For every crisis:

- **Verbalise** the problem. Say out loud….
  ‘This is a **CRISIS**’
- Call for **HELP** early
- **Set oxygen to 100%** (except where stated otherwise)
- Identify a ‘**hands off**’ Team Coordinator
- **Delegate duties** to **specific** team members
- Use **closed loop**, quiet & efficient **communication**
- Use the **indexed pages & coloured boxes** in this manual to **assist you**

Created by Adam Hollingworth

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Adapted from various sources including:

- Guidelines: ANZAAG, AAGBI, NZRC, Starship Protocols
- Hutt Valley & CCDHB: Clinical protocols
- ESA Emergency Quick Reference Guide
- CCDHB Crisis Checklists. Dr A McKenzie
- Wellington ICU Drug Manual. Dr A Psirides & Dr P Young
- Various published peer reviewed papers
Instructions for Use

• Use the **index** and **coloured tabs** to find quick reference pages to assist in a crisis.

• The **handbook is in 2 parts:**
  • The front book: How to treat known **Emergencies**
  • The back book: How to **Diagnose** Problems

• **Routine/obvious tasks** (eg call for help, turn oxygen to 100%) are assumed & thus **not** repeated on every sheet for clarity

• For simplicity & to avoid calculation errors in an emergency, **drug doses** are given for a **70Kg adult**. Paeds doses are clearly marked with 😞 (where appropriate).

- Emergency/Doig tasks
- Thinking tasks, diagnostic or further information
- Doses, equipment or calculation information

• There is an adult & paediatric drug formulary at the back

• Cards are arranged into coloured boxes:
• Work through emergency/doing boxes in a linear fashion. Decision making steps are **highlighted** for clarity.

Using an aid such as this efficiently, in a crisis, is a **learned** skill. You must take time to become **familiar** with this manual and **practise** using it.

It is recommended that a ‘**reader**’, with no other tasks, **read these cards out loud** to the team leader during the crisis.
Airway

1. CICO - Supraglottic
2. CICO - Infraglottic
3. LARYNGOSPASM
4. BRONCHOSPASM
5. ASPIRATION
6. ADULT CARDIAC ARREST - VF or VT
7. ADULT CARDIAC ARREST - Asystole or PEA
8. PAEDIATRIC CARDIAC ARREST
9. PAEDIATRIC EMERGENCY CALCULATIONS
10. ANAPHYLAXIS
11. INTRA-OPERATIVE MYOCARDIAL ISCHAEMIA
12. SEVERE HAEMORRHAGE
13. AIR/GAS EMBOLISM
14. HAEMOLYTIC TRANSFUSION REACTION
15. LOCAL ANAESTHETIC TOXICITY
16. MALIGNANT HYPERTHERMIA
17. HYPERKALAEMIA
18. FIRE - Airway or Patient
19. MATERNAL COLLAPSE
20. NEONATAL LIFE SUPPORT
21. TOTAL/HIGH SPINAL
22. POST PARTUM HAEMORRHAGE
23. PERI-PARTUM SEIZURE
24. AMNIOTIC FLUID EMBOLISM

Breathing

Circulation

Obstetrics

Contents

Diag
1e. CICO - Supraglottic Rescue

Main priority = Oxygenation with stable SpO₂ >90%

- Pre-oxygenate all patients
- Consider passive apnoeic oxygenation with nasal cannula during RSI
- Remove cricoid early

If failure of first supraglottic airway plan:

- Get difficult intubation trolley
- An extra anaesthetic assistant to prepare equipment is very useful
- Use ‘vortex’ approach -
  - No more than 3 attempts at each rescue technique. Move quickly, in any order, between rescue techniques watching SpO₂/EtCO₂:

<table>
<thead>
<tr>
<th>Bag/Mask</th>
<th>LMA</th>
<th>ETT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dentures in</td>
<td>Change type</td>
<td>Dentures out</td>
</tr>
<tr>
<td>Optimise position</td>
<td>Change size</td>
<td>Best: person, position, blade eg video laryngoscope</td>
</tr>
<tr>
<td>2 hands + assistant</td>
<td>Cuff inflation/deflation</td>
<td>BURP</td>
</tr>
<tr>
<td>OPA/NPA</td>
<td>Place with laryngoscope</td>
<td>Bougie - only 1 blind attempt</td>
</tr>
<tr>
<td>+/- Muscle relaxation</td>
<td>+/- Muscle relaxation</td>
<td>+/- Muscle relaxation</td>
</tr>
</tbody>
</table>

- If success with LMA: consider converting to ETT with fibre optic scope
- Before giving muscle relaxation consider possibility of waking patient: sugammadex 1.2g, naloxone 400mcg
- As each rescue attempt fails, escalate & start to prepare for infraglottic rescue:
  - Ready: Get CICO kit from side of anaesthetic machine
  - Set: Open equipment packaging & palpate cricothyroid landmarks

If SpO₂ rapidly falling or persistently low (<90%) despite 3 different techniques:
- Call out loud - ‘We are in a Can’t Intubate, Can’t Oxygenate Scenario’
- Do not delay, start infraglottic rescue. See [tab 2e]

- sugammadex = immediately post roc/vec = 1.2g or 6 x 200mg vials (16mg/kg)
- naloxone = 400mcg bolus (10mcg/kg)
Main priority = Oxygenation with stable SpO₂ >90%

- Dedicated team continuing to attempt oxygenation supraglottically
- Pull patient up bed so head extends over pillow
- 3 options for infraglottic rescue (decide on your preferred 1st method):

1. **Scalpel bougie** *(palpable neck anatomy)*:
   - A bloody, semi-blind technique. Prepare gauze/swabs & suction
   - Method (with 10 blade scalpel):
     - Horizontal stab incision through cricothyroid membrane
     - Rotate scalpel to vertical (blade caudad) and pass bougie alongside blade
     - Remove scalpel, railroad size 6 ETT over bougie

2. **Cannula Cricothyroidotomy** *(palpable neck anatomy)*:
   - CICO Pack: 14G cannula, 5ml syringe (with 2ml NSL), Rapid O₂ (insufflation device)
   - Secure cricoid cartilage & aspirate as you advance the saline filled cannula
   - Success = free aspiration of air - never let go of cannula
   - Connect Rapid O₂ device to cannula & machine aux O₂ port (10L/min @ flowmeter):
     - 1st breath: 6 secs (1000mls) - look for chest rise & fall
     - Wait 20 secs for SpO₂ rise or when SpO₂ starts to drop from peak response
     - 2nd breath: 3 secs (500mls) & repeat only after waiting as previous step
     - If no ↑SpO₂ after 2nd breath or any doubt then abandon technique
   - Convert to Melker size 5 airway using Seldinger technique

3. **Scalpel, Finger, Cannula/Scalpel** *(non-palpable anatomy)*:
   - A very bloody, blind technique. Prepare gauze/swabs & suction
   - Method:
     - Vertical midline 6cm incision through skin & subcutaneous tissue
     - Use both hands to blunt dissect down to airway & secure cartilage
     - Insert cannula or scalpel through cricothyroid membrane
     - Follow step 1 or 2 as above to oxygenate patient

- Choice of 1st method is operator’s personal preference. Decide on your preferred method & practise it - mentally or in a simulation
- If 1st method is unsuccessful move to alternative method immediately
- If no palpable anatomy: scalpel finger method is recommended
Main Priority: Break laryngospasm & maintain SpO\textsubscript{2}

- Ask surgeon to stop
- Delegate & prepare for intubation - Suxamethonium & ETT

Manual procedures:
- Remove LMA & clear the airway
- Consider OP/NP airway
- Jaw thrust & CPAP 30cmH\textsubscript{2}O - do not give +ve pressure breath
- Apply bilateral, painful, inward pressure to Larson’s point (immediately behind lobe of ear)
- If paed: Consider gentle chest compressions (may be more effective than other manual procedures)

If SpO\textsubscript{2} stable & >92% try pharmacological relaxation:
  - Propofol - 20% of induction dose
  - Suxamethonium IV 35mg (\(0.5\text{mg/kg}\))

If SpO\textsubscript{2} dropping or <92% proceed to intubation without delay:
  - Adult: Suxamethonium 100mg
  - Paeds: Suxamethonium IV: 2mg/kg; IM 4mg/kg

Consider atropine 600mcg (\(20\text{mcg/kg}\)) for bradycardia

Consider stomach decompression after event

- Laryngospasm will break with sufficient time & hypoxia but may be preceded by bradycardia, cardiac arrest, aspiration, pulmonary oedema
- Hypoxia may occur rapidly in paed, obese +/- acutely unwell patients
- Pre-prepare IV & IM doses of suxamethonium in such cases (\(\text{see tab 9e}\))

Drug & Equipment dosing
- Paediatric (uncuffed) ET Tube: preterm = 2.5; \(<1\text{yr} = 3.5 - 4; \ >1\text{yr} = (\text{age}/4)+4\) (\(\text{see tab 9e}\))
- Propofol: 20% induction dose
- Suxamethonium:
  - relaxation = 0.5mg/kg IV
  - intubation:
    - adult: induction dose or 100mg
    - paed: IV 2mg/kg; IM 4mg/kg
Main Priority: \( \text{SpO}_2 > 95\% \text{ with Peak Airway Pressures < 50cmH}_2\text{O} \)

- Inform surgeon. Minimise surgical stimulation
- **Check:**
  - Airway position
  - \( \text{EtCO}_2 \) trace
  - Airway pressures
- **Manually ventilate** - confirm high pressures and ensure adequate tidal volume
- **Deepen anaesthesia.** If using desflurane, switch to alternative
- **Emergency Drug** therapy:
  - Inhaled salbutamol **12 puffs** via circuit (<6yr = 6 puffs; >6yr = 12 puffs)
  - Inhaled ipratromium bromide **6 puffs** via circuit (4 puffs)
  - IV salbutamol - **250mcg** slow bolus (below). Repeat at 10mins if needed
  - IV adrenaline - **0.1 - 0.5ml of 1:10,000** (0.01-0.05ml/kg 1:10,000)
- **Optimise ventilator** settings: long expiratory phase, low PEEP, small tidal volumes, intermittent disconnection
- Other **bolus drug adjuncts** (listed in priority order): hydrocortisone, magnesium, ketamine, aminophylline
- If **no improvement** use **infusions** of salbutamol, aminophylline, adrenaline
- Place arterial line. Take serial ABG’s

- **Always consider other causes** of high airway pressure other than primary bronchospasm. Most common include:
  - anaphylaxis
  - laryngospasm (on LMA)
  - tube position
  - chest wall rigidity
  - pneumothorax
  - LV failure
- **Permissive hypercapnia** may be required in order to \( \downarrow \) airway pressures
- Assess response by \( \downarrow \) airway pressures, ABG’s, and improving \( \text{EtCO}_2 \) trace

- **Salbutamol IV** slow bolus: \( \blacklozenge \): <2yrs = 5mcg/kg; 2-18yrs = 15mcg/kg (max 250mcg)
- **Salbutamol Infusion:** 5mg in 50ml NSL. Infuse 0-10ml/hr. (50mls of neat salbutamol. Infuse 5-10mcg/kg/min for 1 hour, then reduced to 1-2mcg/kg/min)
- **Adrenaline infusion:** 5mg in 50mls NSL. Infuse 0-20mls/hr. (not recommended)
- **Hydrocortisone:** 200mg IV (4mg/Kg)
- **Aminophylline:** bolus load: 400mg over 15mins. Infuse: 50mg in 50ml at 35ml/hr. (Load: 10mg/kg over 1hr diluted to 1mg/ml (max 500mg). Infusion varies by age: see tab 36r)
- **Magnesium:** 10mmol (5mls of 49.3%) over 20mins (0.1ml/kg of 49.3% (max 5mls) over 20mins)
- **Ketamine:** 35-70mg IV. (0.5-1mg/kg)
Main Priority: Minimise aspiration while maintaining SpO₂

- Call for help from surgical team members immediately
- Move patient to head down, left lateral position immediately
- Remove LMA/OP airway & suction pharynx

If time & SpO₂ stable >97%:
- Cricoid pressure (if not actively vomiting)
- Suxamethonium IV 100mg (IV 2mg/kg; IM 4mg/kg)
- Intubate
- Suction through ETT with largest possible suction catheter
- Only then, ventilate with 100% O₂

If SpO₂ dropping or <90%:
- Do not delay oxygenation regardless of particulates in pharynx/bronchial tree:
  - Bag mask ventilation with 100% O₂ or
  - Manual breaths via ETT with 100% O₂

Consider bronchoscopy
Consider abandoning surgery
Pass NG tube at earliest convenience

- If patient is asymptomatic 2hrs after event with normal saturation & CXR: ICU referral is not indicated
- Steroids & antibiotics are not routinely used medications in aspiration

Suxamethonium: 😴: IV 2mg/kg; IM 4mg/kg
Main priority = **early defibrillation**

- Ask surgeons to stop (if appropriate)
- Start chest compressions at 100/min (ensure full chest recoil)
- Attach defibrillator. **Shock immediately** at 200J (or max setting)
- Check & secure airway. Monitor EtCO\(_2\) (with compressions)
- 100% O\(_2\), **stop anaesthetic** agents. Ventilate at 10/min (ratio compression:breath=10:1)
- Follow 2 min cycles:
  - Charge defib > Rhythm check > shock > restart compressions
  - **Adrenaline 1mg** (10mls of 1:10,000) immediately after 2nd shock, then every 4mins
  - **Amiodarone 300mg** immediately after 3rd shock
  - If ECG shows QRS complex goto [tab 7e]
- **Read out** & **consider reversible causes** (see below)
- Fetch ultrasound to help r/o causes (if skilled)
- If **ROSC** consider post resuscitation care:
  - Abandon surgery, urgent cardiology referral (\?for PCI)
  - ABCDE’s, ABG’s, 12 lead ECG, therapeutic normothermia (cool if >36 °C)
  - Avoid: SpO\(_2\) >99%, hyperglycaemia (>10mmol/l), hypercarbia

**Reversible Causes:**
- **Hypoxia**
- **Hypovolaemia or Haemorrhage**
- **Hypo/hyper-thermia**
- Electrolyte/Metabolic Disturbance:
  - ↑↓K, ↑↓Mg, ↓BSL, ↓pH, ↓↑Ca
- **Tension Pneumothorax**
- **Tamponade** - cardiac
- **Anaphylaxis & Toxins** - opioids, local anaesthetics, Ca channel or \(\beta\) blocker, other drug errors
- **Thrombosis** - cardiac or pulmonary
- **Pregnant** - manual uterine displacement & start preparations for delivering baby by 5mins [tab 19e]

(Follow all drugs with 20ml flush)
- **Adrenaline** IV: 1mg (10mls of 1:10,000)
- **Amiodarone** IV: 300mg
- **Magnesium** IV: [Torsades]: 10mmol (5ml of 49.3%) over 2mins
- **Calcium Chloride** IV: [↑K or CCB overdose] 10mls of 10%
- **Sodium bicarbonate** 8.4% IV: [↑K or TCA OD or ↓pH] 50ml slow push. Can repeat every 2mins until pH 7.45-7.55
- 1% **lignocaine** IV: [if amiodarone not available] 7mls bolus (0.1ml/kg), Can rpt every 10mins (max 0.3mls/kg)
- **Intralipid** 20% IV: [LA toxicity] Bolus: 100ml (1.5ml/kg); Infusion 1000mls/hr (15ml/kg/hr) - see [tab 15e]
- **Alteplase**: 100mg in 20mls NSL. Infuse at 80ml/hr (be prepared for prolonged CPR - upto 60mins)
7e. ADULT CARDIAC ARREST - Asystole/PEA

Main priority = good quality CPR

☐ Ask surgeons to stop all vagal stimuli
☐ Start chest compressions at 100/min (ensure full chest recoil)
☐ Attach defibrillator
☐ Check & secure airway. Monitor EtCO₂ (with compressions)
☐ 100% O₂, stop anaesthetic agents. Ventilate RR 10/min (ratio compression:breath=10:1)
☐ Follow 2 min cycles:
  • Charge defib > rhythm & pulse check > restart compressions
  • Give adrenaline 1mg (10mls of 1:10,000) immediately, then every 4mins
  • If ECG shows VF/VT goto tab 6e

☐ In asystole: if p waves present consider pacing (see tab 30g)

☐ Read out & consider reversible causes (see below)

☐ Fetch ultrasound & consider reversible causes

☐ If ROSC consider post resuscitation care:
  • abandon surgery, urgent cardiology referral
  • ABCDE’s, ABG’s, 12 lead ECG, therapeutic normothermia (cool if >36 °C)
  • Avoid: SpO₂ >99%, hyperglycaemia (>10mmol/l), hypercarbia

Reversible Causes:
• Hypoxia
• Hypovolaemia/Haemorrhage
• Hypo/hyper-thermia
• Electrolyte/Metabolic Disturbance: ↑↓ K, ↑↓ Mg, ↓ BSL, ↓ pH, ↓ Ca
• Tension Pneumothorax
  • Tamponade - cardiac
  • Anaphylaxis & Toxins - opioids, local anaesthetics, Ca channel or β blocker, other drug errors
  • Thrombosis - cardiac or pulmonary
  • Pregnant - manual uterine displacement & start preparations for delivering baby by 5mins - see tab 15e

(Follow all drugs with 20ml flush)
• [K Rx]:
  • 10mls 10% Ca chloride slow push
  • salbutamol: 12puffs into circuit or 250mcg IV bolus
  • 10u actrapid in 250ml 10% dextrose @500ml/hr
• [Opiate toxicity] Naloxone = 400mcg
• [LA Toxicity]: Intra lipid 20%: Bolus: 100ml (1.5m/kg); Infusion 1000mls/hr (15ml/kg/hr) - see tab 15e
• [β blocker OD]: - adrenaline infusion: 5mg in 50mls NSL. Infuse via CVL 0-20ml/hr
  - isoprenaline: Bolus = 200mcg amp into 20mls with NSL & give 1ml boluses titrated.
  for infusion see tab 35r
  - high dose insulin: Bolus= 50ml of 50% dextrose & 70u actrapid. Infusion= 100u actrapid in 50mls NSL, run at 35ml/hr & 10% dex run at 250mls/hr (monitor BSL & K every 15-30min)
• [Thrombosis] Alteplase: 100mg in 20mls NSL. Infuse at 80ml/hr (be prepared for prolonged CPR - upto 60mins)
Main priority = **Ensure patent airway & adequate oxygenation**

- Ask surgeons to **stop all vagal stimuli**
- **100% O₂**, stop anaesthetic agents. Ventilate RR 15/min (compressions 15 : 2 breaths)
- Start chest compressions at 100/min (ensure full chest recoil)
- **Check & secure airway.** Monitor EtCO₂ (with compressions)
- Attach defibrillator
- Ensure IV access. If none establish **intraosseous access** (do not delay)
- Follow **2 min cycles:**
  - Charge defib 4J/kg > rhythm check +/- shock > restart compressions:
    - If **VF/VT** = shock immediately then every cycle.
      - Give **10mcg/kg adrenaline** straight after 2nd shock, then every 4 mins
      - Give **5mg/kg amiodarone** straight after 3rd shock
    - If **asystole/PEA** = give **adrenaline asap** then every 4mins
- **Atropine 20mcg/kg** is only used in vagal associated bradycardia
- **Read out & consider reversible causes** (see below)
- Fetch ultrasound to help r/o causes (if skilled)
- **If ROSC** consider post resuscitation care as

Reversible Causes:  *(most common in bold)*

- **Hypoxia & Vagal Tone**
- **Hypovolaemia/Haemorrhage/Anaphylaxis**
- **Hypo/hyper-thermia**
- **Electrolyte/Metabolic Disturbance:** ↑↓K, ↑↓Mg, ↓BSL, ↓pH, ↑↑Ca
- **Tension Pneumothorax**
- **Tamponade - cardiac**
- **Anaphylaxis & Toxins** - opioids, local anaesthetics, Ca channel or β blocker, other drug errors
- **Thrombosis** - cardiac or pulmonary

Paeds Calculations  *(Follow all drugs with 20ml flush)*

- **Weight:** age <1yr = (months/2)+4; age 1-5 = (yrs x2)+8; age 6-12 = (yrs x3)+7
- **Energy (J):** 4*Kg; if using AED - use attenuated paeds pads for <8yrs old (if available)
- **Tube (uncuffed):** preterm = 2.5; <1yr = 3.5 - 4; >1yr = (age/4)+4
- **Fluid:** 20ml/kg bolus
- **Adrenaline:** IV = 10mcg/kg (0.1ml/kg of 1:10,000); ETT = 100mcg/kg (0.1ml/kg of 1:1,000)
- **Amiodarone:** 5mg/kg
- **Atropine:** 20mcg/kg IV or IM
- **Glucose:** 2ml/kg of 10% dextrose
- **Sux:** IV: 2mg/kg; IM: 4mg/kg
- **Calcium chloride** 10%: 0.1-0.2ml/kg
- **Naloxone:** 10mcg/kg
- Follow all drugs with an appropriate large flush
- ETT sizes are uncuffed tubes. Consider dropping 0.5-1mm in size for cuffed tubes
- Calculations have been rounded where relevant & insignificant

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Normal HR</th>
<th>Energy (J)</th>
<th>ETT Size (mm)</th>
<th>ETT Length (cm)</th>
<th>LMA Size</th>
<th>Fluid bolus (ml)</th>
<th>Adrenaline (1:10,000)</th>
<th>Amiodarone (mg)</th>
<th>10% Glucose (ml)</th>
<th>Sux - IV (mg)</th>
<th>Sux - IM (mg)</th>
<th>Atropine (mcg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 months or 5 kg</td>
<td>70-190</td>
<td>20</td>
<td>3.5</td>
<td>10.5</td>
<td>1.5</td>
<td>100</td>
<td>0.5 ml</td>
<td>25</td>
<td>10</td>
<td>10</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>6 months or 7 kg</td>
<td>80-160</td>
<td>28</td>
<td>4</td>
<td>11.5</td>
<td>1.5</td>
<td>140</td>
<td>0.7 ml</td>
<td>35</td>
<td>14</td>
<td>14</td>
<td>28</td>
<td>140</td>
</tr>
<tr>
<td>1 yr or 10 kg</td>
<td>80-130</td>
<td>40</td>
<td>4.5</td>
<td>13.5</td>
<td>2</td>
<td>200</td>
<td>1 ml</td>
<td>50</td>
<td>20</td>
<td>20</td>
<td>40</td>
<td>200</td>
</tr>
<tr>
<td>3 yr or 14kg</td>
<td>80-120</td>
<td>55</td>
<td>5</td>
<td>14.5</td>
<td>2</td>
<td>300</td>
<td>1.4 ml</td>
<td>70</td>
<td>30</td>
<td>30</td>
<td>55</td>
<td>280</td>
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<tr>
<td>5 yr or 18kg</td>
<td>75-115</td>
<td>70</td>
<td>5.5</td>
<td>15.5</td>
<td>2</td>
<td>350</td>
<td>1.8 ml</td>
<td>90</td>
<td>35</td>
<td>35</td>
<td>75</td>
<td>360</td>
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<td>10 yr or 37kg</td>
<td>60-100</td>
<td>150</td>
<td>6.5</td>
<td>18</td>
<td>2.5</td>
<td>750</td>
<td>3.7 ml</td>
<td>185</td>
<td>75</td>
<td>75</td>
<td>150</td>
<td>600</td>
</tr>
</tbody>
</table>
Main priority = **Cease triggers, give adrenaline & IV fluid**

- Get anaphylaxis box (if you prefer follow ANZAAG task cards)
- Stop or remove causative agents (eg drugs, blood products, latex products, chlorhexidine etc)
- Minimise volatile but maintain anaesthesia
- Consider early intubation (risk of airway oedema)
- Ensure large bore IV access. If none, consider intraosseous access
- Treat based on grade of anaphylaxis (see yellow box)
  - Give **IV adrenaline & fluids asap**
    (If no IV give IM adrenaline 0.5ml 1:1,000 (0.1ml 1:10,000) Repeat every 5mins)
  - Repeat **adrenaline** & fluid boluses every 1-2 minutes as required:
    
    | IV Adrenaline | Grade 1 (Mild) | Grade 2 (Mod/severe) | Grade 3 (Life threatening) | Grade 4 (Cardiac arrest) |
    |---------------|----------------|---------------------|-----------------------------|---------------------------|
    | Not required  | 10mcg (0.1ml 1:10,000) | 100mcg (1ml 1:10,000) | 1mg (10ml 1:10,000) |
    | Fluid Bolus   | Not required | Rapid 1 litre [10ml/kg] | Rapid 1-2 litres [20ml/kg] | Rapid 2-3 litres [20ml/kg] |
    | Legs          | Not required | Elevate              | Elevate                   | Elevate                   |
  - If >3 adrenaline boluses start **adrenaline infusion**

- **Refractory management:**
  - bronchospasm (see [tab 4](#) for other drug options)
    - Salbutamol: 12 puffs \(=\) IV bolus (see below) \(\rightarrow\) infusion (see below)
  - hypotension:
    - adrenaline infusion \(\rightarrow\) rpt IVF bolus \(\rightarrow\) noradrenaline +/- vasopressin infusion

- Monitor Rx success: MAP, SpO2, airway pressures, EtCO2 waveform, ECHO
- Place arterial line - check ABG’s, FBC, U&Es, coags
- Consider abandoning surgery
- Once stabilised: dexamethasone 12mg \(=\) 0.6mg/kg
- Collect tryptase (yellow tube) levels at time 1, 4, 24hrs

**Grades of anaphylaxis:**

<table>
<thead>
<tr>
<th>Grade 1 = Mild</th>
<th>Grade 2 = Mod/severe</th>
<th>Grade 3 = Life threatening</th>
<th>Grade 4 = Cardiac arrest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mucocutaneous signs</td>
<td>Mucocutaneous signs (+/-) Mucocutaneous signs</td>
<td>Arrhythmias &amp; CVS collapse</td>
<td>Start IVF, adrenaline &amp; CPR!</td>
</tr>
<tr>
<td>+/- Angioedema</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bronchospasm</td>
<td></td>
<td>Severe bronchospasm</td>
<td></td>
</tr>
</tbody>
</table>

- **Consider differential** eg tension pneumothorax [tab 32d](#), auto-PEEP [tab 25d](#)

**Adrenaline** or Noradrenaline infusion (do not need CVL to start): 5mg in 50mls NSL. Infuse 1-20mls/hr \(=\) 0.15mg/kg made to 50mls with saline. Infuse 1-20mls/hr

- Salbutamol IV bolus: 250mcg \(=\) 5mcg/kg; 2-18yrs = 15mcg/kg (max 250mcg) infusion: 5mg in 50mls NSL. Infuse 1-10ml/hr \(=\) 5mcg/kg/min for 1hr then 1-2mcg/kg/min

- Vasopressin (do not need CVL to start): 20units in 20ml NSL. Bolus 1ml. Infuse 1-4ml/hr \(=\) 1unit/kg made to 50mls with saline. Bolus 2mls. Infuse 1-3ml/hr
Main priority = ↓ Myocardial O₂ consumption & ↑ myocardial O₂ supply

- Titrate inspired O₂ to normal SpO₂ 97-99% (PaO₂ 80-100mmHg)
- Check depth of anaesthesia, ensure adequate analgesia

- Control heart rate (target 60-80bpm):
  - Minimise surgical stimulation (where appropriate)
  - Drug strategies:
    - **Esmolol 20mg** boluses titrated to effect
    - **Metoprolol 2.5mg** boluses titrated to effect (max 15mg)

- Target MAP of 65-75mmHg:
  - If MAP <65mmHg:
    - Use vasopressors or ephedrine cautiously
    - If refractory ↓ MAP consider:
      - Drugs: inotrope (eg **dobutamine**) or inodilators (eg **milrinone**)
      - Cardiothoracic referral for placement of Intra-Aortic Balloon Pump
  - If MAP >75mmHg: use **GTN infusion**

- Avoid hypovolaemia - replace surgical losses & transfuse to Hb 80-90

- If ongoing signs of ischaemia commence **GTN infusion** regardless of MAP & support MAP with drugs/Intra-Aortic Balloon Pump as required

- Expedite end of surgery

Other Intra-Op Tasks to consider:
- Discuss anticoagulation with surgeon: heparin +/- aspirin, clopidogrel, enoxaparin
- ECHO to assess myocardial performance/volume status
- Further haemodynamic monitoring eg Cardiac Index Monitoring
- Take baseline Troponin, then at 3hrs or 6 hrs

Post Op Tasks to consider:
- 12 lead ECG and ongoing post-op telemetry
- Immediate cardiology referral - ?suitability for PCI

- Vasopressors - **Phenylephrine**: 50mcg bolus, **Metaraminol**: 0.5mg bolus
- **Ephedrine**: 6mg bolus. Titrate
- **Noradrenaline**: 5mg in 50ml NSL. Infuse 0-20ml/hr preferably via CVL
- **Adrenaline**: 5mg in 50ml NSL. Infuse 0-20ml/hr preferably via CVL
- **Dobutamine**: 250mg in 50ml NSL. Infuse 0-10ml/hr (can infuse peripherally)
- **Milrinone**: 10mg in 50ml NSL. Infuse at 5ml/hr or 10ml/hr only
- **GTN**: 50mg in 50ml NSL. Infuse at 1-12ml/hr titrated to MAP & ECG changes
Main priority = Volume replacement & good teamwork

- **IV access**: x2 16G cannula +/- Rapid Infusion Catheter (RIC)
- Ensure adequate surgical effort to control active bleeding (see yellow box)
- **Contact blood bank** - call for blood
- Set up rapid infusion device (+/- cell saver if available)
- **Give 3 units** O negative or group specific blood

**If ongoing or severe bleeding:**
- Activate massive transfusion protocol
- Request each box in turn and give products asap
- **Assemble a team with clear roles** (eg blood bank liaison, runner to collect boxes, blood checkers, people to hang blood etc..)

- Insert arterial line

- **Use permissive hypotension**: MAP 55-65mmHg until haemostasis established (except head injuries where MAP target = 80-90mmHg)

- Aggressively keep pt warm (>36°C): Warm fluids, warm theatre, forced air warmer

- **Check bloods** every 30mins: Coags (TEG if available), FBC, ABG, iCa²⁺

- **Use treatment thresholds** (in green box) to guide further blood product use

- **Keep ionised Ca²⁺ >1mmol/L = give 10ml 10% calcium chloride**

Other Tasks to consider:

- **Stress to surgeon the need for haemostasis** - compression, packing, direct pressure, arterial/aortic clamping

- If haemostasis achieved call blood bank to 'stand down' protocol

**Additional Treatment Thresholds & Doses:**

- Consider IV **tranexamic acid** with Box 2a - give 1g over 10mins. Then 1g over 8hrs
- **INR >1.5 or APTT >40** = give 4U **FFP**
- **Fibrinogen <1G/L = give 3U cryoprecipitate** (in obstetrics aim for fibrinogen >2G/L)
- **Platelets <75** = give 1 adult pack of platelets
- **Factor VIIa** in consultation with haematologist - 6mg (90mcg/kg)

**Blood product compatibility:**

- **Rbc’s:**

  - Patient (Recipient) | Compatible (Donor)
  - A | A, O
  - B | B, O
  - AB | A, B, AB, O
  - O | O

- **FFP:** (at any time, Rh is not relevant)

  - Patient (Recipient) | Compatible (Donor)
  - A | A, AB
  - B | B, AB
  - AB | AB
  - O | O, A, B, AB

- **Platelets/Cryo:**
  
  - in a crisis, ABO & Rh are not imp (see blood bank)
Main priority = **Restore cardio-respiratory stability**

- **100% oxygen**
- **Stop nitrous oxide**
- **Stop source** of air/gas entry:
  - Surgical site - lower to below level of heart & flood with irrigation fluid
  - Entry point - search for e.g. open venous line
  - Neurosurgery case - consider intermittent jugular venous compression
- **Place patient in head down, left lateral** position
- **Remove pneumoperitoneum** (if in use)
- **If CVL in place - aspirate line**
- **Consider chest compressions 100/min** (even if not in arrest - known to break up volumes of air)
- **Aim MAP >65mmHg:**
  - Assess fluid responsiveness - 500ml bolus crystalloid \((\text{\textbullet} = 20\text{ml/kg})\)
  - Vasoactive medications eg **noradrenaline, adrenaline, dobutamine**
- **Consider early TOE** - (useful to r/o other causes of pulmonary embolism)
- **Consider referral for hyperbaric oxygen therapy**

- **Signs of air/gas embolism:**
  - **Respiratory:** \(\downarrow\text{EtCO}_2\) (most sensitive), \(\downarrow\text{SpO}_2\), pulmonary oedema, bronchospasm
  - **CVS:** shock, tachycardia, \(\uparrow\text{PA pressures}\), cardiovascular collapse

- Use of **PEEP** is controversial. May \(\uparrow\) risk of paradoxical air embolism through PFO (note PFO is present in 10-30% of population)

- **Hyperbaric O\(_2\)** - treatment up to 6hrs post event may improve outcome in paradoxical air embolism

- **Adrenaline:**
  - bolus = 10-100mcg (0.1-1ml of 1:10,000) - \(\text{\textbullet} 0.01-0.05\text{ml/kg of 1:10,000}\)
  - Infusion = 5mg in 50mls NSL. Infuse 0-20mls/hr \(\text{\textbullet see tab 36r}\)

- **Noradrenaline infusion:** 5mg in 50mls NSL. Infuse 0-20mls/hr

- **Dobutamine infusion:** 250mg in 50ml NSL. Infuse 0-10ml/hr (can infuse peripherally)
Main priority = Early recognition & full resuscitation of ABC’s

- Stop transfusion & flush line
- Recheck blood against patient
- Minimise volatile but maintain anaesthesia

- **Resuscitate based on ABC’s:**
  - Consider early intubation
  - Treat bronchospasm if present - see tab 4e
  - Address cardiovascular instability - aim MAP >65mmHg:
    - Assess fluid responsiveness: Leg elevation +/- 500ml fluid bolus (跨20ml/kg)
    - Start **adrenaline infusion** (recommended 1st line due to diagnostic similarity with anaphylaxis)
    - Maintain urine output (aim 1ml/kg/hr) - **IV furosemide 35mg**

- Place arterial line, CVL & urinary catheter (collect urine for analysis)
- Take bloods: U&E, FBC, Coags & sample for re-X match
- Watch for **coagulopathy** & consult haematologist - Treat early see tab 12e
- Consider **IV methylprednisolone 250mg** slow injection
- Collate all blood products & return to lab
- Contact ICU

- **Signs of haemolytic transfusion reaction** (very similar to anaphylaxis):
  - **CVS:** shock, tachycardia/arrhythmias, cardiac arrest
  - **Respiratory:** Bronchospasm, wheezing, Cough/Stridor, Hypoxia, ↑airway pressure
  - **Misc:** urticaria, oedema, bleeding from wound sites/membranes, dark coloured urine

- **Consider differential** eg anaphylaxis, cardiogenic shock, etc.

- If relevant consult protocols for
  - Anaphylaxis - tab 10e
  - Bronchospasm - tab 4e
  - Severe Intraoperative haemorrhage - tab 12e

- **Adrenaline** or **Noradrenaline** infusion: 5mg in 50mls NSL. Infuse 0-20mls/hr
- **Salbutamol:**
  - bolus = 250mcg slow push (<2yrs = 5mcg/kg; <18yrs 15mcg/kg (max 250mcg)
  - infusion = 5mg in 50mls NSL. Infuse 0-10ml/hr (跨50mls of neat salbutamol. Infuse 5-10mcg/kg/min for 1 hour, then reduced to 1-2mcg/kg/min)
Main Priority: Good Quality CPR & early Intralipid

- Stop administration of LA and get LA Toxicity Box

- If signs of cardiac output:
  - Consider need for intubation
  - Ventilate if required - aim for EtCO₂ 30mmHg
  - Confirm IV access
  - Consider giving IV 20% intralipid early: bolus then infusion (see dosing below)
  - If arrhythmia use standard protocols - see tab 29d
    (Consider amiodarone 300mg slow IV push. Avoid lignocaine, caution with ßblockers)
  - Support MAP with fluids & vasopressors
  - Treat seizures:
    - midazolam IV 2mg bolus. Repeat every min (max 10mg) (see green box)
    - If refractory: perform RSI

- If cardiac arrest:
  - Start CPR (see tab 6e or tab 7e) but note:
    - Use reduced dose adrenaline (70mcg/dose) (1mcg/kg) only after intralipid
    - Be prepared to continue for 60 mins
  - Give 20% IV intralipid (see green box):
    - Bolus: 100mls. Can repeat every 5 mins, maximum twice (if required)
    - Infusion: 1000ml/hr neat intralipid. Double rate @ 5mins if no improvement
    - Do not exceed max dose of 840mls
  - Mobilise cardiopulmonary bypass/ECMO team (if available)
  - Send ABG - keep pH >7.25: Give sodium bicarbonate 8.4% 50mls (1ml/kg)
    (Can rpt every 2mins - must ensure adequate ventilation)

- Signs of LA toxicity:
  - CNS: Numb tongue, tinnitus, metallic taste, slurred speech, seizures, unconscious
  - CVS: ↓MAP, broad QRS, bradycardia deteriorating into PEA & asystole
  - Temporary pacing may be required for symptomatic bradycardias (see tab 30g)

PAEDS Dosing (see tab 8e or tab 36r for resus doses)
- Midazolam: IV 0.15mg/kg; IM 0.2mg/kg; buccal 0.5mg/kg. Can repeat at 5mins
- Intralipid 20%: bolus: 1.5ml/kg. Can rpt every 5mins x2. Infusion: 15ml/kg/hr. At 5mins can double rate if no improvement. Max cumulative dose = 12ml/kg
Main Priority: Early Recognition, Removal of Triggers, Dantrolene

- **Recognise problem** - if in doubt treat
- **Call for MH trolley** (if you prefer: distribute & follow MH task cards)
- **Delegate & organise help into teams**
- **Stop volatile** & washout with **100% oxygen at 15 litres.** Switch to **TIVA**
- **Add charcoal filters to circuit. Change soda lime if easy** (Do not waste time changing machine/circuit)
- **Give IV dantrolene** (2.5mg/kg) & **get more** from on call pharmacist:
  - 9 vials of 20mg. Reconstitute each vial into 60ml syringe with water
  - Repeat every 10mins until control achieved (max total 35vials or 10mg/kg)
- **Increase monitoring** if not already in place:
  - **Arterial line +/− CVL.** Take serial bloods: ABGs (every 30min), Coags, CK
  - **Urinary catheter.** Aim for urine output >2ml/kg/hr
  - **Core temperature probe** eg rectal or bladder
- **Treat complications:**
  - **↑>38.5°C:** refrigerated IV fluids (& intraperitoneal if surgical access), surface ice, cold operating room
  - **pH <7.2:** Ventilate EtCO₂ to 30cmH₂O (+/− sodium bicarbonate)
  - **K⁺ >7 or ECG changes:** Give **IV calcium chloride, IV insulin-dextrose infusion, salbutamol puffs**
  - **Arrhythmias:** Defibrillate. Consider **IV amiodarone +/- lignocaine +/- esmolol**
  - **MAP <65mmHg:** start **noradrenaline** infusion
- **Consider abandoning surgery & ICU referral**

**Rapid diagnosis: ABG = mixed respiratory & metabolic acidosis**

**Signs** suggesting possible MH:

<table>
<thead>
<tr>
<th>Early</th>
<th>Developing</th>
<th>Late</th>
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</thead>
<tbody>
<tr>
<td>↑EtCO₂</td>
<td>↑Temp/Sweating</td>
<td>Cola coloured urine</td>
</tr>
<tr>
<td>Masseter spasm</td>
<td>CVS instability</td>
<td>Coagulopathy, ↑↑CK</td>
</tr>
<tr>
<td>↑HR/Arrhythmia</td>
<td>↓pH, ↑K</td>
<td>Cardiac arrest</td>
</tr>
</tbody>
</table>

- **[pH<7.2]: Sodium bicarbonate** 8.4% 50mls, rpt every 2mins
- **[K⁺ >7]: Calcium chloride** 10% 10mls IV (0.2ml/kg); 10units of **actrapid** in 250mls 10% dextrose over 30mins (0.1u/kg actrapid in 2ml/kg of dextrose over 30mins); 12puffs **salbutamol** into circuit (2-6puffs) rpt every 20mins
- **[arrhythmias] Amiodarone** 300mg slow IV push (5mg/kg); 7mls **1% lignocaine** slow IV push (0.1-0.2ml/kg) (Can rpt every 10 mins - max 0.3ml/kg); **Esmolol** 10mg increments
- **[↓MAP]: Noradrenaline** infusion: 5mg in 50mls NSL. Infuse at 0-20mls/hr
17e. HYPERKALAEMIA

Main Priority: Monitor ECG & Treat

- Consider haemolysis or faulty sample & need to re-check
- Stop any source of K+ infusion. Re-check recent drug calculations
- ↑ Minute ventilation. Aim for EtCO₂ of 30mmHg
- If K+ >6.5mmol/L +/- marked ECG changes start drug therapy (see green box):
  - 10% calcium chloride 10ml slow bolus
  - Infuse quickly: 10units of actrapid in 250ml 10% dextrose
  - 6-12 puffs salbutamol into circuit. Repeat every 20mins
- If refractory high K+ consider (see green box):
  - 50mls 8.4% sodium bicarbonate (ensure adequate ventilation)
  - 20-40mg IV frusemide
  - Referral for dialysis
- Correct any reversible precipitating factors

- ECG signs of hyperkalaemia:
  - peaked T waves
  - prolonged PR
  - wide QRS
  - loss of P waves
  - ↓ R amplitude
  - asystole

- Precipitating factors to consider:
  - trauma
  - burns
  - suxamethonium use in burns, spinal injury, neurological disease
  - MH
  - acidosis
  - acute renal failure
  - organ reperfusion eg following clamp/tourniquet
  - haemolysis/massive transfusion
  - medications

- Avoid:
  - further doses of suxamethonium
  - respiratory acidosis

PAEDS Doses
- Calcium chloride 10% 0.2ml/kg
- Insulin/dextrose:
  - Periph IV: Bolus 0.1u/kg actrapid in 5ml/kg of 10% dextrose
  - Central Line: Bolus 0.1u/kg actrapid in 2ml/kg of 50% dextrose
- Salbutamol: <5yrs: 6puffs every 20mins; >5yrs: 6-12puffs every 20mins
- Sodium bicarbonate 8.4%: 1ml/kg slow push. Can repeat every 2mins
- Frusemide: 1mg/kg IV bolus
AIRWAY FIRE

Main priority = Disconnect circuit & flood with saline

- Stop ignition source - laser or diathermy
- Turn off oxygen & disconnect breathing circuit from airway device
- Extinguish fire:
  - Flood fire with saline: 50mls into mouth, 10-20mls down ETT (1ml/kg max 20mls)
  - CO₂ extinguisher (safe to use in airway)
- Remove airway device & keep for inspection
  (only consider leaving ETT in place if difficult intubation & very low risk of fire extending into ETT)
- Remove any flammable material in mouth - packs, gauze & sponges
- Retrieve debris with a Yankauer sucker or large bore suction catheter
- Convert to TIVA anaesthetic
- Restart ventilation only when fire is fully extinguished (wait 1-3min if SpO₂ allows):
  - Use bag mask ventilation initially but prepare for early intubation
  - Use lowest possible oxygen to maintain normal SpO₂
- If unable to re-intubate: perform infraglottic technique depending on urgency:
  - emergency: infraglottic technique (see tab 2e)
  - urgent: call ENT to perform tracheostomy
- Terminate or expedite end of surgery
- Post crisis care:
  - Perform bronchoscopic exam to assess mucosal airway damage
  - Do not extubate; refer to ICU

PATIENT FIRE

Main priority = Recognise fire and extinguish

- Stop any flow of oxygen or nitrous near/into to fire
- Remove all drapes and flammable material from patient
- Extinguish fire with:
  - Saline, fire blanket or CO₂ extinguisher (safe in wounds & electrical equipment)
  - Do not use alcohol liquids
  - Do not use any liquid on/around electrical equipment
- If fire persists: activate fire alarm, turn off gas supply to room, evacuate

To decrease risk of airway fire:
- Use lowest possible oxygen, avoid nitrous
- Place saline in ET & LMA cuffs
- Pack wet throat pack around ETT’s
- If LASER surgery: use LASER resistant ETT with methylene blue in proximal cuff, saline in distal cuff

To decrease risk of patient fire:
- Allow time for skin preps to fully dry
- Use moistened sponges & gauzes near ignition sources
**Main Priority: Good CPR, Diagnose Cause, Prepare for Delivery**

- Review all infusions/medications recently administered
- **Activate MTP** now. Start volume resuscitation asap (See tab 12e)
- **If no cardiac output:**
  - Call 777 & declare ‘MET call + obstetric & neonatal emergency’
  - Start preparations to deliver baby **now** (peri-mortem Caesarean or instrumental)
  - Remove all foetal monitoring
  - Start CPR > apply **defib** > check rhythm > see tab 6e or tab 7e
  - Ensure IV access, if none consider IO access
  - Consider reversible causes & attempt diagnosis & treat asap (see yellow box)

- Note ‘maternal’ specific tasks during CPR:
  - Lift uterus skyward & displace to left
  - Intubate early & ventilate with EtCO₂ target of 30mmHg
  - Perform chest **compressions higher** on chest & push deeper
  - Patient >24 weeks: If no rapid ROSC then start immediate preparations to deliver baby within 5mins (peri-mortem Caesarean or instrumental)

- **if Peri or Post Arrest:**
  - Start standard peri-arrest care. Supporting ABC’s as appropriate (intubate early)
  - Consider reversible causes & attempt diagnosis & treat asap (see yellow box)
  - Ensure ongoing lifting of uterus skyward & displaced to left (if baby not delivered)

- **Delivery of baby** is performed to improve maternal prognosis, not babies
  - Consider the reversible causes of collapse in pregnancy (Ts & Hs):
    - Hypoxia: aspiration, high spinal
    - Hypovolaemia/hypotension: bleeding, high spinal
    - Metabolic disorders: AKI from severe pre-eclampsia, ↓BSL
    - Hypertension: intracranial haemorrhage, eclamptic seizure
    - Toxicity: Anaphylaxis, ↑Mg²⁺, LA toxicity, eclampsia/seizures
    - Thromboembolism: VTE/PE, amniotic fluid or air embolism
    - Tamponade: cardiac 2nd to aortic dissection, trauma
    - Tension PTX: trauma

- **Magnesium** (49.3%) [eclampsia]:
  - loading infusion: 8mls in 100ml NSL. Infuse at 300ml/hr to complete
  - For maintenance & rescue doses see tab 23e
- **Calcium chloride 10%** [MgSO₄ toxicity antidote]: 5mls slow push. (can repeat)
- **20% Intralipid** [LA toxicity]: (max total 12ml/kg)
  - bolus: 100mls (1.5ml/kg). Repeat (max twice) every 5 mins, if required
  - maintenance: 1000ml/hr (15ml/kg/hr). Double speed @5mins if no improvement
- **Alteplase** [Thrombosis]: 100mg in 20mls NSL. Infuse at 80ml/hr (be prepared for prolonged CPR - upto 60mins)
  - [To reverse]: Stop infusion. Give **1g tranexamic acid**. Discuss with haematologist (cryo +/- platelets)
Main Priority: **Dry baby, Oxygenate & Reassess every 30secs**

- Pre-setup neopuff: Gas supply @10L, PEEP 5, PIP 30cmH₂O. Heater & suction
- In 1st minute: **Vigorously dry** baby & apply warm, dry towels
- Then work in **30 sec cycles**. Perform intervention then reassess at end of cycle:
  - **Tone** - UL & LL
  - **HR** - use SpO₂ probe or stethoscope (tap beats out +/- count beats for 3secs, then x 20)
  - **RR** - Are they gasping or apnoeic?

- **If HR >100, good tone, regular RR:** give routine care
- **If baby well except ↑WOB:** give 5 cmH₂O CPAP with room air
- **If any of HR <100, poor tone, gasping/apnoeic:** start ventilating:
  - Fine tuning of neutral head position with jaw thrust is vital
  - Room air initially. ↑O₂ every 30 secs if no improvement: 40% then 100%
  - consider x5 inflation breaths of 2-3 sec: PIP 30cmH₂O
  - Once adequate **chest rise**: RR 40-60/min: PIP 15-20cmH₂O

- **If HR <60:**
  - 100% O₂. Consider LMA or intubation (if skilled)
  - Start chest compressions @ 90/min (2 thumb technique with 2nd person for airway is preferred)
  - Use ratio = **compressions 3 : 1 breath** (half second compression pause to deliver breath)

- **If Ongoing HR <60:**
  - Give **1:10,000 adrenaline** based on gestation
  - **Umbilical venous catheter** is preferred (1 vein, 2 arteries)

<table>
<thead>
<tr>
<th>23-26 Weeks</th>
<th>27-37 Weeks</th>
<th>38-43 Weeks</th>
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<tbody>
<tr>
<td>Umbilical Adrenaline</td>
<td>0.1 ml</td>
<td>0.25 ml</td>
</tr>
<tr>
<td>ETT Adrenaline</td>
<td>1ml/kg (100mcg/kg) then 2ml normal saline flush</td>
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- Consider umbilical **saline bolus** 10ml/kg

- If **preterm** use lower inflation pressures: 28-32wks = 25/5; <28wks = 20/5
- Significant **meconium** delivery: Only suction a flat baby prior to oxygenating
- Place NG to decompress stomach if difficulty ventilating
- Assistant can place SpO₂ probe on right arm at any point. **Targets:**
  - 1min = 60-70%
  - 2min = 65-85%
  - 3min = 70-90%
  - 4min = 75-90%
  - 5min = 80-90%
  - 10min = 85-90%

**Neonatal Drugs & Equipment** *(see tab 9e)*
- **Naloxone:** Full term = 200mcg IM (otherwise 10mcg/kg IM/IV)
- ETT: uncuffed size = [term] 3-3.5mm, [preterm] 2.5mm (have size above & below to hand); length 10cm
Main Priority: Rapid management of ABC’s

- If on **delivery suite**: Call 777 & declare “obstetric & neonatal emergency”
- Review all infusions/medications & consider reversible causes (yellow box below)

- **If no cardiac output:**
  - Start CPR > apply *defib* > check rhythm - see tab 6e or tab 7e
  - If obstetrics, follow ‘maternal’ specific tasks:
    - Lift uterus skyward & displace to left
    - **Intubate early** & ventilate with EtCO2 target of 30mmHg
    - Perform chest **compressions higher** on chest & **push deeper**
    - Patient >24 weeks: If **no rapid ROSC** then start **immediate** preparations to deliver **baby** within 5mins (peri-memortem Caesarean or instrumental)
  - Note ‘**total spinal**’ specific tasks:
    - Give **adrenaline 1mg** (10ml 1:10,000) (20mcg/kg) asap
    - Early rapid infusion of 2-3 litres of **fluid** (20ml/kg)

- **If respiratory arrest or distress or falling SpO2:**
  - Elevate head of bed to 30 degrees
  - Assist ventilation with 100% O2 via BMV while preparing to RSI
  - Consider induction with **midazolam 5-10mg, alfentanil 1mg & sux 100mg**

- **If cardiovascularly unstable (↓HR & ↓MAP):**
  - **Elevate** legs, rapidly infuse 2-3 litres fluid (20ml/kg)
  - If obstetrics, **lift uterus** skyward & displace to left
  - If HR <60 then give **600mcg atropine** (20mcg/kg). Repeat if required (max adult 3mg)
  - Give **vasopressor** (see below) depending on HR. Repeat as required.
  - Refractory ↓MAP: use **adrenaline boluses +/- infusion**

- **Diagnosis is clear if witnessed rapidly ascending block following neuraxial procedure**
- If unwitnessed collapse consider **other causes** (if obstetrics see tab 19e):  
  - Vasovagal
  - Haemorrhage (external or concealed)  
  - LA Toxicity tab 15e  
  - Amniotic Fluid Embolism tab 24e  
  - Mg toxicity
  - IVC compression
  - Massive pulmonary embolus
  - Drug error

- **Vasopressor:** *phenylepherine* 100mcg (10mcg/kg); *metaraminol* 1mg (10mcg/kg);  
  - **epinephrine** 9mg (0.1mg/kg)
- **Adrenaline** - bolus: 0.1-0.5ml 1:10,000 (10-50mcg); infusion: 5mg in 50mls NSL. Infuse at 0-20mls/hr (infusion only: 0.15mg/kg (max 5mg) in 50mls NSL. Infuse 0.5-10ml/hr)
Main Priority: Prepare for Massive, Rapid Blood Loss

- **x2 16G IV** cannula - consider intraosseous access if needed
- Encourage **surgical control** of uterine tone & bleeding (see yellow box)
- Review with surgeon every 10mins: diagnosis & plan (see yellow box)
- Rapidly infuse crystalloid to match blood loss

**If ongoing severe blood loss:**
- Call blood bank & rapidly transfuse up to **3 units of blood**
- If required activate **massive transfusion protocol** (see tab 22e)
- Note **obstetric specific MTP actions:**
  - If fibrinogen level <2 then give **3 units cryoprecipitate**
  - Give **1g tranexamic acid** slow push asap. Can repeat after 30mins

**If out of theatre:** call 777 declare an “**obstetric emergency**”

- Use **vasopressors** to maintain a MAP >65mmHg
- Aggressively keep pt **warm** (>36°C): Warm fluids, warm theatre, forced air warmer

- Use **oxytocics** to address uterine atony:
  - **Oxytocin IV 5 units slow push.** Follow with **infusion** (see green box)
  - **Ergometrine 500mcg IM** (avoid if ↑MAP)
  - **Carboprost 250mcg IM** (avoid if asthmatic). Can repeat every 15mins (max 8 doses)
  - **Misoprostol 1000mcg PR/vaginal**

- Perform **RSI** to enable surgical control (spinal only if haemodynamically normal). Consider:
  - Induction: **Ketamine 100mg** (1-2mg/kg), **suxamethonium 100mg**
  - Maintenance: **TIVA** or **volatile/nitrous**

- Place arterial line +/- CVL

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- **Major causes of PPH:**
  - Tone (75%)
  - Tissue/Retained placenta (15%)
  - Trauma/Laceration (5-10%)
  - Thrombosis/Coagulopathy
  - Splenic artery rupture (rare)

- **Surgical control** of bleeding can include:
  - Pre-theatre: Uterine massage, bimanual compression, aortal compression
  - Intra-op: BAKRI balloon, B Lynch suture, aortal compression, artery ligation, hysterectomy

---

- **Oxytocin** infusion: 40units in 250ml NSL. Infuse at 62.5ml/hr
- Vasopressors: **Metaraminol** 1mg; **phenylepherine** 100mcg, **Adrenaline**: 10-100mcg & titrate
- **Adrenaline/Noradrenaline** Infusion: 5mg in 50mls NSL. Infuse at 10-20ml/hr preferably via CVL
Main Priority: Oxygenation, Magnesium & Treating Hypertension

☐ Call 777 & state “obstetric emergency”
☐ Call for eclampsia box
☐ Give $O_2$ 15L/min via non-rebreathe facemask
☐ Apply monitoring: $SpO_2$, ECG, NIBP
☐ Start timer: Measure length of seizure (eclamptic seizures normally self terminate)
☐ Maximise patient safety while displacing gravid uterus (if antenatal):
  - Pillows & covered bed sides
  - Depending on staff safety: Lift uterus up & to left or place in full left lateral

☐ Prepare and give Magnesium (49.3%) asap:
  - Loading dose: IV 8mls in 100mls NSL. Infuse at 300mls/hr to completion.
    (If no IV then give 10mls IM into each gluteal region (total 20mls))
  - Then Maintenance infusion (see green box)
  - If repeat seizure give rescue dose (see green box)

☐ If ongoing seizures or seizure lasting >10mins: then escalate treatment:
  - give Midazolam IV 2mg bolus, repeat every minute (max 10mg)
    (if no IV then use high concentration 5mg/ml midazolam: Nasal: 2ml via atomiser or IM: 2ml into deltoid)
  - perform RSI & refer to ICU

☐ Post seizure:
  - Review A, B, C & check blood sugar level
  - Send blood tests (FBC, LFTs, U&Es, uric acid, coag screen, Mg, G&H)
  - Consider chance of aspiration: $SpO_2$, auscultate chest, perform chest XR (if needed)
  - If $bp >160/100$mmHg then consider one or both:
    - Labetalol IV (neat=5mg/ml): 4ml over 2mins. Repeat every 10 mins (max 3 doses)
    - Hydralazine IV (neat=1mg/ml): Give 5ml slow push. Repeat every 20min
  - Restrict total fluid input to 80mls/hr & monitor hourly urine with catheter

☐ If antenatal: Discuss with obstetric team: Plan for delivery of baby
☐ Consider other causes of seizure other than eclampsia: discuss with neurologists

- Check reflexes, sedation score & vitals: Initially every 30min, then hourly
- Serum magnesium levels are only needed if concurrent renal dysfunction:
  - Therapeutic Mg$^{2+}$ level = 2-4mmol/L
  - Send yellow top 1 hour after start of maintenance dose. Rpt levels every 4 hrs if concern
- If concern over magnesium toxicity: Stop infusion & give calcium chloride 10% 5mls IV push

- Magnesium (49.3%):
  - Maintenance: add 25mls (5 vials) to 100mls NSL. Infuse at 10mls/hr for 24hrs
  - Rescue (i.e. another seizure): 4mls with 6mls NSL. Infuse at 120ml/hr (5mins)
- Labetalol infusion: Make 200mg up to 200mls with NSL. Infuse at 20ml/hr. Double rate 30mins (max 160ml/hr)
- Hydralazine infusion (neat=1mg/ml): Start infusion at 5ml/hr. Change rate every 30mins (max 18ml/hr)
Amniotic fluid embolism is rare, but life threatening. Always consider it in your differential.

- **System & Signs**
  - **General**: Restless, anxious, chest pain, vomiting
  - **Respiratory**: Hypoxia, bronchospasm, pulmonary oedema, ARDS
  - **Cardiovascular**: Hypotension, chest pain, cardiac arrest
  - **Neurological**: Headaches, seizure, loss of consciousness
  - **Fetus**: Acute bradycardia

- **Lab/Investigation Findings**
  - Pulmonary hypertension
  - Right heart strain
  - Coagulopathy
  - DIC

- **Main Priority: Recognition & Aggressive Resuscitation**
  - Get senior help or call 777 & declare an “obstetric +/- neonatal emergency”
  - For all patients: Start treatment for haemorrhage & coagulopathy (see tab 12e):
    - Activate MTP now & give **O negative blood** until MTP boxes arrive
    - Call for & give empirically **3 units cryoprecipitate** asap
    - Consider early **tranexamic acid: 1g over 10min**, then 1g over 8hrs
    - Send urgent blood tests including FBC, coagulation studies, TEG (if available)
  - If no cardiac output: Start CPR & consider reversible causes - see tab 6e / tab 7e
    - If antenatal perform maternal specific CPR tasks:
      - Removal all foetal monitoring
      - Lift uterus skyward & displace to left
      - Intubate early & ventilate with EtCO₂ target of <30mmHg
      - Perform chest **compressions higher** on chest & push deeper
      - If no rapid ROSC then start immediate preparations to deliver baby within 5mins
  - If signs of cardiac output: then start resuscitation:
    - Ensure patent airway. Consider **early intubation**
    - Address **oxygenation**: High flow oxygen, BiPAP, CPAP or high PEEP
    - Give **blood & products** as MTP. Use **vasopressors** or **inotropes** as required
    - Perform early **ECHO** (Any signs of right heart dysfunction or pulmonary hypertension?)
  - Discuss with obstetricians:
    - If antenatal: urgent delivery of baby
    - Rule out sources of haemorrhage (eg placenta, uterine rupture or tone, trauma)
    - Possibility of hysterectomy if controllable bleeding
  - Refer to ICU early (drugs & monitoring for pulmonary hypertension may be required)

- **Amniotic fluid embolism** is rare, but life threatening. Always consider it in your differential.
- **The following** features are suggestive of AFE:
  - sudden agitation e.g. non compliance, pulling out drips etc.
  - symptoms with no clear other explanation
  - peri-partum onset: during labour, delivery or within 30mins of baby delivery

- **[Bolus]:** metaraminol 1mg; phenylepherine 100mcg, ephedrine 9mg, adrenaline 10-50mcg
- **[Infusions]:** noradrenaline/adrenaline infusion: 5mg in 50mls. infuse 0-20ml/hr
Anaesthetic Crisis Handbook

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For Nichola. Thank you for your never-ending support and patience.

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Many other thanks to excellent colleagues who contributed to this manual. Without their suggestions, improvements, fact & error checking & so on, it wouldn't have been possible.

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Disclaimer: Every effort has been taken to prevent errors/omissions/mistakes. However, this cannot be guaranteed. Graded assertiveness to query team leader decisions/management steps which are contrary to this manual are encouraged. However, clinical experience & acumen are vital in complex situations such as crises and may be more appropriate than this manual in certain situations.
Anaesthetic Crisis Handbook

For every problem:

• **Verbalise** the problem. Say out loud....
  ‘We have a **problem**, I am **concerned**’

• Call for **HELP** early

• **Set oxygen to 100%** (except where stated otherwise)

• Identify a ‘**hands off**’ **Team Coordinator**

• **Delegate duties** to **specific** team members

• Use **closed loop**, quiet & efficient **communication**

• Use the **indexed pages & coloured boxes** in this manual to **assist you**

Created by Adam Hollingworth
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Adapted from various sources including:
• Guidelines: ANZAAG, AAGBI, NZRC, Starship Protocols
• Hutt Valley & CC DHB: Clinical protocols
• ESA Emergency Quick Reference Guide
• CCDHB Crisis Checklists. Dr A McKenzie
• Emergencies in Anaesthesia. Oxford Handbook
• Wellington ICU Drug Manual. Dr A Psirides & Dr P Young
• Various Published Peer Reviews Papers
Instructions for Use

• Use the **index** and **coloured tabs** to find quick reference pages to assist in a crisis.

• The **handbook is in 2 parts:**
  • The front book: How to treat known **Emergencies**
  • The back book: How to **Diagnose** Problems

• **Routine/obvious tasks** (eg call for help, turn oxygen to 100%) are assumed & thus **not** repeated on every sheet for clarity

• For simplicity & to avoid calculation errors in an emergency, drug doses are given for a 70Kg adult. Paeds doses are clearly marked where appropriate.

• There is an adult & paediatric drug formulary at the back
  - Emergency/Doing tasks
  - Thinking tasks, diagnostic or further information
  - Doses, equipment or calculation information

• Cards are arranged into coloured boxes:
• Work through emergency/doing boxes in a linear fashion. Decision making steps are **highlighted** for clarity.

Using an aid such as this efficiently, in a crisis, is a **learned** skill. You must take time to become **familiar** with this manual and **practise** using it.

It is recommended that a ‘**reader**’, with no other tasks, **read these cards out loud** to the team leader during the crisis.
Listen to chest. Watch for bilateral chest rise & fall

Switch to bag - manually ventilate to confirm high pressure

Examine EtCO₂ waveform - ?bronchospasm ?kinked ETT

Exclude light anaesthesia & inadequate muscle relaxation

Perform a systematic visual check:
  * airway device (inside & outside mouth) ⇒ filter ⇒ circuit ⇒ valves ⇒ ventilator

Check airway - the position & patency - suction full length of ETT
(Consider performing bronchoscopic exam)

If suspect autoPEEP watch for persistent expiratory flow at end expiration. Try disconnecting circuit.

If problem not identified need to exclude circuit > filter > airway > patient source:
  * Exclude circuit: replace circuit with Ambu-bag (if required convert to TIVA)
  * Exclude filter: replace or remove
  * Exclude airway: replace ETT. If using LMA convert to ETT
  * Not resolved = patient problem

Consider timing of event eg CVL insertion, position change, surgical event

Possible causes (most common in bold):

**Circuit:**
  - ventilator settings
  - kinked tube
  - valve failures
  - obstructed filter
  - O₂ flush failure

**Airway:**
  - laryngospasm
  - tube position
  - tube size
  - blocked or kinked tube

**Patient:**
  - chest wall rigidity
  - bronchospasm
  - anaphylaxis
  - pneumothorax
  - pneumoperitoneum
  - tracheal problems/pathology:
    * FB
    * secretions
    * tumour
  - obesity
  - alveolar problems/pathology:
    * oedema
    * infections
    * ARDS
    * contusion
Check FiO₂ & turn to 100% O₂
Check patient colour, peripheral temperature & probe position
Switch to bag to test circuit integrity & lung compliance
Check the SpO₂ & EtCO₂ waveforms to aid systematic diagnosis:

- **If EtCO₂ waveform abnormal or absent:**
  - Exclude: disconnected circuit, cardiac arrest, ↓ cardiac output
  - Consider laryngospasm or bronchospasm (if LMA convert to ETT)
  - **Check airway** position & patency:
    - Visualise cords = r/o oesophageal ETT
    - Suction full length of ETT (consider performing bronchoscopic exam)
    - Look inside mouth for kinks/gastric contents
  - Check ventilator mode & setting
  - Ventilate via Ambu-bag to exclude ventilator/circuit/probe problem

- **If EtCO₂ waveform normal:** (∴ intact circuit integrity):
  - Check fresh gas flow / FiO₂
  - Exclude endobronchial ETT
  - Inspect neck veins, chest rise & auscultate. Use ultrasound (if skilled)
  - Consider airway, lung/breathing, circulation causes (see yellow box)

Work through diagnostic checklist below to exclude all other causes

- Consider timing of event eg position change, surgical event
- **Possible causes** (most common in bold):
  - **Airway:**
    - airway obstruction
    - laryngospasm
    - bronchospasm
    - endobronchial intubation
    - 1 lung ventilation
    - aspiration
  - **Lungs/Breathing:**
    - apnoea/hypoventilation
    - atelectasis
    - pneumothorax
    - sepsis/ARDS
    - pulmonary oedema
    - contusion
    - pneumonia
    - interstitial lung disease
  - **Ventilator/Circuit/Probe:**
    - probe displacement
    - inadequate reversal
    - mal: function/setting
    - auto-PEEP
    - low fresh gas flow
    - oxygen supply failure
    - circuit obstruction/ disconnection
  - **Circulation:**
    - cardiac arrest
    - cardiac failure
    - anaphylaxis
    - embolism: pulmonary, air, CO₂, cement
    - hypothermia/poor periph circulation
    - methaemoglobinaemia e.g. prilocaine
Quick check patient monitors: ?oxygenated & anaesthetised patient:

- **Anaesthetist’s** A Airway \(\text{EtCO}_2\), B \(\text{SpO}_2\), C HR, D Vent Settings, E MAP, Depth of anaesthesia, Temp

This is generally not a crisis. Use the time to consider the causes

**Frequency gamble:**

- Check monitors & ventilator:
  - **\(\text{EtCO}_2\) waveform**
  - **Fresh Gas Flow** - correct for circuit type, size of patient
  - **Ventilator** settings & mode - Resp rate, Tidal volume
- Check **soda lime** ?exhausted
- Review:
  - Anaesthetic **depth**
  - Recent **drug doses** for errors

**Systematically** work through all causes (see below)

Consider timing of event eg drug administration, surgical event

**Possible causes** (most common in bold):

**↑Production**

- **Endogenous**:
  - sepsis/↑temp
  - MH
  - thyroid storm
  - malignant neuroleptic syndrome
  - reperfusion

- **Exogenous**:
  - \(\text{CO}_2\) insufflation
  - bicarb administration

**↓Elimination**

- **Lungs**:
  - hypoventilation
  - bronchospasm/asthma
  - COPD

- **Circuit/machine**:
  - ↓Fresh Gas Flow/re-breathing
  - incorrect vent settings
  - soda lime exhaustion
  - airway obstruction
  - ↑dead space
  - valve malfunction
28d. LOW EtCO₂

Quick check patient monitors: ?oxygenated & anaesthetised patient:
- Anaesthetist’s A Airway EtCO₂, B SpO₂, C Vent Settings, D Map, E Depth of anaesthesia, F Temp

If **no EtCO₂ waveform** diagnose immediately:
- Cardiac arrest - see tab 6e or tab 7e
- Incorrect ETT placement - if in doubt replace
- Check circuit & CO₂ sample line connections

If **low EtCO₂** then first frequency gamble:
- Check sampling line - securely connected & patent
- Check MAP
- Examine patient:
  - Airway position & patency
  - Auscultate & ensure bilateral chest rise - (r/o laryngospasm/bronchospasm)
- Check ventilator:
  - Switched on & functioning
  - Correct settings: tidal volume, RR

If **problem not identified** work through causes **systematically** (see yellow box)

- Consider timing of event e.g. post intubation, drug administration, surgical event
- **Possible causes** (most common in bold):
  - **NO EtCO₂!!:**
    - oesophageal intubation
    - no ventilation, no airway
    - cardiac arrest
    - circuit/sampling line disconnection
    - ventilator failure or not on
    - apnoea
  - **↓ Production:**
    - hypothermia
    - deep anaesthesia
    - ↓ thyroid
  - **Sampling dilution:**
    - high FGF
    - sampler placed incorrectly
    - dilution of sampling gas with air
    - circuit disconnected
  - **↓ Elimination:**
    - hyperventilation
  - **↓ Transport of CO₂ in blood:**
    - severe hypotension
    - anaphylaxis
    - cardiac arrest
    - embolism - air or pulmonary
    - tamponade/tension pneumothorax
  - **↓ CO₂ diffusion in lung:**
    - low tidal volumes/dead space
    - laryngospasm
    - severe bronchospasm
    - ETT obstruction
    - endobronchial intubation
Check patient monitors: is the patient oxygenated & anaesthetised?:

- Anaesthetist’s A, Airway, E, EtCO2, B, SpO2, C, Vent Settings, D, HR, MAP, E, Temp

If there is diagnostic uncertainty & MAP <65 with HR >150 then give synchronised DC shock (see yellow box for joules)

Differentiate sinus tachycardia & complex tachy-arrhythmia:
- current surgical/pain stimulation
- sinus rhythm?
- QRS regularity?
- QRS width?

If sinus tachycardia consider causes (see yellow box below)

If complex tachy-arrhythmia treat based on MAP:
- MAP <65mmHg = synchronised DC shock (see yellow box for joules)
- MAP >65mmHg = manage by regularity & QRS width:

  - Regular:
    - Narrow: [SVT] vagal manoeuvres, adenosine, β blocker
    - Wide:
      - [VT] amiodarone
      - [SVT with aberrancy] see narrow
      - [WPW] amiodarone
  - Irregular:
    - Narrow: [AF] β blocker or amiodarone
    - Wide:
      - [torsades] magnesium
      - [AF with pre-excitation] amiodarone
      - [AF with aberrancy] see narrow

Send urgent ABG. Ensure high normal K+ & Mg2+

Consider timing of event eg drug administration, surgical event etc.

Possible causes of sinus tachycardia (most common in bold):

- Primary causes:
  - IHD
  - cardiomyopathy
  - sick sinus syndrome
  - accessory conduction pathways
  - myocarditis
  - pericarditis
  - valvular disease
  - congenital heart disease

- Secondary causes:
  - hypovolaemia
  - anaesthesia depth
  - drugs - incl drug error
  - pain
  - electrolyte abnormalities
  - cardiac tamponade
  - sepsis
  - thyroid storm
  - MH

Synchronised shock guides:
- AF/monomorphic VT: 100J ⇒ 150J ⇒ 200J (0.5J/kg ⇒ 1J/kg ⇒ 2J/kg)
- SVT or flutter: 50J ⇒ 100J ⇒ 200J (0.5J/kg ⇒ 1J/kg ⇒ 2J/kg)
- polymorphic VT or unstable: 200J (4J/kg)

Adenosine: 6mg, then 12mg, then 12mg then consider other causes (0.1mg/kg⇒0.2mg/kg,0.3mg/kg)

β blocker: Esmolol 10mg titrated. Metoprolol 2.5mg boluses titrated (max 15mg)

Amiodarone: 300mg slow IV push (5mg/kg)

Magnesium: [torsades] 10mmol (5ml of 49.3%) over 2mins (0.1ml/kg). (Give slower for other causes)
**30d. BRADYCARDIA**

- **Quick check patient monitors:** is the patient oxygenated & anaesthetised?:
  - Anaesthetist’s A Airway, B ECG, C SpO₂, D Vent Settings, E MAP, F Depth of anaesthesia, G Temp

- **If MAP >65mmHg** you have time (see causes listed in yellow box below):
  - Frequency gamble common causes
  - Systematically work through all causes

- **If MAP <65mmHg +/- with evidence of ↓ perfusion** then consider:
  - **Atropine 600mcg** (∆ = 20mcg/kg) or **glycopyrrolate 200mcg** (∆ = 10mcg/kg)
  - **Ephedrine 9mg** bolus titrated (∆ = 0.1 mg/kg)
  - **Adrenaline** infusion (∆ = see green box)
  - **Isoprenaline bolus**, followed by infusion (∆ = see green box)

- **If drug toxicity or overdose:**
  - βblocker = as above + **high dose insulin** infusion, Na bicarb (if propanolol OD)
  - Ca channel = as βblocker + **10mls 10% Ca chloride** slow push (can repeat)

- **If severe refractory bradycardia** try external temporary pacing:
  - attach defib & ECG leads
  - set to PACER mode
  - select rate 60/min
  - ↑ mA of output until capture (normally 65-100mA required)
  - set final mA 10mA above capture
  - confirm pulse

- **If PEA at any point** start CPR - see tab 7e

- Consider timing of event eg drug administration, surgical event
- **Possible causes** (most common in **bold**):
  - **Primary causes:**
    - IHD
    - AV block
    - pacemaker malfunction
    - cardiomyopathy
    - sick sinus syndrome
    - myocarditis
    - pericarditis
    - valvular heart disease
    - pulmonary HTN
    - athlete
  - **Secondary causes:**
    - electrolyte abnormality
    - **drugs** eg error, overdose, anti-arrhythmics
    - ↓ thyroid
    - ↓ temperature
    - **vagal stimulation**
    - ↑ ICP
    - cardiac tamponade
    - tension pneumothorax
  - **Anaesthetic causes:**
    - hypoxia
    - volatile
    - suxamethonium
    - opioids
    - anticholinesterases
    - vasopressors
    - auto-PEEP
    - MH
    - high/total spinal
    - ↑ ↓ K+

- **For paediatric normal heart rates see** tab 9e

- **Isoprenaline**: bolus: dilute 200mcg amp into 20mls then give 1ml boluses titrated (∆ = use infusion – see tab 36). Infusion: dilute 1mg (5vials) into 50mls. Infuse at 0-60mls/hr
- **Adrenaline**: 5mg in 50mls NSL. Infuse at 0-20ml/hr (see tab 36)
- **Na bicarb 8.4%** (β blocker OD): 50ml slow push. Can rpt every 2mins (target pH 7.45-7.55)
- **High dose insulin** [β blocker/CCB OD]: Bolus= 50ml of 50% dextrose & 70u actrapid. Infusion= 100u actrapid in 50mls NSL, run at 35ml/hr and 10% dex run at 250mls/hr (Monitor BSL & K every 30mins)
**31d. HYPERTENSION**

- **Quick check patient monitors:** is the patient oxygenated & anaesthetised?
  - Anaesthetist’s A, B, C, D, E

- **Check accuracy** of reading: check equipment (including transducer height)

- **Frequency gamble on common causes:**
  - Check for painful surgical activity - give analgesia
  - Check recent drug infusions & recent doses for drug error (incl LA with adrenaline)
  - Check tourniquet time
  - Consider bladder volume/fluids infused

- **Systematically work** through possible causes (see yellow box)

- Once all reversible causes have been addressed then consider IV antihypertensive agents (as green box below) to SBP target of ~160mmHg

- Consider timing of event eg drug administration, surgical event

- **Possible causes** (most common in bold):
  - **Anaesthesia:**
    - too light
    - pain
    - hypoxia
    - hypercapnia
    - MH
    - **drugs** - consider error
    - IV line - non-patent/tissued
    - A line transducer height
  - **Patient related:**
    - essential HTN
    - rebound HTN - B blocker stopped
    - full bladder
    - pre-eclampsia
    - renal disease
    - phaeochromocytoma (always give a blocker before β blocker)
    - thyroid storm
    - ↑ICP
  - **Surgery:**
    - tourniquet
    - aortic clamping
    - carotid endarterectomy
    - baroreceptor stimulation
    - pneumoperitoneum

- **β Blocker** = esmolol: 10mg boluses titrated; metoprolol: 2.5mg boluses titrated (max 15mg)
- **α Blocker** = labetalol (also β blocker): 5mg boluses titrated (max 100mg). phentolamine: 5-10mg IV rpt’ed every 5-15mins
- **α Agonists** = clonidine: 30mcg boluses titrated (max 150mcg)
- **vasodilators** = GTN: S/L spray or IV infusion: 50mg in 50ml NSL at 3ml/hr and titrate; magnesium: slow bolus 5mls of 49.3%, repeat if required
32d. HYPOTENSION

☐ Check patient monitors: is the patient oxygenated & anaesthetised?:
  - Anaesthetist’s A Airway ETCO₂, B SpO₂, C Vent Settings, D MAP, E Temp

☐ Check accuracy of reading: check equipment (including transducer height)

☐ Assess severity: visualise patient, check ECG & EtCO₂:SpO₂ waveform:
  - No cardiac output or critical MAP: start CPR - see tab 6e or tab 7e
  - MAP <65mmHg & concern then consider:
    - Leg elevation
    - Rapid infusion of fluid +/- ready to transfuse blood (see tab 12e)
    - IV vasopressors or inotropes

☐ Consider reversible causes:
  - Frequency gamble on common causes
  - Systematically consider each cause in turn

☐ Consider:
  - ECHO (if skilled) to help differentiate causes
  - Other invasive monitoring to assist with diagnosis e.g. PPV SVV from arterial line, cardiac index monitoring

- Consider timing of event e.g. drug administration, surgical event, scope surgery (always suspect concealed haemorrhage)

- Possible causes (most common in bold):
  - ↓Preload:
    - blood loss/hypovolaemia
    - ↑ intrathoracic pressure
    - ↓VR - eg IVC compression, pt position, pneumoperitoneum
    - tamponade/tension pneumothorax
    - embolism
  - ↓Contractility:
    - drugs incl. volatiles
    - IHD
    - cardiomyopathy
    - myocarditis
    - arrhythmia
    - valvular heart disease
  - ↓Afterload:
    - drugs eg vasodilators incl anaesthetic agents, opioids, antiHTN drugs
    - neuraxial techniques
    - sepsis
    - tourniquet or clamp release
    - anaphylaxis
    - addisons crisis
    - ↓thyroid
  - Equipment/human:
    - artefact or failure
    - Invasive: wrong transducer height
    - NIBP: wrong cuff size
    - drug error

- ECHO: Consider LVEDV, LV function, gross valvular abnormality
- PPV SVV: >12% (only if: intubated, paralysed, Vt >8ml/kg, in sinus rhythm, norm abdo pressure) Suggests hypovolaemia
- Normal CI = >2.6 L/min/m²
- Pressors: metaraminol 1mg (‡ 10mcg/kg), phenylepherine 100mcg, ephedrine 9mg (‡ 0.1mg/kg), adrenaline 10-50mcg
  - noradrenaline/adrenaline infusion: 5mg in 50mls. infuse 0-20ml/hr
33d. FAILURE TO WAKE

☐ This is generally not a crisis. Use the time to consider the causes

☐ Airway: ensure patent unobstructed airway

☐ Breathing:
  • Ensure established respiratory pattern
  • Check SpO₂
  • Check EtCO₂ trace and value

☐ Cardiovascular: Ensure normal HR, MAP and ECG

☐ Drugs: Review all drugs given during anaesthetic:
  • Check muscle relaxation with nerve stimulator. Give reversal agent (see green box)
  • Consider timing and infusions of all agents
  • Consider drug errors
  • Consider drug interactions
  • Consider patient factors e.g. renal/hepatic failure, elderly

☐ Others:
  • Neurological:
    - check pupils
    - apply BIS for signs of seizure (frontal lobe seizure only)
    - consider need for CT
  • Metabolic: send an ABG - check PaO₂, PaCO₂, Na, glucose
  • Temperature: ensure >30°

☐ Systematically work through all causes (see below)

- Possible causes (most common in bold):

  Drugs:
  • analgesic agents e.g. opioids, α₂ agonists
  • anaesthetic agents e.g. volatile, propofol
  • muscle relaxants e.g. suxamethonium apnoea, inadequate reversal
  • sedative agents e.g. benzodiazepines, anticholinergics, antihistamines, antidepressinergics
  • magnesium toxicity

  Metabolic:
  • ↑↓ blood sugar
  • ↑↓ sodium
  • ↑ urea

  Hypothermia

- [rocuronium/vecuronium relaxant]: Sugammadex dose on TBW: PTC>2 = 4mg/kg (70kg=280mg); >T₂ = 2mg/kg (70kg=140mg)
- [all non-depolarising relaxants]: Neostigmine 2.5mg (50mcg/kg) & glycopyrrolate 500mcg (10mcg/kg). Rpt at 15min
- [suxamethonium apnoea]: No reversal option ⇒ continue anaesthesia/refer to ICU

Respiratory Failure:
  • hypoxia or hypercapnia:
    - ↓ central drive e.g. stroke, COPD
    - lung disease e.g. PE, ARDS
    - muscle power e.g. obesity

Neurological:
  • stroke - infarct, bleed or embolism
  • seizure (Non-convulsive status epilepticus or post-ictal)
  • local anaesthetic toxicity

Other - Uncommon:
  • central anticholinergic syndrome
  • dissociative coma
  • thyroid failure
  • valproate toxicity
EMERGENCY OUT OF THEATRE
- MET Team

ANAESTHETICS & THEATRES
- Duty Anaesthetist
- Duty Technician
- Theatre Coordinator
- PACU Coordinator
- Perfusionist

OBSTETRICS
- Obstetric Doctor
- Delivery Technician
- Charge Midwife
- Paed/NICU Doctor

LABORATORY/X-RAY
- Blood bank
- Blood tests
- X-Ray Technician
- Duty Radiologist

REFERRALS
- ICU Doctor
- ICU Coordinator
- Haematology Doctor
- Surgical Doctor
- Paediatric Doctor
- Cardiology Doctor
<table>
<thead>
<tr>
<th>Drug</th>
<th>Bolus</th>
<th>Infusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adenosine</td>
<td>6mg, then 12mg, then 12mg.</td>
<td>-</td>
</tr>
<tr>
<td>Adrenaline</td>
<td>[Arrest] 10ml of 1:10,000 (1mg) [Other] 0.1ml - 1ml of 1:10,000 (10-100mcg/ml). Titrate</td>
<td>5mg in 50mls NSL. Infuse 0-20ml/hr</td>
</tr>
<tr>
<td>Alteplase</td>
<td>-</td>
<td>[PE in cardiac arrest] 100mg in 20mls NSL. Infuse at 80mls/hr</td>
</tr>
<tr>
<td>Aminophylline</td>
<td>400mg over 15mins</td>
<td>50mg in 50mls at 35ml/hr</td>
</tr>
<tr>
<td>Amiodarone</td>
<td>300mg slow push</td>
<td>900mg in 500ml D5W over 24hours</td>
</tr>
<tr>
<td>Ca2+ Chloride (10%)</td>
<td>5 - 10mls slow push</td>
<td>-</td>
</tr>
<tr>
<td>Clonidine</td>
<td>30mcg. Titrate (max 150mcg)</td>
<td>-</td>
</tr>
<tr>
<td>Dobutamine</td>
<td>-</td>
<td>250mg in 50ml NSL. Infuse 0-10ml/hr</td>
</tr>
<tr>
<td>Esmolol</td>
<td>10mg. Titrate</td>
<td>-</td>
</tr>
<tr>
<td>GTN</td>
<td>[tocolytic] 100-250mcg</td>
<td>50mg in 50ml NSL. Infuse 3-12ml/hr. Titrate to MAP/ECG</td>
</tr>
<tr>
<td>Hydrocortisone</td>
<td>200mg</td>
<td>-</td>
</tr>
<tr>
<td>Insulin (actrapid)</td>
<td>[β-blocker or CCB OD] 50ml of 50% dextrose &amp; 70u actrapid (1u/kg). Give as bolus.</td>
<td>[TK] 10units in 250ml D5W @500ml/hr</td>
</tr>
<tr>
<td>Intralipid (20%)</td>
<td>100ml bolus (1.5ml/kg), Rpt ev 5min, max x2</td>
<td>1000ml/hr (15mg/kg/hr). Can double rate @5mins (max total dose = 12ml/kg)</td>
</tr>
<tr>
<td>Isoprenaline</td>
<td>200mcg into 20mls NSL. Give 1ml boluses titrated</td>
<td>1mg into 50mls NSL. Infuse at 0-60mls/hr</td>
</tr>
<tr>
<td>Ketamine</td>
<td>[induction] 70-140mg (1-2mg/kg) [bronchospasm] 35-70mg (0.5-1mg/kg)</td>
<td>-</td>
</tr>
<tr>
<td>Labetalol</td>
<td>5mg slow push. Titrate (max 100mg)</td>
<td>300mg in 60mls (neat). Infuse 0-30mls/hr</td>
</tr>
<tr>
<td>Lignocaine (1%)</td>
<td>[Arrhythmia] 7mls (0.1ml/kg). Can rpt ev 10mins (max 0.3ml/kg)</td>
<td>Neat 1% at 6-24ml/hr. (Total max in 1 hr = 30mls ie 3mg/kg)</td>
</tr>
<tr>
<td>Magnesium (49.3%)</td>
<td>[bronchospasm] 5mls over 20min [torsades] 5ml slow push [eclampsia] 6mls in 100ml NSL. Infuse @ 324ml/hr</td>
<td>[eclampsia]: Maintainence = 16mls in 100ml NSL. Infuse 14.5ml/hr for 8hrs Rescue (another seizure). 4mls in 6mls NSL. Infuse 120ml/hr</td>
</tr>
<tr>
<td>Metaraminol</td>
<td>0.5-1mg. Titrate</td>
<td>10mg in 20mls NSL. Infuse 0-40mls/hr</td>
</tr>
<tr>
<td>Metoprolol</td>
<td>2.5mg. Titrate (max 15mg)</td>
<td>-</td>
</tr>
<tr>
<td>Midazolam</td>
<td>[seizures] 2-7mg. Titrate</td>
<td>-</td>
</tr>
<tr>
<td>Mirinone</td>
<td>-</td>
<td>10mg in 50ml NSL. Infuse at 5ml or 10mls only</td>
</tr>
<tr>
<td>Naloxone</td>
<td>[emergency] 400mcg [titration] 40mcg (max 800mcg)</td>
<td>Infusion with hourly rate = 2/3 of bolus dose required for initial clinical effect</td>
</tr>
<tr>
<td>Noradrenaline</td>
<td>-</td>
<td>5mg in 50mls NSL. Infuse 0-20ml/hr</td>
</tr>
<tr>
<td>Oxytocin</td>
<td>[elective] 3units slow bolus (do not rpt) [emergency] 5units slow bolus (do not rpt)</td>
<td>40units in 1000ml NSL. Infuse 250ml/hr</td>
</tr>
<tr>
<td>Phentolamine</td>
<td>5-10mg. Repeat every 5-15 mins as req’ed</td>
<td>-</td>
</tr>
<tr>
<td>Phenytoin</td>
<td>100mcg bolus. Titrate</td>
<td>10mg in 100ml NSL (100mcg/ml). Infuse 0-40mls/hr</td>
</tr>
<tr>
<td>Salbutamol</td>
<td>250mcg slow push (Inhaled: 12 puffs via circuit)</td>
<td>5mg in 50ml NSL. Infuse 0-10ml/hr</td>
</tr>
<tr>
<td>Sodium Bicarb (8.4%)</td>
<td>50ml slow push. Can rpt every 2mins [løgøt pøt 7.45-7.55]</td>
<td>-</td>
</tr>
<tr>
<td>Sugammadex</td>
<td>[emergency post intubation] = 16mg/kg; [PTC&gt;2] 4mg/kg; &gt;2T= 2mg/kg</td>
<td>-</td>
</tr>
<tr>
<td>Suxamethonium</td>
<td>[laryngospasm] 35mg (0.5mg/kg)</td>
<td>1g in 100ml NSL. Infuse at 12.5ml/hr (8hrs)</td>
</tr>
<tr>
<td>Tranexamic Acid</td>
<td>1g over 10mins (15mg/kg)</td>
<td>1g in 100ml NSL. Infuse at 12.5ml/hr (8hrs)</td>
</tr>
<tr>
<td>Vasopressin</td>
<td>1unit slow push</td>
<td>20units in 20mls NSL. Infuse 1-4ml/hr</td>
</tr>
<tr>
<td>Drug</td>
<td>Bolus</td>
<td>Infusion</td>
</tr>
<tr>
<td>------------------------</td>
<td>--------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td><strong>Adenosine</strong></td>
<td>0.1mg/kg, then 0.2mg/kg, then 0.3mg/kg</td>
<td></td>
</tr>
<tr>
<td><strong>Adrenaline</strong></td>
<td>[Arrest IV] 0.1ml/kg 1:10,000 (10mg/kg)</td>
<td>[1bp] 0.15mg/kg (max 5mg) in 50mls NSL. Infuse 0.5-10ml/hr</td>
</tr>
<tr>
<td></td>
<td>[Arrest ETT] 0.1ml/kg of 1:1,000 (100mg/kg)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[Other] 0.01-0.05ml/kg 1:10,000 (1-5mg/kg)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[IM dose] 0.01ml/kg of 1:1,000 (10mg/kg)</td>
<td></td>
</tr>
<tr>
<td><strong>Aminophylline</strong></td>
<td>10mg/kg over 1hr diluted to 1mg/ml (max 500mg)</td>
<td>1-9yrs: 55mg/kg into 50mls D5W. Infuse 1ml/hr</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10-15yrs &amp; &lt;35kg: 35mg into 50mls D5W. Infuse 1ml/hr</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10-15yrs &amp; &gt;35kg: neat drug in 50mls. Infuse 0.028ml/kg/hr</td>
</tr>
<tr>
<td><strong>Amiodarone</strong></td>
<td>5mg/kg slow push (max 300mg)</td>
<td></td>
</tr>
<tr>
<td><strong>Atropine</strong></td>
<td>20mcg/kg</td>
<td></td>
</tr>
<tr>
<td><strong>Ca²⁺ Chloride (10%)</strong></td>
<td>0.2ml/kg (max 10mls) slow push</td>
<td></td>
</tr>
<tr>
<td><strong>Dobutamine</strong></td>
<td>-</td>
<td>15mg/kg in 50ml NSL. infuse 0.5-4ml/hr</td>
</tr>
<tr>
<td><strong>Ephedrine</strong></td>
<td>0.1mg/kg</td>
<td></td>
</tr>
<tr>
<td><strong>Esmolol</strong></td>
<td>500mcg/kg slow push. Titrate</td>
<td></td>
</tr>
<tr>
<td><strong>Glycopyrrolate</strong></td>
<td>10mcg/kg</td>
<td></td>
</tr>
<tr>
<td><strong>Hydrocortisone</strong></td>
<td>4mg/kg</td>
<td></td>
</tr>
<tr>
<td><strong>Insulin (actrapid)</strong></td>
<td>[β blocker or CCB OD] 25-50ml 50% dextrose then 1unit/kg insulin bolus</td>
<td>[1K] Bolus periv IV: 0.1unit/kg in 5ml/kg 10% dex</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[8 blocker or CCB OD] 0.5-2 unit/kg/hr infusion &amp; 10% dextrose at 250ml/hr</td>
</tr>
<tr>
<td><strong>Intralipid (20%)</strong></td>
<td>1.5ml/kg bolus. Rpt ev 5min, max x2</td>
<td>15ml/kg/hr. Can double rate @5min (max total dose=12ml/kg)</td>
</tr>
<tr>
<td><strong>Isoprenaline</strong></td>
<td>-</td>
<td>300mcg/kg in 50mls NSL. Infuse at 1ml/hr (0.1mcg/kg/min) and titrate up.</td>
</tr>
<tr>
<td><strong>Ketamine</strong></td>
<td>[bronchospasm] 0.5-1mg/kg</td>
<td></td>
</tr>
<tr>
<td><strong>Labetalol</strong></td>
<td>0.25-0.5mg/kg slow push. rpt ev. 10min as req'ed</td>
<td>50mg/kg &amp; NSL to make 50ml. Infuse 0-3ml/hr(0-3mg/kg/hr)</td>
</tr>
<tr>
<td><strong>Lignocaine 1% (5mg/mg)</strong>*</td>
<td>[arrhythmia] 0.1-0.2ml/kg. Can rpt ev 10mins (max 0.3ml/kg)</td>
<td></td>
</tr>
<tr>
<td><strong>Magnesium 49.3% (1ml = 2mmol = 0.5g)</strong></td>
<td>0.1ml/kg over 20mins</td>
<td></td>
</tr>
<tr>
<td><strong>Metaraminol</strong></td>
<td>10mcg/kg</td>
<td></td>
</tr>
<tr>
<td><strong>Metoprolol</strong></td>
<td>0.1mg over 5mins</td>
<td></td>
</tr>
<tr>
<td><strong>Midazolam</strong></td>
<td>[seizures] IV: 0.15mg/kg; IM 0.2mg/kg; buccal 0.5mg. Can rpt dose @ 5mins</td>
<td></td>
</tr>
<tr>
<td><strong>Naloxone</strong></td>
<td>[emergency] 10mcg/kg [tirrate] 2mg/kg (400mcg in 20mls give 0.1ml/kg)</td>
<td>300mcg to 30ml D5W &amp; run at 0-1ml/hr (10mcg/kg/hr)</td>
</tr>
<tr>
<td><strong>Noradrenaline</strong></td>
<td>-</td>
<td>0.15mg/kg (max 5mg) in 50mls NSL. Infuse 0.5-20ml/hr</td>
</tr>
<tr>
<td><strong>Phenylepherine</strong></td>
<td>2-10mcg/kg. Titrate</td>
<td>10mg in 100mls NSL. Infuse 0-20mls/hr (1-5mcg/kg/min)</td>
</tr>
<tr>
<td><strong>Salbutamol</strong></td>
<td>IV: &lt;2yr=5mcg/kg slow; &lt;18yr=15mcg/kg (max 250) Inhalated: &lt;5yr=5puffs; &gt;5yrs 12puffs via circuit</td>
<td>Make neat salbutamol up to 50mls</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Infuse at 5-10mcg/kg/min for 1hr. Then 1-2mcg/kg/min</td>
</tr>
<tr>
<td><strong>Sodium Bicarb 8.4%</strong></td>
<td>1ml/kg slow push. Can rpt every 2mins (target pH 7.45-7.55)</td>
<td></td>
</tr>
<tr>
<td><strong>Sugammadex</strong></td>
<td>[emergency post intubation] = 16mg/kg; [PTC&gt;2] 4mg/kg; [&gt;T₉]=2mg/kg</td>
<td></td>
</tr>
<tr>
<td><strong>Suxamethonium</strong></td>
<td>[intubation] IV: 2mg/kg; IM 4mg/kg [laryngospasm] 0.5mg/kg</td>
<td></td>
</tr>
<tr>
<td><strong>Tranexamic Acid</strong></td>
<td>15mg/kg diluted in 20-50mls NSL over 10mins</td>
<td>2mg/kg/hr in 500ml NSL over 8hrs</td>
</tr>
<tr>
<td><strong>Vasopressin</strong></td>
<td>1unit/kg in 50mls NSL. Bolus 1-2mls</td>
<td>1unit/kg in 50mls NSL. Infuse 1-3mls/hr</td>
</tr>
</tbody>
</table>

36r. PAEDIATRIC DRUG FORMULARY

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Emerg | Diag
Anaesthetic Crisis Handbook

By Adam Hollingworth
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For Nichola. Thank you for your never-ending support and patience.

Second addition special thanks to Dr M Ku for your learned ideas and feedback.

Many other thanks to excellent colleagues who contributed to this manual. Without their suggestions, improvements, fact & error checking & so on, it wouldn’t have been possible.

This includes (but not limited to): Dr D Borshoff, Dr J Cameron, Dr H Truong, Mr R Pryer, Mrs J Dennison, Dr D Mein, Dr N Chadderton, Dr L Kwan, Dr A Haq, Dr S McRitchie, Miss L Anderson, Dr D Heys, Miss D Hantom, Mr D Livesey, Dr J Dieterle, Dr V Singh, Dr P Tobin, Dr B Waldron, Dr J McKean, Miss K Chadwick-Smith & many more.

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Disclaimer: Every effort has been taken to prevent errors/omissions/mistakes. However, this cannot be guaranteed. Graded assertiveness to query team leader decisions/management steps which are contrary to this manual are encouraged. However, clinical experience & acumen are vital in complex situations such as crises and may be more appropriate than this manual in certain situations.