# EMERGENCY ANAESTHESIA IN THE ED FOR MAJOR TRAUMA PATIENTS

**PRINCIPLES**

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

**STAFFING**

- The reception of major trauma patients in the emergency department should be by an anaesthetist of ST4 level or above and capable of dealing with airway problems and initiating damage control resuscitation of the trauma patient.
    - MTC: specific bleep
    - TU: *insert local contact details here*
- Within the MTC the further management of critically injured patients, whether in theatre (anaesthesia for the control of major traumatic haemorrhage and other damage control interventions) or in the interventional radiology suite (haemorrhage control by embolization of vessels) should be consultant delivered.
    - 8-6 on weekdays-General ICU consultant is available to come down to the ED and assess the patient if needed.
    - 8-6 all days-MTC consultant anaesthetist will provide further care in theatre.
    - 8-8 all days-General acutes theatre consultant will anaesthetise for radiology intervention in the IR suite.
    - Out of these hours, the resident on-call anaesthetic consultant will be available to come down to the ED and provide further care as needed.
- Within Trauma Units all such cases must be discussed with the on-call anaesthetic consultant.
- Trained anaesthetic assistance must be present at all times in all clinical areas where anaesthetics are administered, including the emergency department and the interventional radiology suite.
    - MTC: Jubilee theatres ODP-bleep 1338
    - TU: *insert local contact details here*
- Appropriately skilled theatre staff should be available who are experienced in the various surgical subspecialty procedures required in patients with multiple injuries. There is 24/7 availability of a trauma theatre, general and neurosurgery acute theatres.
    - MTC: To book theatres, call bunker room-25275, mobile-07880243156
    - TU: *insert local contact details here*

**EQUIPMENT AND FACILITIES**

1. Equipment for airway management-laryngoscopes with different blade sizes, endotracheal tubes of various sizes, bougie, syringe, suction.
2. Equipment for the management of the difficult airway - A 'difficult intubation trolley' which should include a variety of laryngoscopes such as McCoys, laryngeal mask airways, stylets, videolaryngoscopes (e.g. airtraq), fibreoptic bronchoscope [optional], emergency surgical airway equipment.
3. Anaesthetic drugs (ED drug box in the MTC fridge)
4. Resuscitation drugs
5. Portable ventilator
6. Portable monitors
7. Rapid infusion devices ('Level 1')
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 -ve blood should be available in or adjacent to the theatre suite at all times for emergency use. O-ve blood for use in the ED and IR suite should be immediately available from transfusion.

**AIRWAY MANAGEMENT**

Airway management in the major trauma patient is likely to be difficult due to various reasons: an unfamiliar environment, time pressures, multiple interventions being carried out 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 immediate endotracheal intubation***

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

***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. Facial or neck injury with the potential for airway obstruction,

8. Respiratory distress (without hypoxia or hypoventilation)
9. Cervical spinal cord injury with any evidence of respiratory insufficiency (complete cervical cord injury or incomplete injuries C5 and above).

***Orotracheal rapid sequence intubation is method of choice for securing the airway in major trauma patients***

***Special considerations***

**1. Traumatic cardiac arrest for resuscitative thoracotomy**

a. Patients in traumatic arrest will not require induction of anaesthesia prior to intubation. However, endotracheal intubation should 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. It is difficult (poor haemodyanamic stability) and unpleasant (for the patient) to have to induce anaesthesia just as the patient starts waking up.
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. Anaesthesia may be maintained with an infusion or bolus doses of intravenous anaesthetic. 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 including apnoiec oxygenation
- Hyperventilation manually with bag and mask before intubation
- Use of topical lignocaine spray to vocal cords and trachea
- Atropine 0.6mgs 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 if feasible make arrangements to transfer to theatres for securing the airway.

***Technique for airway management***

- Full AAGBI monitoring
- C Spine immobilisation by manual in line stabilisation (MILS) applied from the back or side. (MILS applied from the front can interfere with gaining surgical airway access if needed). Once MILS applied, remove the front of the hard collar as it can interfere with laryngoscopic views. The back of the hard collar can be left in place.

- Adequate trained assistance-at least 4 people are needed
    - To intubate (anaesthetist)
    - To provide cricoid pressure (ODP)
    - To provide MILS (assistant/ can be paramedic)
    - To give drugs (ED doctor)
- Anticipate difficulty
- Preoxygenate if possible-injury/agitation may make this difficult. **Apnoeic oxygenation** has shown prolongation of the time to desaturation during RSI and is recommended. Apnoiec oxygenation may be delivered by attaching nasal cannulae with oxygen flow rate of upto 15L/minute during conduct of RSI (mask pre-oxygenation and intubation).
    - Consider the use of ketamine (10mg increments, upto 50mgs) to relieve pain & agitation and allow pre-oxygenation
- Induce anaesthesia and paralysis with appropriate drugs (see drugs section below)
- 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 correctly applied cricoid pressure, careful ventilation should not cause gastric inflation and may prevent life-threatening hypoxaemia.
- Use a bougie and a Macintosh blade 4 as routine instead of increasing pressure on C spine or having multiple attempts at intubation.
- If the view is poor, release cricoid pressure.
- Use uncut tube in cases of burns or severe facial trauma to allow for swelling.
- Confirm tube placement with clinical signs and capnography.
- Replace the hard collar, lateral blocks and straps before releasing MILS.

***Drugs***

- Induction agents available in the ED major trauma drug box are thiopentone and propofol; ketamine is in the CD cupboard. Whatever induction agent is chosen, the key aim is to use it in such a way as to minimise hypotension, which is detrimental. Ketamine is the most cardiostable of the 3 mentioned induction agents. There is insufficient evidence in literature to recommend the use of one agent over the other in the hospital environment.
- Rocuronium is the preferred muscle relaxant in trauma patients, as there is evidence to indicate a lesser degree of desaturation due to lack of fasciculations which increase oxygen use. If there is difficulty in intubating a major trauma patient, the most likely course of action would be to find alternative means of securing an airway. Returning to spontaneous ventilation is not usually an option in this scenario. Suxamethonium(2mg/kg) is the other option available.
- Fentanyl, upto 3microgrammes/kg may be given during the trauma RSI-it enables a lower dose of induction agent to be given and prevents hypertensive surges during intubation.
- Prehospital physicians use the 3-2-1 regime, which is **3 microgrammes/kg of fentanyl, 2mgs/kg of ketamine and 1mg/kg of rocuronium**, the drugs being given in rapid succession in that order. If the patient is in extremis, the dose of the

anaesthetic agent and opioid are reduced (the so called 1-1-1 regime with 1mic/kg of fentanyl, 1mg/kg of ketamine and 1mg/kg of rocuronium). This regime has shown advantages in the pre-hospital scenario, where it is key to avoid hypotension as access to vasopressors may not be as easy as in the ED.

- Maintain anaesthesia with infusion of propofol and an opioid.
- Try and avoid vasopressors if possible
- Anticipate haemodynamic instability after induction. Hypovolaemia and positive pressure ventilation may cause circulatory collapse. Be aware of the potential for other causes of shock in trauma: tamponade, pneumothorax & neurogenic shock.

**MTC Drugs**

An emergency anaesthesia drug box is present in the ED refrigerator, which contains the immediately needed drugs for anaesthesia (induction agents, muscle relaxants) and vasopressors. Use this box in the first instance. Controlled drugs will need to be taken from the CD cupboard as always.

***Anaesthetic drugs in ED***

| DRUG | PREPARATIONS | LOCATION |
|---|---|---|
| PROPOFOL | 2%-20mg/ml- 20ml ampoule, 50ml vial | MTC drug box, ED drug cupboard |
| KETAMINE | 100mg/ml, 10mg/ml vials | CD cupboard |
| THIOPENTONE | 500 mg vials in powder form | MTC drug box |
| SUXAMETHONIUM | 50mg/ml- 2ml ampoule | MTC drug box |
| ROCURONIUM | 10mg/ml-5ml vial | MTC drug box |
| ATRACURIUM | 10mgs/ml-5ml ampoule | MTC drug box |
| FENTANYL | 50mics/ml-2ml ampoule | CD cupboard |
| PHENYLEPHRINE | 10mg/ml ampoule | MTC drug box |
| EPHEDRINE | 30mg/ml ampoule | MTC drug box |

***Failed intubation***

- If the first intubation attempt is unsuccessful, and oxygenation is adequate, try again with a change in size/type of laryngoscope (including Airtraq or similar) plus external laryngeal manipulation.
- If second attempt fails, a more experienced operator should take over.
- A **maximum** of 3 attempts are acceptable **if oxygenation is maintained between attempts.**
- 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.
- Often the most practical step in this scenario is to progress to a surgical airway (cricothyroidotomy). However these may be tried in the meantime
    - The airway may require reopening with basic airway manoeuvres and airway

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 are: Intubating LMA, LMA with fibreoptic guided intubation, direct FOB 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
- IF SAD unsuccessful, prepare for emergency surgical access via cricothyroidotomy (see surgical airway guidance)

**HAEMORRHAGE CONTROL**

**VASCULAR ACCESS**

- Large bore (16G-grey and 14G-orange) 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 significantly.

| **Size of cannula** | **Rate of flow with gravity (ml/minute)** | **Rate of flow with pressure (ml/minute)** |
|---|---|---|
| 18G green | 98 | 153 |
| 16G grey | 154 | 334 |
| 14G orange | 236 | 384 |
| 18G triple lumen central line | 29 | 79 |
| 16G triple lumen central line | 69 | 116 |

***Caution:*** Large bore connectors should not be used for contrast injection in CT as they cannot withstand the pressure generated and have failed on occasion. In these instances either connect the contrast directly to the venflon or to an ordinary iv connector.

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

- MTC: Large bore 'haemodialysis' central lines are available in the 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/ intubated
- 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.

***Difficult arterial access***

In the event of difficulty in siting an arterial line swiftly, senior support must be sought immediately and alternative sites [e.g. brachial artery] tried. Failure to site an arterial line does not prevent and should not significantly delay transfer for imaging / definitive care. A risk / benefit assessment must be made by the trauma leader taking into consideration the opinions of the team members.

**CENTRAL VENOUS ACCESS**

- Not usually needed in ED
- Third line access for rapid fluid resuscitation after peripheral wide bore cannulae and IO access.
- Inotropes are not normally required or indicated in this group of patients in the early stages
- May 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 in patients with active bleeding, until definitive control of haemorrhage has taken place, either by surgery or interventional radiology.
- Aim of PH is to adopt a 'restrictive resuscitation strategy' and 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, particularly in the context of a brain-injured patient, who needs a higher blood pressure to achieve adequate cerebral perfusion and patients with complex co-morbidities. A pragmatic approach based on recent NICE guidance (Feb 2016) is detailed below, but may require modification in certain patients.

- In the pre hospital and ED setting, give 250ml boluses of crystalloids in the first instance until central / femoral pulse is palpable which corresponds to a systolic pressure of approximately 80mmHg. If blood is available in ED, avoid crystalloid entirely.

- Once blood and blood products are available, switch to blood based resuscitation using the same principle of maintaining a palpable central/femoral pulse.
- Use a ratio of 1:1 for PRBC:FFP with early use of platelets for actively bleeding patients. Use laboratory tests to guide transfusion in later stages.
- In patients with severe traumatic brain injury (TBI) and haemorrhagic shock
    - If haemorrhagic shock is the dominant condition, continue restrictive volume resuscitation **or**
    - If traumatic brain injury is the dominant condition, use a less restrictive volume resuscitation approach to maintain cerebral perfusion.
        - Brain Trauma Foundation- SBP > 90mmHg
        - AAGBI: MAP > 80mmHg
- If blood pressure is not maintained by fluid and blood resuscitation, start vasopressors. Without central venous access, phenylephrine is the vasopressor of choice. Dilute one ampoule of 10mgs in 50mls of 0.9% NaCl (200micrograms/ml) and infuse via syringe pump at a rate of 0-20mls/hour titrated to achieve target blood pressure. **Use of vasopressors to maintain BP is a holding measure only and must not delay definitive control of haemorrhage.**
- Ensure tranexamic acid bolus has been given and start infusion of 1g over 8 hours(1g in 100ml saline at a rate of 12.5mls/hour via a volumetric pump).
- Aggressively prevent hypothermia (temperature <35$^0$C) as it will worsen coagulopathy. Use Bair Huggers, fluid warmers, foil blankets.
- Maintain serum calcium levels above 1mmol/L-they will fall with transfusion of coagulation products.
- Use coagulation testing TEG (in the MTC 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 massive haemorrhage protocol.
- A higher ratio of FFP to PRBC is associated with better survival in trauma and is recommended.
- Haemodyanamic goals of resuscitation:
    - Hb 70-90g/L
    - Platelets: maintain above 80X10$^9$ /L
    - PT/APTT: maintain <1.5 times normal
    - Fibrinogen: >1g/L

**DAMAGE CONTROL SURGERY**

Damage control surgery (DCS) is rapid surgery to save life or limb while avoiding potentially time consuming reconstruction. NICE recommends damage control surgery in patients with haemodynamic instability who are not responding to volume resuscitation. The aim is to enable the patient to be resuscitated by stopping active bleeding while at the same time

minimizing surgical insult. Only immediately essential surgery is performed, after which the patient is then resuscitated in the ICU before coming back for further DCS or definitive surgery. This is usually in 24-48 hours. The components of DCS are

1. Haemorrhage control
2. Decompression of compartments: cranium, thorax, abdomen, limbs
3. Decontamination of wounds and ruptured viscera
4. Fracture splinting

DCS is not indicated if patients are haemodyanamically stable; in this case they can have definitive surgery.
*The decision between DCS and definitive surgery is based on the patient's physiological and metabolic parameters and should be decided after discussion between senior anaesthetists, surgeons and critical care team.*
Some suggested parameters for DCS are

| | |
|---|---|
| **Type of injury** | • High-energy thoraco-abdominal trauma ± pelvic fractures<br>• High-energy retroperitoneal hematoma<br>• High-grade liver injury<br>• Penetrating duodeno-pancreatic lesions<br>• Combined lesions (vascular, solid organ, hollow viscera) |
| **Low physiologic reserve** | • Temperature < 35$^{o}$C<br>• pH < 7.2<br>• Lactic acid > 5mmol/L<br>• Prothrombin time < 50%<br>• Systolic blood pressure : < 90 for >1 hour |
| **Intraoperative findings** | • Intraoperative bleeding : 4 L of blood loss<br>• Coagulopathy Non-mechanical diffuse bleeding |

Lactates may also be used to dictate the duration of DCS. If lactates are progressively rising, it may be necessary to stop surgery and resuscitate the patient for a few hours before attempting further surgery. Serial lactate measurements have been used as a tool to assess the adequacy of resuscitation and prognosticate. Normalisation of lactate levels in the first 24 hours post trauma suggests a good prognosis.

**PREVENTION OF HYPOTHERMIA**
It is vitally important to prevent hypothermia in trauma patients. Ensure iv fluids are warmed whenever possible and make full use of warming devices such as a Bair huggers or under patient warming devices. Instigate continuous temperature monitoring in all critically injured patients.

**Further Reading / Resources**


- Major trauma: assessment and initial management. NICE guidelines: NG39. February 2016
- Guidelines for Provision of Anaesthesia Services. Anaesthesia Services for Trauma and Orthopaedic Surgery. Royal College of Anaesthetists. www.rcoa.ac.uk/gpas2015 gpas@rcoa.ac.uk
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- Emergency Tracheal Intubation Immediately Following Traumatic Injury. Mayglothing J, Therese M, Gibbs M et al. J Trauma. 73(5):S333-S340, November 2012
- The Difficult Airway Society guidelines including 'failed inubation' and 'can't intubate, can't ventilate' (www.das.uk.com)
- Emergency thoracotomy: "how to do it". Wise D, Davies G, Coats T, Lockey D, Hyde J, Good A. *Emerg Med J* 2005;22:22-24
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Author: Rashmi Menon, Consultant in Anaesthesia, Leeds General Infirmary
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