitative** – The best medical outcome, if achieved is so poor that medical treatment is not indicated.

## Quadrant 2: Patient Preferences

### What does or would the patient or carers want?

Establish:

- Is the patient capable of making a decision
  - older children can be involved in making decisions
- If so, what do they want
- If not, what do the carers want and is it in the best interest of the child?
- Are the patient and carers aware of benefits and risk and do they understand the consequence of their decision.
- Have they consented to treatment?

It is the right of a patient with capacity to choose, even if deemed and unwise choice, but it is the duty of the clinician to act in the best interest of the child.

### Quadrant 3: Quality of life

#### What quality of life is likely with the proposed course of treatment

Establish:

- Quality of life prior to injury
- Expected mental, physical and social function if treatment is successful
- Biases may be prejudice the assessors opinion of patients quality of life
- Is the anticipated quality of life desirable

### Quadrant 4: Contextual factors

#### What contextual factors are there that influence the ethical decision

These include:

- Resource issues within and external to the treatment facility
- Local medical capability to provide ongoing treatment required to reach desired medical outcomes
- Legal
- Family issues
- Cultural and religious factors
- Conflicts of interest
- Financial factors
- Impact on others, for example facility moral

## END OF LIFE CARE

When it is recognized that a child's life is coming to an end it is important to plan for and manage this process. The child and family will require emotional and psychological support and the child will require symptom management, including pain and anxiety. Hydration and nutrition will also need to be managed.

# Safeguarding Children

Every child has the right to survival, protection and education

The United Nations Committee on the Rights of Children sets out the rights that should be made available to all children.

In some environments safeguarding children may seem impossible or even of low priority in comparison with the requirement to deal with life threatening injury. Children in conflict areas are extremely vulnerable and at risk of both physical and psychological harm, trafficking, sexual exploitation and enslavement.

This risk may be presented by family, strangers, military personnel, aid workers and anyone else who may come into contact with vulnerable children.

## **Each medical facility should:**

- Have one person named as safeguarding lead
- Keep parents and carers with children at all times wherever possible
- Clearly document all patient details including name, date of birth, ID number, address and parents/carers names
- Document the name, DOB, ID Number, address and relationship of any adults who accompany a child to a medical facility
- Photograph the child and parent or carer's face and keep with the clinical records
- Do not allow any photography other than that required for identification and clinical care.
- Do not allow a child to leave a medical facility with an unknown adult
- Be aware of any local safeguarding agencies such as the United Nations and know how to contact them
- If possible undertake training for all staff to recognise a child at potential risk of harm and have a safeguarding policy

It is the duty of all those who care for children to protect them from harm and exploitation

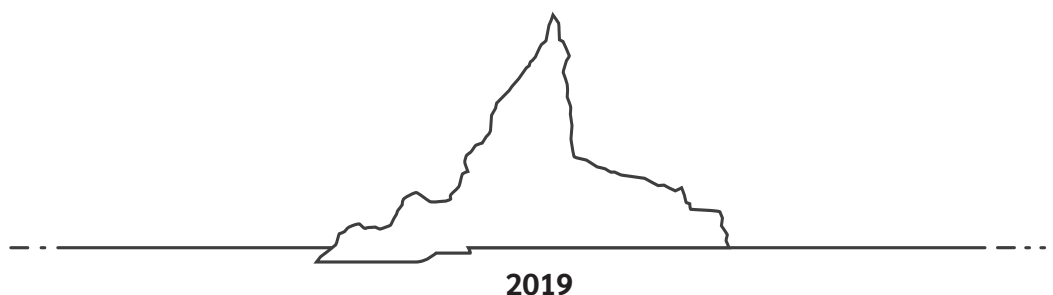
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