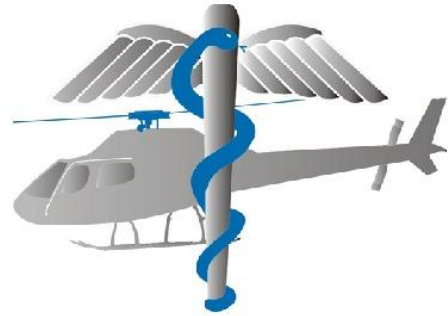


UK HEMS

Clinical Excellence in Helicopter Medicine



MEDICAL EMERGENCIES IN PRE-HOSPITAL CARE

CRASH CARDS:

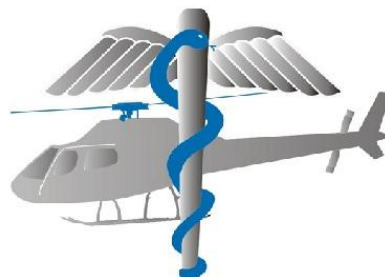
DRILLS FOR USE IN THE EMERGENCY SETTING

These quick reference cards are designed for clinicians who work in a helicopter-based pre-hospital care system, particularly for those who operate under a doctor-paramedic model. They are for use in conjunction with service standard operating procedures. In an emergency, the cards can be read out as a 'challenge-response' list in order to assist with troubleshooting and successful resolution of the problem. They are equally suitable to be used as part of a training exercise or as a structured debrief of any encountered emergencies. They are freely available to be used as a template for similar documents that are individualised for any service. Please acknowledge UK HEMS where appropriate.

Dr Adam Chesters

MEDICAL CRASH CARDS

1. Ventilated patient – rising ETCO₂
2. Ventilated patient – falling ETCO₂
3. Ventilated patient – tachycardia
4. Ventilated patient – compromising bradycardia
5. Ventilated patient – hypertension
6. Ventilated patient – high pressure alarm
7. Ventilated patient – low pressure alarm
8. Ventilated patient – falling oxygen saturations
9. Ventilated patient – cardiac arrest
10. Awake aeromedical transfer – severe pain
11. Awake aeromedical transfer – severe agitation
12. Awake aeromedical transfer – seizure
13. Awake aeromedical transfer – vomiting
14. Awake aeromedical transfer – cardiac arrest
15. Awake aeromedical transfer – hypotension <80mmHg
16. Awake aeromedical transfer – compromising bradycardia
17. RSI – failed intubation
18. RSI – no ETCO₂ trace after intubation
19. RSI – bradycardia during intubation
20. RSI – drugs not absorbed
21. RSI – anaphylaxis after induction
22. RSI – cardiac arrest after induction
23. Head injury – peri-arrest with signs of raised ICP
24. Pregnancy – cardiac arrest
25. Ketamine – Laryngospasm
26. Spinal cord injury – hypotension <100mmHg
27. Catastrophic haemorrhage from injured limb



1. Ventilated patient – rising ETCO₂

Potential Causes

Inappropriate ventilator settings

Excessive dead space causing re-breathing

Herniation of ETT cuff above vocal cords with re-breathing

Malignant hyperpyrexia, hyper metabolic states, some toxic ingestions

- Check ventilator settings
 - If appropriate increase the tidal volume or respiratory rate
- Check circuit dead space
 - If necessary remove components of the circuit:
 - Colourimetric CO₂ detector
 - Catheter mount (can be concertinaed or removed)
 - Ventilator tubing (switch to manual ventilation)
 - The capnography monitoring device **must** remain in the circuit
- Consider and exclude cuff herniation above cords (and subsequent re-breathing)
- Consider rarer causes and look for associated features:
 - Malignant hyperpyrexia
 - Hypermetabolic states
 - Toxic ingestions
- Inform other crew members as required, consider requirement for additional treatment after landing or diversion to alternate destination

2. Ventilated patient – falling ETCO₂

Potential Causes

Inappropriate ventilator settings

Reduced cardiac output (any cause)

Cardiac arrest (very low or absent ETCO₂)

Disconnection of circuit or ventilator failure (absent ETCO₂)

Failure of monitoring connections (absent ETCO₂)

- Check ventilator settings
 - If appropriate decrease tidal volume or increase respiratory rate
- Check for evidence of reduced cardiac output
 - Absent radial or central pulses, or decreased measured BP
 - Suspected bleeding (check splints, under dressings, under patient)
 - Reduced oxygen saturations (peripheral shut down, PE) or tachycardia
- Check monitor for cardiac rhythm
 - VF, VT, asystole, PEA
- If cardiac arrest identified:
 - Inform other crew members
 - **Bleeding** – control any controllable haemorrhage (pelvis, extremities), commence IV fluid resuscitation, consider requirement for additional treatment after landing (has blood been requested for arrival?) or diversion to alternate destination
 - **Tension pneumothorax** – if thoracostomies present; re-finger, check adequacy of incision and track and consider ICD if persistent leak. If no thoracostomies; immediate bilateral needle decompression, left sided thoracostomy (plan for immediate right sided thoracostomy when landed), unless immediate improvement in condition consider landing to ensure both lungs decompressed before onwards travel to destination, consider requirement for additional treatment after landing or diversion to alternate destination
 - **Penetrating trauma to the cardiac danger zone** – assume tamponade, refer to crash card 9.
 - **Head injury** – consider and treat critically decompensated ICP, consider requirement for additional treatment after landing or diversion to alternate destination
 - **Medical cardiac arrest** – commence CPR (Autopulse or ACD), defibrillate as required (inform pilot), follow ALS algorithms, consider requirement for additional treatment after landing or diversion to alternate destination
- Check that circuit is intact and the ventilator is delivering breaths
- Check ETCO₂ cable attached to monitor and circuit ETCO₂ device – if connected and still failing to read, monitor ETCO₂ using colourimetric device or backup monitoring (if accessible)

3. Ventilated patient – tachycardia

Potential causes

Pain

Anaesthetic awareness

Shock

Tachyarrhythmia

- Check monitor for cardiac rhythm
 - Treat tachyarrhythmia – inform other crew members, electrical cardioversion as appropriate (inform pilot), follow ALS guidelines, consider requirement for additional treatment after landing or diversion to alternate destination
 - Identify cardiac arrest (pulseless VT) and treat as per cardiac arrest ‘crash card’
- Consider pain and anaesthetic awareness
 - Look for signs – lacrimation, dilated pupils, tachycardia, hypertension
 - Titrate boluses of morphine and midazolam – generous opiates in cases of painful injuries, midazolam if likely to be more of a sedation requirement
- Check for evidence of shock and treat accordingly
 - Absent radial or central pulses, or decreased measured BP
 - Falling ETCO₂
 - Suspected bleeding
 - Reduced oxygen saturations (peripherally shut down, PE) or tachycardia
- Inform other crew members as required, consider requirement for additional treatment after landing or diversion to alternate destination

4. Ventilated patient – compromising bradycardia

Potential causes

Sinus bradycardia – drug toxicity, raised ICP, hypoxia, vagal stimulation, severe hypothermia

Heart block

- Check monitor for cardiac rhythm; sinus bradycardia vs. heart block
- Assess patient for adverse features (SBP <90mmHg, HR <40bpm, ventricular arrhythmias)
- Sinus bradycardia
 - Inform other crew members
 - In head injured patients, look for signs of raised ICP and treat accordingly (HTS in monitor bag, optimise ETCO₂, loosen collar, prop up head end of stretcher)
 - Ensure patient is not hypoxic (especially children)
 - Consider low core temperature (oesophageal temperature probe, ECG changes)
 - Ensure that sedation is satisfactory
 - Drugs – atropine 500mcg (or paediatric calculated dose) and assess response, can be repeated up to maximum of 3mg. Consider diluted dose of IV adrenaline (1:100,000 in 1ml boluses)
 - External transcutaneous pacing
- Heart block
 - Drugs – atropine 500mcg (or paediatric calculated dose) and assess response, can be repeated up to maximum of 3mg. Consider diluted dose of IV adrenaline (1:100,000 in 1ml boluses)
 - External transcutaneous pacing
- Inform other crew members as required, consider requirement for additional treatment after landing or diversion to alternate destination

5. Ventilated patient – hypertension

Potential causes

Anaesthetic awareness

Pain

Raised ICP (or general intracranial pathology)

Drug toxicity

- Consider pain and anaesthetic awareness
 - Look for signs – lacrimation, dilated pupils, tachycardia, hypertension
 - Titrate boluses of morphine and midazolam – generous opiates in cases of painful injuries, midazolam if likely to be more of a sedation requirement
- In head injured patients, look for signs of raised ICP and treat accordingly (hypertonic saline, optimise ETCO₂, loosen collar, prop up head end of stretcher)
- **Note** – if isolated hypertension in the setting of intracranial pathology, it is not appropriate to treat in the absence of invasive monitoring and accurate infusion devices
- Consider drug toxicity – look for other toxidromic features
- Inform other crew members as required, consider requirement for additional treatment after landing or diversion to alternate destination

6. Ventilated patient – high pressure alarm

Potential causes

Obstruction in circuit (ventilator to ETT connection)

Obstruction of ETT (kink, blood, secretions, foreign body)

Obstructive airways (bronchospasm)

Mechanical obstruction to chest expansion (patient packaging, abdominal pathology)

Tension pneumothorax

- Disconnect ventilator circuit and manually ventilate patient to assess lung compliance
- If easy to manually ventilate, continue (with ETCO₂ monitoring) and assume obstruction in ventilator circuit. Inform other crew members and consider options for onwards transport.
- If difficult to manually ventilate, consider the following (reassess after each intervention):
 - Suction down the ETT – soft suction catheters
 - Ensure both lungs inflated - if thoracostomies present; re-finger, if no thoracostomies; immediate bilateral needle decompression, left sided thoracostomy (plan for immediate right sided thoracostomy when landed), unless immediate improvement in condition consider landing to ensure both lungs decompressed before travel to destination
 - Treat bronchospasm (asthma or anaphylaxis) – consider endotracheal adrenaline, Consider diluted dose of IV adrenaline (1:100,000 in 1ml boluses), consider nebulised bronchodilators via T-Piece. A ventilation strategy of permissive hypercapnia is appropriate to avoid lung barotrauma
 - Ensure chest excursion not limited by tight patient packaging – loosen straps
 - For patients with circumferential full-thickness chest burns, consider escharotomy
 - Suspected raised intra-abdominal pressure – place orogastric tube head-up position if possible, consider adopting a ventilation strategy of permissive hypercapnia to avoid lung barotraumas
- In all cases, inform other crew members and consider requirement for additional treatment after landing or diversion to alternate destination
- **Note – high pressure alarm sounds immediately that relief pressure (pMax) is reached**

7. Ventilated patient – low pressure alarm (sounds after 10 seconds of pressure <10cm H₂O)

Potential causes

Circuit has become disconnected (ventilator to ETT connection)

ETT cuff leak

Tube has become dislodged (balloon herniation or complete extubation)

Oxygen has become disconnected or has run out

- Check and secure circuit connections:
 - Ventilator tubing to side of ventilator
 - Ventilator tubing to ETCO₂ device
 - ETCO₂ device to HME filter
 - HME filter to catheter mount
 - Catheter mount to ETT connector
 - ETT connector to plastic tube
- When circuit confirmed to be intact, check ETCO₂ trace on monitor
 - If absent and ventilator still functioning, assume complete extubation – inform other crew members, arrange alternate airway management (adjuncts, BVM, LMA), consider requirement for additional treatment after landing or diversion to alternate destination.
ENSURE OXYGEN IS CONNECTED TO RESCUE DEVICE
DO NOT ATTEMPT TO RE-INTUBATE WHILST IN FLIGHT
 - If absent and ventilator not functioning, assume that the oxygen supply has become disconnected or run out – disconnect ventilator and manually ventilate with self-inflating bag, check oxygen supply and plug ventilator (or self-inflating bag) into spare CD cylinder
 - If present, consider potential cuff herniation or leak –, check ETT length at teeth compared to when intubated, consider deflating cuff and advancing ETT 1-2cm before re-inflating cuff and reassessing. If low pressure alarm persists, cuff leak is probable. Consider need for alternative airway management, requirement for additional treatment after landing or diversion to alternate destination
- In all cases inform other crew members and consider requirement for additional treatment after landing or diversion to alternate destination

8. Ventilated patient – falling oxygen saturations

Potential causes

Failure of monitoring (movement artefact, lead failure, BP cuff inflated, probe off)

Failure of monitoring (peripheral shutdown of any aetiology – includes shock)

Progressive deterioration of lung pathology

Tension pneumothorax or collapsed lung of any aetiology

Inadvertent extubation or ventilator failure

- Clinically assess patient for signs of hypoxia (colour and chest movement)
- Check that ventilator is working and that ETCO₂ trace is present. If ventilator failure, manually ventilate with self-inflating bag and troubleshoot ventilator failure. If ETCO₂ trace is absent and ventilator is still functioning, refer to crash card number 2 and crash card number 7.
- Check SpO₂ trace on monitor
 - If no trace, ensure that probe is on finger and that lead is not disconnected
 - If poor trace, ensure that probe is secured on finger or try alternate location, probe or monitor (disposable probes or backup monitor)
 - If peripheral shut down, identify and address cause of shock and/or ensure core temperature is appropriate (oesophageal temperature probe, bubble wrap, blankets)
- Consider deteriorating lung pathology such as asthma, anaphylaxis, contusion and treat
- Consider tension pneumothorax or collapsed lung of any other aetiology – if thoracostomies present; re-finger, if no thoracostomies; immediate bilateral needle decompression, left sided thoracostomy (plan for immediate right sided thoracostomy when landed), unless immediate improvement in condition consider landing to ensure both lungs decompressed before onwards travel to destination, consider requirement for additional treatment after landing or diversion to alternate destination
- In all cases, consider disconnecting the ventilator and manually ventilating the patient with the self-inflating bag to assess lung compliance
- In all cases inform other crew members and consider requirement for additional treatment after landing or diversion to alternate destination

9. Ventilated patient – cardiac arrest

Potential causes

Traumatic cardiac arrest

Medical cardiac arrest

- Confirm cardiac (or circulatory) arrest – absent central pulse, significant reduction of ETCO₂
- Inform other crew members
- Check monitor for cardiac rhythm
 - VF, VT, asystole
 - May be PEA
- **Bleeding** – control any controllable haemorrhage (pelvis, extremities), commence IV fluid resuscitation, consider requirement for additional treatment after landing (has a code red been declared?) or diversion to alternate destination
- **Tension pneumothorax** – if thoracostomies present; re-finger, if no thoracostomies; immediate bilateral needle decompression, left sided thoracostomy (plan for immediate right sided thoracostomy when landed), unless immediate improvement in condition consider landing to ensure both lungs decompressed before onwards travel to destination, consider requirement for additional treatment after landing or diversion to alternate destination
- **Penetrating trauma to cardiac danger zone** – assume cardiac tamponade and plan for immediate thoracotomy when landed – initial left-sided thoracostomy and incision may be possible whilst in flight, inform pilot (may have to divert to alternate location in order to land so that procedure can be performed as soon as possible)
- **Head injury** – consider and treat critically decompensated ICP, consider requirement for additional treatment after landing or diversion to alternate destination
- **Medical cardiac arrest** – commence CPR (Autopulse or ACD), defibrillate as required (inform pilot), follow ALS algorithm, consider requirement for additional treatment after landing or diversion to alternate destination
- In all cases, ensure that the receiving unit is aware of deterioration (particularly PCI units)
- In cases of medical cardiac arrest, direct conveyance to PCI suite may be appropriate

10. Awake aeromedical transfer – severe pain

Potential causes

Inadequate analgesia provision

Flight vibrations and turbulence

Deteriorated clinical condition

- Inform other crew members that the patient is in severe pain
- Attempt verbal contact through patient headphones via aircraft intercom
- If verbal contact impossible, revert to pre-arranged hand signals
 - Reassure the patient that the pain will be treated effectively
 - Ascertain the location and severity of the pain
- Ensure that broken limbs are not wedged against airframe and transmitting flight vibrations
- Ensure that monitoring, equipment, and straps are not pressing against painful area
- Review analgesia provision
 - In flight, there should be easy access to an intravenous cannula
 - Ensure that cannula is still in vein and is not occluded
 - Ask permission from the pilot to unstrap and state reason
 - Titrate boluses of morphine or ketamine as appropriate (as per SOP)
 - Re-strap, note additional analgesia on run sheet and continuously reassess the patient's analgesia requirement
- Consider whether the pain is in proportion to the injuries identified on the initial clinical assessment – if not; **presume that there is an additional injury, complication, or deterioration**
- In all cases inform other crew members and consider requirement for additional treatment after landing or diversion to alternate destination

11. Awake aeromedical transfer – severe agitation

Potential causes

Reaction to medications (illicit drugs, medical ketamine)

Hypoxia or shock

Fear of flying/heights/confined spaces

- **The safety of the aircraft and crew is paramount**
- Inform other crew members that the patient is severely agitated
- Attempt verbal contact through patient headphones via aircraft intercom
- If verbal contact impossible, revert to pre-arranged hand signals
 - Offer reassurance and attempt to ascertain cause of agitation
 - Patients with fear of flying/heights/confined spaces can generally be reasoned with
- Check the patient for hypoxia
 - Colour, SpO2 trace, suspected illness or injury causing hypoxia
 - Apply oxygen facemask only if tolerated
- Check for signs of shock and treat accordingly
- Consider pharmacological sedation
 - In flight, there should be easy access to an intravenous cannula
 - Ensure that cannula is still in vein and is not occluded
 - Use midazolam for anxiolysis in small doses or in larger doses if agitation is thought to be due to ketamine (emergence or side-effect)
 - Larger doses of ketamine are useful for rapid control of severely agitated and unmanageable patients who are a risk to the safety of the aircraft or crew
 - Ensure that sedation is provided in accordance with the monitoring standards listed in the HEMS SOP
- In some cases, physical restraint may be necessary as a short term measure to ensure the safety of the aircraft and crew while the situation is brought under control
- Consider requirement for additional treatment after landing and reassess the patient who may have deteriorated clinically or who may now be deeply sedated

12. Awake aeromedical transfer – seizure

Potential causes

Medical (including toxic drug ingestions, intracranial bleeding or thrombosis, CNS infection)

Traumatic (including traumatic brain injury and hypoxia)

- Inform other crew members that the patient is having a seizure
- Ask the pilot's permission to unstrap and state the reason why
- If safe to unstrap:
 - Ensure that cannula remains in the vein and is patent
 - Administer appropriate dose of intravenous benzodiazepine (most likely to have pre-drawn midazolam closest to hand) as per HEMS SOP
 - Provide high-flow oxygen
 - Consider requirement for airway management. Adjuncts, BVM, LMAs)
 - **Do not attempt to intubate whilst in flight**
 - **Do not unstrap patient whilst in flight even if recovery position is desirable**
- If not safe to unstrap:
 - Administer appropriate dose of intravenous benzodiazepine (most likely to have pre-drawn midazolam closest to hand) as per HEMS SOP if cannula is accessible
 - Consider requirement for urgent landing to gain control of the situation and communicate with the pilot and crew
 - Once landed or safe to unstrap, manage seizure as per HEMS SOP
- If seizure terminates whilst in flight:
 - Manage post-ictal patient – consider airway management (manual control, adjuncts, suction) and optimise oxygenation
 - Ensure that treatment is optimised for underlying diagnosis
- If seizures do not terminate in flight:
 - Consider additional step-wise management of status epilepticus
- Ensure that treatment is optimised for underlying diagnosis in all cases reassess the patient and review/amend the working diagnosis
- In all cases update other crew members and consider requirement for additional treatment after landing or diversion to alternate destination

13. Awake aeromedical transfer – vomiting

Potential causes

Motion sickness

Emetic action of drugs therapy (particularly opiates)

Head injury

Any other cause of vomiting

- Patients who have a GCS of 15 should be able to protect their own airway so in general for patients with a high GCS, vomiting is extremely unpleasant but not life-threatening. Patients with a GCS of <15 should have been the subject of a careful risk-benefit analysis before opting for an awake aeromedical transfer
- Personal protective equipment (particularly gloves) must be worn
- Patients who are immobilised with spinal precautions
 - Inform other crew members that the patient is vomiting
 - Attempt to reassure the patient with verbal contact or hand signals. They will be scared
 - Assist vomit clearance with gently suction (most easily applied to corner of the mouth after removal of Yankauer attachment). **Do not blindly suction the oropharynx and this may provoke further vomiting**
 - The patient will feel better and less embarrassed if excess vomit is removed from the face with a cleaning wipe as soon as practicable
 - If the patient appears to be choking, this represents a situation of much greater urgency – inform the crew of the situation, ask permission to unstrap, and prepare to manage the airway from the head end of the bed. Deeper suction may be required but should still take place gently and under direct vision
- Patients who are not immobilised should be allowed to sit up and encouraged to clear their own vomit from the upper airway. Suction is not usually required and may make the situation worse.
- Anti-emetics have a relatively slow onset of action so there is no clear advantage to their administration during flight, especially if this means finding and drawing up the drug in a confined space in flight
- Clearly document any episodes of vomiting on the run sheet as this may influence investigation and treatment decisions for the hospital team

14. Awake aeromedical transfer – cardiac arrest

Potential causes

Medical cardiac arrest

Traumatic cardiac arrest

- Confirm cardiac (or circulatory) arrest – absent pulse, significant reduction of ETCO₂
- Inform other crew members
- Check monitor for cardiac rhythm
 - VF, VT, asystole
 - May be PEA
- Arrange airway management, consider requirement for additional treatment after landing or diversion to alternate destination. **Do not attempt to intubate in flight**
- **Bleeding** – control any controllable haemorrhage (pelvis, extremities), commence IV fluid resuscitation, consider requirement for additional treatment after landing (has blood been requested for arrival?) or diversion to alternate destination
- **Tension pneumothorax** – if thoracostomies present; re-finger, if no thoracostomies; immediate bilateral needle decompression, left sided thoracostomy (plan for immediate right sided thoracostomy when landed), unless immediate improvement in condition consider landing to ensure both lungs decompressed before onwards travel to destination, consider requirement for additional treatment after landing or diversion to alternate destination
- **Penetrating trauma to cardiac danger zone** – assume cardiac tamponade and plan for immediate thoracotomy when landed – initial left-sided thoracostomy and incision may be possible whilst in flight, inform pilot (may have to divert to alternate location in order to land so that procedure can be performed as soon as possible)
- **Head injury** – consider and treat critically decompensated ICP, consider requirement for additional treatment after landing or diversion to alternate destination
- **Medical cardiac arrest** – commence CPR (Autopulse or ACD), defibrillate as required (inform pilot), follow ALS algorithms, consider requirement for additional treatment after landing or diversion to alternate destination
- In all cases, ensure that the receiving unit is aware of deterioration (particularly PCI units)
- In cases of medical cardiac arrest, direct conveyance to PCI suite may be appropriate

15. Awake aeromedical transfer – hypotension <80mmHg

Potential causes

Bleeding causing hypovolaemic shock

Tension pneumothorax

Cardiac tamponade

Spinal cord injury

Medical causes including sepsis and profound dehydration

- In the context of trauma patients seen by HEMS, a focused assessment of the patient should suggest the most likely cause of hypotension. In all cases, inform the other crew members of developments
- **Bleeding**
 - Control any controllable haemorrhage (pelvis, extremities),
 - If the patient is not talking, commence IV fluid resuscitation in 250ml boluses of crystalloid until the patient talks or regains a radial pulse
 - Consider requirement for additional treatment after landing (has a code red been declared?) or diversion to alternate destination
- **Tension pneumothorax**
 - Optimise oxygenation
 - Consider needle chest decompression if peri-arrest or in severe respiratory distress, and plan for RSI, positive pressure ventilation and thoracostomies once landed
 - Unless immediate improvement in condition, consider landing to ensure both lungs decompressed before onwards travel to destination. Consider requirement for additional treatment after landing or diversion to alternate destination
 - Commence IV fluid resuscitation as above in case of undiagnosed volume issue
- **Penetrating trauma to cardiac danger zone**
 - Assume cardiac tamponade and plan for potential thoracotomy if the patient suffers cardiac arrest (refer to HEMS SOP). Inform pilot (may have to divert to alternate location in order to land so that procedure can be performed as soon as possible if necessary)
 - Consider requirement for additional treatment after landing or diversion to alternate destination. Rapid transfer to a cardiothoracic centre is essential
 - Commence IV fluid resuscitation as above in case of undiagnosed volume issue
- **Spinal cord injury**
 - Commence IV fluid resuscitation to achieve a SBP of >100mmHg as per HEMS SOP
 - Consider small doses of intravenous adrenaline to maintain the BP >100mmHG
- **Medical causes of hypotension**
 - May require large volumes of fluid. Ensure that treatment of underlying condition is optimised

16. Awake aeromedical transfer – compromising bradycardia

Potential causes

Sinus bradycardia – drug toxicity, raised ICP, hypoxia, vagal stimulation, severe hypothermia

Heart block

- Check monitor for cardiac rhythm; sinus bradycardia vs. heart block
- Assess patient for adverse features (SBP <90mmHg, HR <40bpm, ventricular arrhythmias)
- Ensure patency of airway and adequate oxygenation
- Sinus bradycardia
 - Inform other crew members
 - In head injured patients, look for signs of raised ICP and treat accordingly (HTS in monitor bag, optimise ETCO₂, loosen collar, prop up head end of stretcher)
 - Ensure patient is not hypoxic (especially children)
 - Consider low core temperature
 - Drugs – atropine 500mcg (or paediatric calculated dose) and assess response, can be repeated up to maximum of 3mg. Consider diluted dose of IV adrenaline (1:100,000 in 1ml boluses)
 - External transcutaneous pacing. See below
- Heart block
 - Drugs – atropine 500mcg (or paediatric calculated dose) and assess response, can be repeated up to maximum of 3mg. Consider diluted dose of IV adrenaline (1:100,000 in 1ml boluses)
 - External transcutaneous pacing. See below
- External transcutaneous pacing
 - Will require sedation of the patient who is likely to still be conscious
 - Midazolam and morphine have advantages over ketamine and propofol in this setting
 - Whether to commence external transcutaneous pacing in-flight will depend on the state of flight and condition of the patient and should be discussed as a crew
- Inform other crew members, consider requirement for additional treatment after landing or diversion to alternate destination

17. RSI – failed intubation

30 second drills

- *Adjust your position*
 - *Adjust patient's position*
 - *Suction*
 - *Insert blade to maximum and slowly withdraw*
 - *BURP and external laryngeal manipulation*
 - *Release cricoid pressure*
 - *Change blade (longer blade or McCoy)*
-
- Prior to RSI, the failed intubation plan should be considered and verbalised so that both team members are aware of the intended step-wise management of the failed airway for that patient
 - The 30-second drills should be carried out in an order dictated by the view obtained at laryngoscopy or with a specific reason for the failed intubation in mind. For example:
 - Blood/secretions in the airway – suction
 - Grade 3 or 4 view – change blade, BURP or ELM
 - Medical patient – adjust patient position
 - Sunlight or environmental problem – adjust your position
 - Distorted anatomy – release cricoid pressure or fully insert blade and withdraw
 - Ensure that the grade of view and any problems encountered are verbalised to enable the HEMS paramedic to predict and suggest the optimisation techniques that may be required
 - The paramedic should assist the doctor in the drills, closely watch the SpO₂, and explicitly inform the doctor of the need to oxygenate the patient when saturations fall
 - Re-oxygenation after a failed attempt should be with 2-person BVM (and triple adjuncts) or via a correctly-fitting LMA. There should be a discussion amongst the HEMS and assisting teams as to how to alter conditions to optimise the next attempt and the ongoing failed intubation plan should be agreed
 - If it is thought that intubation will be totally impossible, or after a second failure, the options are:
 - Allow the patient to wake up and transport to the nearest ED self ventilating (with assistance as necessary – adjuncts, BVM, breathing through LMA)
 - Anaesthetise, paralyse and ventilate through a LMA and consider appropriate triage
 - Perform a surgical airway and transport to hospital in the usual manner
 - In all cases, excellent communication amongst the HEMS team and assisting emergency services personnel is crucial to ensure the safe management of the situation
 - The PHC consultant on call can guide the decision making process in the case of a failed intubation

18. RSI – no ETCO₂ trace after intubation

Potential causes

Oesophageal intubation

Failure of monitoring – technical fault, disconnection of the lead or the circuit

Cardiac arrest – medical or traumatic (extremely low value rather than no trace more likely)

- If there is no longer visual confirmation of the ETT passing through the cords or there was a ‘semi-blind’ intubation following a difficult view at laryngoscopy
 - If the EasyCap is not yellow, **assume that the intubation is oesophageal**, remove the tube and prepare to re-oxygenate the patient as per the failed intubation drill
 - If the EasyCap is yellow and the patient remains well oxygenated, assess the ETT position clinically and proceed to troubleshooting of the mainstream ETCO₂ monitoring device
 - If there is any doubt as to the position of the tube, **assume oesophageal intubation**
- If there is visual confirmation of the ETT passing through the cords
 - Keep the view of the ETT passing through the cords, ensure that the patient is oxygenated with a self-inflating bag and check for signs of cardiac or circulatory arrest
 - If the patient has no signs of cardiac or circulatory arrest, keep the view of the ETT passing through the cords, ensure that the patient is oxygenated with a self-inflating bag and troubleshoot the ETCO₂ monitoring devices
 - If the EasyCap is not yellow
 - Replace it first and ensure the circuit is in tact
 - If new EasyCap does not change colour and there is still no ETCO₂ trace, check the position of the ETT clinically and attach backup monitor if appears correctly positioned
 - If there is any doubt, the safest approach is to **assume that there is a problem with the intubation**, remove the tube and re-oxygenate as per the failed intubation drill
 - If the EasyCap is yellow,
 - If the patient remains well oxygenated, assess the ETT position clinically and proceed to troubleshooting of the mainstream ETCO₂ monitoring device if appears correct
 - Change the ETCO₂ adapter and ensure the cable is plugged in
 - Attach the backup ETCO₂ monitoring device
 - If there is any doubt as to the position of the tube, **assume oesophageal intubation**
- If there is any doubt at any stage, the safest approach is to **assume that the intubation is oesophageal**, remove the tube and prepare to re-oxygenate the patient as per the failed intubation drill

19. RSI – bradycardia during intubation

Potential causes

Hypoxia (particularly in children)

Vagal stimulation during laryngoscopy

Effect of second dose of suxamethonium

- If clinical suspicion of critical hypoxia, immediately discontinue attempt at intubation and re-oxygenate as per failed intubation drill (2-person BVM with adjuncts or LMA)
- If not hypoxic and a second dose of suxamethonium has been given, consider atropine
- If the bradycardia is thought to be due to vagal stimulation (HR and BP will both be low)
 - Secure the airway with the minimum amount of laryngeal manipulation possible
 - Confirm tube position and oxygenate the patient
 - Recheck the monitor – the bradycardia will often resolve after laryngoscope is removed and ongoing anaesthesia is provided
- If the patient has persistent and compromising bradycardia
 - Treat with atropine 20mcg/kg up to 500mcg per dose as per ALS guidelines
 - Reassess the patient for missed diagnoses (including ECG analysis)
 - Consider external transcutaneous pacing
- In all cases, hand over the complication to the receiving anaesthetist and emergency team

20. RSI – drugs not absorbed

Potential causes

Cannula or IO no longer in correct position

- The anaesthetic drugs used by HEMS for RSI have an onset of approximately 90 seconds. This may be delayed in low output states. If there are no signs of anaesthesia or paralysis after 90 seconds, assume that the drugs have not been effectively absorbed
- Inform the team that the drugs have not been effective and a second dose may be required
- Maintain oxygenation, MILS of the cervical spine in trauma patients, and gentle cricoid pressure
- **Be aware that extravasated drugs may still be partially absorbed**
- Ask for additional anaesthetic drugs to be drawn up – the doses will usually be the same
- Both crew members should check the vials to ensure the spare RSI drugs are correct and in date
- Do not use the original cannula or IO to deliver the second dose of drugs
- Check the patency of the spare cannula, or place a new cannula or IO and confirm position
- Once the drugs are drawn up and the position and patency of the spare/new cannula or IO is confirmed, the RSI process should begin again as if it is the first attempt – pre-oxygenation and check list prior to standard HEMS RSI

21. RSI – anaphylaxis after induction

Potential Causes

Anaphylaxis to anaesthetic drugs – estimated incidence 1 in 5000 to 1 in 30,000

- Recognise the signs of anaphylaxis (may not all be present)
 - Skin rash
 - Sweating
 - Rapid hypoxia
 - Bronchospasm – difficult to ventilate
 - Cardiovascular collapse with tachycardia and profound hypotension
- Secure the airway as per HEMS standard RSI
- The half life of the HEMS anaesthetic drugs means that the allergen is removed quickly
- Commence drug therapy of anaphylaxis as per ALS guidelines
 - Intramuscular adrenaline 1:1000 can be given
 - Titrate intravenous adrenaline 1:10,000
 - Intravenous hydrocortisone and chlorphenamine
 - Rapid infusion of intravenous fluid may be required to increase blood pressure (be aware of complicated issue of bleeding trauma patients with severe anaphylaxis)
- Consider ventilation strategy
 - Bronchospastic patients may benefit from endotracheal adrenaline
 - Consider permissive hypercapnia – the acceptable level of ETCO₂ will depend on the clinical state of the patient. Until the bronchospasm is broken, oxygenation is critical and the ETCO₂ may not be modifiable
 - **Do not miss a tension pneumothorax** – consider bilateral thoracostomies
- The triage decision and mode of transport should be reviewed based on the clinical condition of the patient and the response to initial treatment outlined above.
- Speak to the on call PHC consultant in all cases

22. RSI – cardiac arrest after induction

Potential Causes

Traumatic cardiac arrest

Medical cardiac arrest

- Secure the airway as per HEMS standard RSI and oxygenate the patient
- Confirm cardiac (or circulatory) arrest – absent pulse, very low or absent ETCO₂
- Check monitor for cardiac rhythm (VF, VT, asystole, PEA)
- Consider titrated dose of IV adrenaline to counteract vasodilatation causes by induction agent
- **Bleeding** – control any controllable haemorrhage (pelvis, extremities), commence IV fluid resuscitation and identify the source of bleeding (chest, abdomen, pelvis, long bones)
- **Tension pneumothorax or massive haemothorax** – immediate bilateral needle decompression whilst bilateral thoracostomies are performed
- **Penetrating trauma to cardiac danger zone** – assume cardiac tamponade and perform immediate thoracotomy as per HEMS SOP
- **Head injury** – consider and treat critically decompensated ICP
- **Medical cardiac arrest** – commence Q CPR (Autopulse or ACD), defibrillate as required, follow ALS algorithms and Q CPR SOP, identify and treat reversible causes
- **The patient who is in cardiac arrest should not usually be conveyed to hospital unless:**
 - ROSC is achieved after treatments outlined above
 - The patient is a child, in which case the patient should be conveyed with resuscitation attempts ongoing to the nearest ED (only after reversible causes have been addressed by the pre-hospital team)
 - The underlying diagnosis is a STEMI and the receiving unit are willing to perform PCI with cardiac compressions ongoing
- In all cases, ensure that the receiving unit is aware of deterioration (particularly PCI units)
- Ensure that blood is requested to be available on arrival at hospital if appropriate
- In cases of medical cardiac arrest, direct conveyance to PCI suite after ROSC may be appropriate
- In cases of traumatic cardiac arrest, if ROSC is achieved the triage decision and mode of transport should be carefully reviewed and discussed with the on call PHC consultant

Thoracotomy in order to control bleeding in the chest or below the diaphragm is not part of the HEMS SOP.

Cases should be discussed on an individual basis with the on call PHC consultant

23. Head injury – peri-arrest with signs of raised ICP

Potential causes

Critical decompensation of traumatic brain injury

- **The patient is likely to already be intubated, ventilated and anaesthetised. If not, laryngoscopy at this stage may precipitate disastrous spike in ICP and brainstem herniation**
- Recognise critical decompensation of traumatic brain injury – check pupils, GCS and monitor
 - Unilateral or bilateral pupil dilatation with GCS <8
 - Progressive hypertension (>160) and bradycardia (<60) with GCS <8
- Administer 5% (hypertonic) saline (HTS):
 - 6mls/kg up to a maximum of 350mls
 - Take care when inserting giving set into polyfusor (can snap at entry point)
 - Attach giving set to 3-way tap to patent cannula (or IO)
 - Give correct dose using 50ml syringe and 3-way tap (either infuse as required number of 50ml boluses or remove excess from polyfusor, allowing remaining volume to infuse)
- Optimise neuroprotective care package:
 - Loosen cervical spine collar and ETT tie and document
 - Provide adequate sedation and analgesia and document ‘no signs of undersedation’
 - Ensure 20 degree head up position and document
 - Ensure ETCO₂ at lower end of normal range (around 4KPa)
- Review triage decision and ensure neurosurgical capabilities at receiving hospital
- Hand over deterioration to receiving trauma team (including treatment given and timings)
- In all cases, consider other injuries and additional aetiologies for clinical state of patient (in particular bleeding, tension pneumothorax and spinal cord injury)

24. Pregnancy – cardiac arrest

Potential causes

Medical causes – in particular, PE

Traumatic cardiac arrest

The pregnant patient with a sudden collapse and cardiac arrest

- Secure the airway and commence QCPR (Autopulse or ACD), defibrillate as required, follow ALS algorithms and QCPR SOP, identify and treat reversible causes
- If **over 28/40** gestation and **within 5 minutes** of cardiac arrest without response to standard treatment, consider peri-mortem operative delivery of fetus:
 - Continue QCPR
 - Horizontal incision 2-3cm above symphysis pubis; 20cm length incision
 - Cut through skin, then fat and the rectus sheath.
 - Use hands to pull peritoneum open
 - Cut in same direction through uterine wall and widen hole with hands
 - Insert one hand under presenting part of foetus
 - Pull fetus out of cavity, clamp umbilical cord and cut.
 - Hand fetus to colleague or leave to one side if no spare people.
 - Remove placenta.
 - This will take less than 2 minutes
 - Put pressure on any bleeding and reassess patient.
 - Only turn your attention to fetus once everything has been done for mother that can be done. Ambulance crew and/or HEMS paramedic can begin resuscitation of fetus
- A number of cycles of CPR should be completed before pronouncing maternal life extinct
- Thrombolysis is likely to cause major haemorrhage in this setting

The pregnant trauma patient in cardiac arrest

- Secure the airway and provide focused reversible cause treatment based on clinical assessment (volume, chest decompression, intubation and oxygenation, thoracotomy as indicated)
- If **over 28/40** gestation and **within 5 minutes** of cardiac arrest without response to standard treatment listed above, consider peri-mortem operative delivery of fetus
- Assess response to treatment should be reviewed after PMOD and make a decision regarding ongoing resuscitation attempts based on the presumed cause of the traumatic arrest

25. Ketamine - laryngospasm

Potential causes

Side effect of ketamine – incidence around 1 in 300

- Recognise laryngospasm – stridor, respiratory distress, agitation, tracheal tug, paradoxical chest-abdomen movement, bradycardia, central cyanosis, loss of nasal capnography trace
- Inform rest of team of emergency and begin treatment
- BVM ventilation with generation of PEEP
 - BVM available in Thomas pack
 - Tight seal using two-person technique with third person squeezing bag
 - **Adjuncts in partially awake patient may worsen situation**
 - High flow oxygen to fill reservoir
 - Upper airway resistance to ventilation will be high – long, slow, firm squeezes of the bag
 - If partial ventilation possible and oxygenation acceptable, wait for patient to wake up, laryngospasm will break as the effects of the drug wears off
 - If impossible to ventilate or adequately oxygenate, prepare for immediate RSI
- Emergency RSI using rapid check list
 - Attempts at pre-oxygenation should be made as above
 - Use usual HEMS anaesthetic drugs (the suxamethonium will break the spasm)
 - The rapid RSI check list is used due to **critical hypoxia** and **complete airway obstruction**
 - Intubate and check the position of the tube
 - Provide anaesthesia and paralysis as per HEMS SOP
 - It is unwise to attempt to wake the patient and extubate in the pre-hospital setting as laryngospasm may be provoked again
- Once situation is under control and patient is safe, consider the triage options and discuss case with duty PHC consultant. The nearest ED with anaesthetic/ITU services is usually appropriate

26. Spinal cord injury – hypotension <100mmHg

Potential causes

Shock due to other injuries (in particular, bleeding)

Spinal shock (loss of vasomotor tone)

- Reassess the patient for missed injuries or deterioration of injuries identified
- In isolated spinal cord injury (in a patient who is not bleeding)
 - Infuse 250ml boluses of intravenous crystalloid to keep SBP >100mmHg (crystalloid and giving sets in the main compartment of the Thomas pack)
 - Prepare a diluted intravenous solution of adrenaline 1:100,000 – 1ml of 1:10,000 from Thomas pack mixed with 9mls 0.9% saline in a labelled 10ml syringe
 - If the BP is unresponsive to fluid boluses, cautiously titrate 1ml boluses of the 1:100,000 solution of adrenaline to achieve a SBP of 100mmHg
 - Alterations to the patient's position (legs up, head down) are likely to prove impossible to maintain during transfer and may compromise spinal stability
- In a polytrauma patient with spinal cord injury
 - Ensure that other traumatic causes of hypotension have been sought and excluded or treated (tension pneumothorax and bleeding in particular)
 - The target BP is a risk-benefit decision – in patients thought to be bleeding significantly, a lower BP (80mmHg) is the target (as per the HEMS SOP)
 - When all other causes of shock have been excluded and the patient is not thought to have uncontrolled haemorrhage, inotropic support as above may be appropriate if the BP is unresponsive to fluid challenges
- In all cases, ensure adequate oxygenation and strict spinal precautions at all times

27. Catastrophic haemorrhage from an injured limb

Potential causes

Penetrating trauma

Traumatic amputation

- Ensure large-calibre IV access, in at least 2 sites in unaffected limbs
- Attach monitoring and oxygen
- Visualise the wound, irrigation may be helpful (but may also dislodge clots)
- Apply direct pressure to the wound with large dressings (right side pocket, monitor bag)
- Elevate the affected limb
- If bleeding not controlled after direct pressure and elevation, attempt indirect pressure on proximal arterial supply (femoral artery or brachial artery)
- If bleeding still not controlled attempt to identify areas for large silk suture ligation
- If bleeding still not controlled, apply Combat Application Tourniquet
 - Attempt to assess distal neurovascular status prior to applying CAT
 - Apply CAT proximal to bleeding, preferably over a large muscle belly over a single bone
 - Tighten until bleeding controlled
 - Note the time of application
 - The conscious patient will need analgesia or sedation (ketamine)
 - Consider RSI (anticipated clinical course or humanitarian grounds)
- Once bleeding is controlled, boluses of intravenous fluid should continue to maintain SBP >80mmHg as per HEMS SOP. Request blood to be available at receiving hospital
- In all cases, ensure that the appropriate triage decision is made (MTC usually most appropriate)
- Ensure that the following information is handed over to the receiving trauma team
 - Usual description of mechanism and injuries (including description of wound)
 - That a CAT has been applied
 - The time of application of the CAT
 - The CAT must not be removed unless prepared for definitive surgical control of bleeding