Major Trauma: Paediatric Emergency Anaesthesia in the ED

PRINCIPLES

1. Time critical
2. Limited time for history and assessment
3. Airway management likely to be difficult
4. Damage control resuscitation

EQUIPMENT AND FACILITIES

1. Equipment for airway management-laryngoscopes with different blade sizes, endotracheal tubes of various sizes, bougies, stylets, suction.
    a. **APPENDIX 1 (basic equipment and tube size guidance)**
2. Equipment for the management of the difficult airway - A 'difficult intubation trolley' with a variety of laryngoscopes such as McCoys, laryngeal mask airways, stylets, videolaryngoscopes (e.g. airtraq), fibreoptic bronchoscope, emergency surgical airway equipment.
3. Intraosseous drill and range of needles
4. Anaesthesia drugs
5. Resuscitation drugs
6. Portable ventilator
7. Portable monitor
8. Fluid warming devices
9. An ultrasound scanner with a probe for visualising vessels, nerves and other structures to facilitate vascular access and for regional nerve blocks if needed.
10. Near-patient testing for haemoglobin, arterial blood gases, lactate, calcium, potassium and blood sugar.
11. Access to a thromboelastography device (TEG or ROTEM) to assess the need for further platelets, fibrinogen and other clotting factors
12. Group O-rhesus negative blood available on immediate request.

AIRWAY MANAGEMENT

Airway management in the major trauma patient is likely to be difficult due to various reasons:

- unfamiliar environment,
- time pressures,
- multiple interventions ongoing at the same time,
- the need for C spine stabilisation,
- trauma to face and neck with oedema or soiling of the airway with blood,
- agitated, often un co-operative patients due to pain and hypoxemia

10% of all RSIs in the ED are difficult.

Consider using a microcuff tube for children >3kg if airway soiling or the need for high pressure ventilation are likely.

*Consider **immediate** endotracheal intubation*

1. Airway obstruction
2. GCS < 8
3. Severe haemorrhagic shock
4. Cardiac arrest

*Consider **early** intubation*

1. Hypoventilation
2. To protect lower airway from aspiration of blood/gastric contents
3. Burns/smoke inhalational injury
4. Persistent hypoxemia ($SaO_2 \leq 90\%$) despite supplemental oxygen
5. Severely injured patient needing intervention in theatre or radiology suite
6. To perform therapeutic and diagnostic procedures in persistently combative patients refractory to pharmacologic agents
7. Stabilisation prior to intrahospital transfer or retrieval
8. Facial or neck injury with the potential for airway obstruction
9. Respiratory distress (without hypoxia or hypoventilation)
10. Cervical spinal cord injury with any evidence of respiratory insufficiency (complete cervical cord injury or incomplete injuries C5 and above).

Oro-tracheal rapid sequence intubation is the method of choice for securing the airway in major trauma patients

Special considerations

1. Patient with traumatic cardiac arrest undergoing resuscitative thoracotomy

a. Patients in traumatic arrest will not require induction of anaesthesia prior to intubation. However, endotracheal intubation must be performed before or during the procedure, and drugs to maintain anaesthesia and muscle relaxation must be ready if and when spontaneous circulation returns and the patient starts to show signs of life.
b. Patients who are peri-arrest but awake will require a modified rapid sequence intubation prior to resuscitative thoracotomy. Induction of anaesthesia may lead to a dramatic loss of blood pressure and so ketamine and/or an opiate will be preferable to the standard intravenous induction agents. Muscle relaxation is maintained throughout.

2. High spinal cord injuries

In cervical or high thoracic cord injuries, impaired control of the autonomic nervous system (loss of sympathetic activity and uninhibited parasympathetic activity) may lead to hypotension and bradycardia. Severe bradycardia may be precipitated by tracheal stimulation (during intubation or suctioning) and hypoxia. This may lead to cardiac arrest during intubation. To minimize this risk, consider

- Adequate pre-oxygenation
- Maintain oxygenation by ventilation prior to intubation
- Atropine 20mcg/kg iv

3. Severe facial/neck injuries

Airway management will need to be individualized based on the degree of injury. Call for senior help immediately, and consider whether moving the patient to theatres may be the safest option.

Technique

- Full AAGBI monitoring
- C Spine immobilisation by manual in line stabilisation (MILS) applied from the back. (MILS applied from the front can interfere with gaining surgical airway access). Once MILS applied, remove the front of the hard collar as it will interfere with laryngoscopic views. The back of the hard collar can be left in place.
- Adequate trained assistance-at least 3 people are needed (anaesthetist to intubate, assistant to provide MILS, ODP/nurse to provide cricoid pressure and assist with intubation)
- Anticipate difficulty
- Preoxygenate if possible; injury/agitation may make this difficult
- Induce anaesthesia and paralysis with appropriate drugs
- Airway obstruction, chest injury, or both may render the patient hypoxaemic before induction and rapid desaturation may occur. Pulse oximetry lags behind the in vivo value. If necessary, maintain arterial oxygen saturation by gentle ventilation while waiting for paralysis. With correct cricoid pressure, careful ventilation should not cause gastric inflation and may prevent life-threatening hypoxaemia. If gastric distension does occur, the stomach can be rapidly decompressed using an appropriately sized oro-gastric suction catheter.
- If view is poor, use adjuncts such as bougie/McCoy scope early rather than increasing pressure on C spine
- Use uncut tube in cases of burns or severe facial trauma to allow for swelling
- Consider using a microcuff tube for infants and children >3kg particularly if high pressure ventilation or airway soiling are likely
- Confirm tube placement with clinical signs **and capnography**
- Replace the hard collar, lateral blocks and straps before releasing MILS.
- Insert a nasogastric tube. If there is a head injury use the orogastric route.

Drugs

- Depending on haemodyamic stability choose between thiopentone, propofol and ketamine. Suxamethonium or Rocuronium can be used as muscle relaxants. Maintain anaesthesia with infusion of opioid and midazolam or propofol.
- Anticipate haemodynamic instability after induction. Hypovolaemia and positive pressure ventilation may cause circulatory collapse; treat this with rapid intravenous fluid, inotropic/vasoconstrictor drugs, or both. Be aware of the potential for other causes of shock in trauma: tamponade, pneumothorax & neurogenic shock

Failed intubation (See APA/DAS Difficult airway guidelines)

- If the first intubation attempt is unsuccessful, and oxygenation is adequate, try again with a change in size/type of laryngoscope plus external laryngeal manipulation and a bougie.
- If second attempt fails, a more experienced operator should take over
- A maximum of 4 attempts are acceptable if oxygenation is maintained
- If hypoxia develops, immediately switch priority to ventilation with cricoid pressure in situ
- Waking the patient up is not practical in the major trauma scenario
- The airway may require reopening with basic airway manoeuvres and adjuncts
- Poorly-applied cricoid pressure may aggravate airway obstruction; a trial of relaxing cricoid pressure during positive pressure ventilation may be indicated, with suction to hand.
- Further options depending on the cause of difficulty are: videolaryngoscopes, LMA with fibreoptic guided intubation, direct fibreoptic guided intubation (may be complicated by soiling of the airway with secretions/blood and wearing off of anaesthetic drugs)
- If sufficient oxygenation cannot be restored quickly, a 'cannot intubate—cannot ventilate' situation has arisen
- Supraglottic airway devices (SAD) may help restore ventilation. Consider a second generation device to allow higher pressure ventilation and placement of a gastric tube
- IF SAD unsuccessful, prepare for emergency transtracheal access
    - See the **Paediatric Emergency Surgical Airway** guidance

VASCULAR ACCESS

- Large bore peripheral access is the ideal as it enables high rate fluid infusions. Large bore iv connectors are available to attach to these and will not reduce flow rates.

Size of cannula	**Approximate flow rate with gravity (ml/minute)**	**Approximate flow rate with pressure (ml/minute)**
24G yellow	13	25
22G blue	31	60
20G pink	54	100
18G green	98	153

Caution: Central lines & large bore iv connectors should not be used for power injection of contrast in CT as they cannot withstand the pressure generated and may rupture.

- Consider early use of intraosseous access (IO) access - anaesthesia can be satisfactorily induced via this route. Easy-IO kits are available in ED.

Size of IO needle	Recommended for child of weight	Flow rate
15mm x 15g	**3-39kg**	**Flow under gravity 0.5-4ml/min. Syringe drugs or use a pressure bag for infusions.**
25mm x 15g	**>40kg**	
45mm x 15g	**adult**	

  - Preferred sites for IO are proximal tibia, distal femur and proximal humerus
  - A chubby infant may need a 25mm needle
  - Use local anaesthetic if appropriate
  - Use the stabiliser system to fix the IO in place
  - All anaesthetic and resuscitation drugs can be given by the IO route
  - Fluids given by the IO route should be pressurised
  - Once patient is adequately resuscitated, peripheral venous access may become possible
  - IO needles should not be left in situ for longer than 24 hours-alternative access (either peripheral or central) must be obtained by then.

- After initial resuscitation consider central venous access
- For older children, large bore 'haemodialysis' central lines are available in ED and are ideal for rapid fluid resuscitation via the central route. The subclavian route should be considered in patients with cervical collars in place

INVASIVE BLOOD PRESSURE MONITORING

Invasive blood pressure monitoring (IBP) via an arterial line can be a useful adjunct in the monitoring of unstable trauma patients - particularly in those who have sustained a traumatic brain injury when avoidance of hypotension is vital to limit secondary brain injury.

The usefulness of IBP must be weighed against the potential delay in obtaining diagnostic imaging or accessing definitive care that may result from siting an arterial line and setting up and transferring additional monitoring equipment.

Pre-alert

On receipt of a pre-alert that indicates a patient with a GCS of 13 or below is en route, the ED nursing team should set up an IBP transducer line in readiness and ensure the necessary equipment for siting an arterial line is readily available.

Patient arrival

Following initial assessment and provision of any immediately required treatment the decision to site an arterial line or not should be made by the team leader taking into consideration the opinions of the team members.

Examples of patients likely to benefit from IBP monitoring include:

- Haemodynamically unstable patients with a GCS <13 even after resuscitation
- Patients with a reduced GCS likely to be the result of a significant traumatic brain injury who may be at risk of haemodynamic instability (including as a result of the induction and maintenance of anaesthesia).

In most conscious patients IBP is **not needed** as:

1. An adequate BP in an actively bleeding patient can be gauged by the maintenance of conscious level supported by NIBP measurement.
2. The maintenance of a normal GCS suggests that a significant brain injury is unlikely.
3. There is very little place for the use of inotropic support in hypovolemic trauma patients.

Central lines

- Not usually needed in ED
- Peripheral large bore access for fluids and blood is ideal
- Inotropes are not normally required in this group of patients in the early stages
- Can be inserted later in theatre/ICU

DAMAGE CONTROL RESUSCITATION

Current evidence suggests that aggressive fluid resuscitation prior to haemostasis leads to additional bleeding through hydraulic acceleration of haemorrhage, soft clot dissolution, and dilution of clotting factors. Hence, in major trauma patients with suspected or known major haemorrhage, a more controlled strategy of limited resuscitation is recommended, using mainly blood and blood products.

Goals of DCR

The goals of DCR are to mitigate metabolic acidosis, hypothermia and coagulopathy and stabilise the patient as early as possible in a critical care setting.

Key components of DCR in trauma are

1. Time limited permissive hypotension (PH)
2. Use of massive haemorrhage protocols
3. Damage control surgery (DCS)

PERMISSIVE HYPOTENSION (PH)

- PH is the practice of allowing a lower than 'normal' blood pressure in the initial stages of trauma, until definitive control of haemorrhage has taken place, either by surgery or interventional radiology.
- Aim of PH is to limit the amount of fluid given and hence reducing the risk of clot disruption and dilutional coagulopathy.
- PH should be time limited and definitive resuscitation started as soon as haemorrhage control is achieved.

Target pressures are a subject of extensive debate in children, particularly in the context of a brain-injured child, who needs a higher blood pressure to achieve adequate cerebral perfusion, and in patients with complex co-morbidities. A pragmatic approach is detailed below, but may require modification in certain patients.

- 10ml/kg boluses of crystalloids in the first instance until radial pulse is palpable.
- Once blood and blood products are available, switch to blood based resuscitation. A ratio of 1:1:1 may be appropriate in a trauma setting but our current protocols are 1:2 (FFP:PRBC). This is likely to be modified following the publication of NICE guidance in Feb 2016.
- In patients with severe traumatic brain injury (TBI) a higher blood pressure is recommended to maintain cerebral perfusion pressures > 40mmHg in the 0-5's and > 50mmHg in the 6-17 year olds
- If blood pressure is not maintained by fluid and blood resuscitation, start vasopressors. Without central venous access, phenylephrine is the vasopressor of choice. Dose should be titrated to achieve target blood pressure. (range 0.01-0.5mcg/kg/min
- Ensure tranexamic acid bolus has been given and give a bolus of 15mg/kg and an infusion of 2mg/kg/h.

- Aggressively prevent hypothermia (temperature <35^{0}C) as it will worsen coagulopathy.
- Maintain serum calcium levels above 1mmol/L: they will fall with transfusion of coagulation products.
- Use coagulation testing TEG (in Jubilee theatres-perfusionists can run a TEG) or ROTEM to determine need for blood products but in their absence continue treatment with blood and blood products.

USE OF MASSIVE HAEMORRHAGE PROTOCOLS

All hospitals should have a major haemorrhage protocol, which should be followed in the major trauma scenario. Haematology advice may be sought in complex cases.

- See LTHT or local neonatal/paediatric massive haemorrhage protocol.
- Haemodyanamic goals of resuscitation:
  - Hb 70-90g/L
  - Platelets: maintain above 80X10^9 /L
  - PT/APTT: maintain <1.5 times normal
  - Fibrinogen: >1g/L

Further Reading / Resources

DAS difficult airway algorithms
https://www.das.uk.com/guidelines/paediatric-difficult-airway-guidelines
http://www.apagbi.org.uk/publications/apa-guidelines

Guideline for the provision of anaesthetic services 2015
www.rcoa.ac.uk/gpas2015

Children's surgical forum standards for the non-specialist emergency surgical care of children 2015
http://www.rcseng.ac.uk/surgeons/surgical-standards/working-practices/childrens-surgery/documents/csf-standards-consultation

Paediatric Critical Care Medicine 2014 - Age specific CPP targets
http://journals.lww.com/pccmjournal/Abstract/2014/01000/Age_Specific_Cerebral_Perfusion_Pressure.10.aspx