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Crisis Resource Management Principles

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DISCLAIMER

Every effort has been made to ensure the information contained within this book is accurate and correct; especially with regard to drug dosages. Despite this, errors may have been made and advances or changes in medical science and practice may render some information incorrect or incomplete. Current drug product information monographs are the most reliable source of prescribing information.
INTRODUCTION

This handbook has two potential uses. It can be used ‘on-the-spot’ in the event of an anaesthetic emergency. But its primary role is as an educational resource. It is given to anaesthetic trainees/ rural generalists in an attempt to equip them with the knowledge to learn and practise the principles for the safe administration of anaesthesia. Most hospital Departments of Anaesthesia will have other handbooks containing guidelines eg. Preadmission Clinic, Acute Pain Service. This handbook outlines management strategies for all of the common anaesthetic emergencies. The content has a local focus, i.e. it references predominantly Australian and Queensland produced guidelines.

A very valuable resource that practitioners may forget to utilize in a crisis situation is your anaesthetic assistant. Commonly they have a wealth of experience and have been involved in the management of numerous crises in the past. Often they will be able to locate and rectify an equipment problem faster and more efficiently than you. Ask for and heed advice from your anaesthetic assistant.

The seven crisis resource management principles are listed on the following page. As Douglas Adams says, “Don’t panic!” The first two principles are: know your environment and anticipate and plan. This handbook endeavours to address these two principles. Safe anaesthetic practice relies upon accurate assessment and preparation of both the patient as well as the anaesthetic environment. The majority of anaesthetic crises can be predicted and are hence potentially preventable. Similarly the diagnosis and management of most crises is very straightforward. The benefit of a book like this is that it provides a systematic framework to defer to in the rare but critical situation where you cannot solve the problem intuitively. Crises are relatively uncommon in anaesthesia but when things go wrong they usually go bad quickly and there is significant time pressure to solve the issue to prevent adverse outcomes.

The appendix contains several guidelines as well as useful formulae and equipment checklists. It is a mandatory requirement of all practising anaesthetists to be able to conduct an anaesthetic machine check. An example of the Checklist for the Aespire machine that is most commonly found in regional Queensland hospitals is reproduced.

I trust you find the contents of this handbook useful and hope you don’t need to refer to them too often!

Lachlan Rathie
Senior Staff Anaesthetist
Supervisor of Training
Toowoomba Hospital

REFERENCES

Below are listed the primary references I have used to compile this handbook. Particularly useful references are underlined. Most of these references are readily accessible via QH intranet or the Internet.

**Early Management of Anaesthetic Crises (EMAC) Course book**
UK Difficult Airway Society Guidelines, [www.das.uk.com](http://www.das.uk.com)
Gaba, D., Crisis Management in Anesthesiology
Mason R, Anaesthesia Databook
Australian Red Cross Blood Product guidelines, [www.redcross.org.au](http://www.redcross.org.au)
ANZCA Resources and Policy Documents
CRISIS RESOURCE MANAGEMENT PRINCIPLES

- Know your environment
- Anticipate and plan
- Call for help early
- Take a leadership role
- Communicate effectively
- Allocate attention wisely, use all available information
- Distribute the workload and use all available resources

We all tend to initially solve problems intuitively, i.e. quickly assess the situation, think of the most likely cause and act to correct the problem using our provisional diagnosis. Generally speaking, this is an appropriate course of action and works most of the time. Unfortunately intuitive problem solving doesn’t always work and in a crisis situation our cognitive problem solving skills can evaporate. Detrimental behaviours in this situation include:

- Mental block- in which you can’t remember information vital in order to solve the problem;
- Freezing- in which you are unable to undertake any sort of corrective action; and
- Tunnel Vision- continuing to pursue a particular course of action despite evidence to the contrary.

It is in this situation where algorithms can be very useful- they constitute a proven and systematic problem-solving pathway to be used when initial attempts have failed. They constitute a valuable training aid and are most useful when practised.

We are all fallible and even experienced anaesthetists make mistakes in an emergency situation.
CALLING FOR HELP

HAVE A LOW THRESHOLD TO CALL FOR HELP

You should familiarize yourself with the location of emergency buzzers both in theatre and on the wards.

IF REQUESTING IMMEDIATE ASSISTANCE ON THE PHONE- SAY SO BEFORE GIVING FURTHER DETAILS, EG: “I’ve got an emergency situation. Can you come in straight away…”

GENERALLY SPEAKING YOUR FIRST CONTACT SHOULD BE YOUR SUPERVISING CONSULTANT IN THE EVENT OF AN INTRAOPERATIVE CRISIS.

• If they aren’t in the theatre itself, ask your anaesthetic assistant or the scout nurse to get senior assistance.
• If the patient is dangerously unstable/ peri-arrest hit the red buzzer as well.
• If senior assistance is not directly available in the theatre complex, eg. after hours: hit the buzzer, get someone to immediately call switch and get them to contact the anaesthetic consultant on call urgently.
• If you still need immediate help after doing the above- consider calling for senior assistance from the Emergency Department or the Intensive Care Unit. Familiarize yourself with what other staff you can call for assistance after hours- in many hospitals you (the registrar) will be the most ably qualified person to manage a crisis situation!

All hospitals have a PET/MET call team. Often the anaesthetic team is not on this team but you may be called to assist. Below are the criteria for a PET call.

PHONE NUMBERS

You should compile a list of phone numbers to use in the event of an emergency and add them to your contacts on your mobile. Many on call units will have a duty phone. Suggested contacts include:

• All your consultants
• Intensivists
• Blood Bank
• ED/ICU on call
• Theatre Nurse Coordinator.
• Anaesthetic Assistant on duty
# CODE BLUE

If Medical Emergency, Cardiac Arrest or worried *(see on back)*, call **666**

**State**  CODE BLUE
**State**  Adult, Paediatric or Obstetric
**State**  Location

<table>
<thead>
<tr>
<th>Adult CODE BLUE</th>
<th>Paediatric (includes neonates) CODE BLUE</th>
<th>Obstetric CODE BLUE</th>
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<td>SMO ED or ED Registrar after MN</td>
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<td>ICU Consultant or Reg A/h Med Reg</td>
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<td>Bed Manager Wardsperson</td>
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<td>Paed Consultant Paediatric Reg Paediatric RMO</td>
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### Criteria for calling the CODE BLUE TEAM

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<th>Physiology</th>
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<td></td>
<td>• All Respiratory Arrests</td>
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<tr>
<td></td>
<td>• Respiratory Rate &lt; 5 or &gt; 24</td>
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<td></td>
<td>• Oxygen Saturation &lt; 90% (<em>unless otherwise medically determined</em>)</td>
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<tr>
<td></td>
<td>• All cardiac arrests</td>
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<td>• Pulse Rate &lt; 40 or &gt; 140</td>
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<td>• Systolic Blood Pressure &lt; 90 mmHg</td>
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<tr>
<th>Acute changes in NEUROLOGICAL</th>
<th>Physiology</th>
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<tr>
<td></td>
<td>• Sudden fall in level of consciousness (<em>fall in GCS &gt; 2 points</em>)</td>
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<td></td>
<td>• Repeated or prolonged seizures</td>
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<tr>
<th>Acute changes in OTHER</th>
<th>Physiology</th>
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<tr>
<td></td>
<td>• Any patient whom you are seriously worried about and who does not meet the above criteria.</td>
</tr>
</tbody>
</table>

**Call 6666**

**State CODE BLUE**

**State Adult, Paediatric or Obstetric**

**State Location**
ACCESSING AARK RECORDS- good for most anaesthetics in Qld post 2010*

You can use any computer at work for this:
- Open internet explorer
- Click on ‘Links’
- Click on the ‘AARK’ shortcut at the top of the list
- Enter novell login details
- Click on ‘Time Line’
- Search using demographics or hospital specific UR number
- Can print these if want to.

*Not for most private hospitals, not for the Mater or Gold Coast Hospitals.

Note- if you review a patient’s previous anaesthetics on the AARK module itself you can only access records done in your hospital.

*Not for most private hospitals, not for the Mater or Gold Coast Hospitals.
**APPROACH TO THE DIFFICULT AIRWAY**

**Recognition of the difficult/threatened airway**
- Principally this entails taking a history and performing a physical examination. Don’t forget to document an “Anaesthetic Alert” if you suspect difficult airway management when you see a patient in PAC.
- Investigations that can be helpful include:
  - CT scan neck/chest to assess airway compression/distortion especially with neck masses
  - Nasoendoscopy- best for supraglottic/glottic lesions. Often the ENT team has already done this, see OPD notes.
- Physical signs that suggest a difficult intubation are poorly predictive if only one sign is present but in combination are highly suggestive of potential difficulties. A reduced thyromental distance (<6cm) is of particular concern. The morbidly obese patient as well as being more likely to be a difficult intubation/difficult mask ventilation will poorly tolerate failed or lengthy attempts at conventional intubation because of their severely reduced respiratory reserve.
- Don’t forget to look at previous anaesthetic records- these are an invaluable source of information. Don’t forget to look for AARK records.
- Historical elements that should concern you include:
  - Known Hx difficult intubation
  - Hx cervical trauma/surgery eg. Fusion.
  - Hx previous neck surgery/radiotherapy
  - Hx of night panics/positional related airway obstruction.
- Signs of a threatened airway:
  - Any signs of obstruction - suprasternal and intercostal recession, stridor (may be absent or very quiet in a patient at rest), pooling of secretions, pt sitting up and unable or reluctant to lie flat, dysphagia, tachypnoea, signs of sympathetic stimulation (anxiety, ↑HR, ↑BP).
  - Dire signs are- silent chest and quiet patient (patient has expended their sympathetic drive), fatigue (hugely increased work of breathing) and hypoxaemia despite supplemental oxygen.

**Formulating a management plan**
- Assess the patient as above.
- Call for senior/experienced help- both surgical and anaesthetic.
- Prepare your equipment and drugs (see below for a list of equipment available to use in our OT).
- Formulate a primary and back-up plan based upon:
  - Anatomical level of the lesion- is it oral/supraglottic, laryngeal or tracheal.
  - Can the patient open their mouth? Can I get an LMA in there?
  - Will they be compliant with an awake intubation?
  - What is the degree of airway obstruction- how much time do you have, can the patient lie flat?
  - Is there a risk of airway soiling from pus, blood or gastric contents?
  - Are you able to get surgical access to the trachea and if so is it likely to be difficult?
Airway Emergencies

- When formulating a plan you also need to consider:
  - Does the patient require general anaesthesia? Eg. Pt with atlantoaxial instability for lower limb surgery may be appropriate to do with regional technique.
  - Does the patient need to be intubated? Is it reasonable to do case with an LMA? - beware if aspiration risk or anticipated difficulty ventilating the patient esp. obese patient. **Elective use of an LMA solely to avoid intubating a suspected difficult airway is unwise**: airway management may be even more difficult in the event of failed LMA insertion.
  - Is bag mask ventilation likely to be difficult? If so it may be prudent to secure the airway prior to inducing anaesthesia.
  - What techniques am I familiar/ experienced with? An airway emergency is not the time to use an airway adjunct/ technique for the first time.

General comments
- Practise and be familiar with your airway drills.
- Practise using various airway devices and techniques on elective cases under supervision. This is a teaching hospital and has a large array of equipment (see below) - it is in the interest of all anaesthetic personnel (yourself, your supervisor, anaesthetic technician) for you to regularly use and be familiar with this equipment.
- Always have a Plan A and Plan B: Be prepared.
- Warn your assistant if you anticipate difficulties.
- Have a low threshold to bring the difficult intubation trolley into theatre.
- Failed intubation doesn’t kill- failed oxygenation and ventilation does. Don’t forget the option of bailing out early and waking the patient up.
- Ensure secure IV access before you start- this includes paediatric patients.

Pros and Cons of some techniques for difficult airway management

**AWAKE TRACHEOSTOMY UNDER LA**

- **PROS:**
  - The ‘Gold Standard’- a definitive airway is secured without the need for sedation or impairing the patient’s protective reflexes.
  - Indications:
    - Patient with stridor at rest, eg. Neck trauma, supraglottic/ glottic tumour
    - Patient who can’t open mouth- trismus, jaw problem.

- **CONS:**
  - Takes time.
  - Need cooperative patient.
  - Need experienced surgeon available to do the procedure.
  - Difficult to do with patient sitting up; really need them to lie down.
  - Relatively contraindicated if field is contaminated, eg. Local sepsis, infiltrating tumour.
  - No help with obstruction distal to proximal trachea.
Airway Emergencies

**AWAKE FIBREOPTIC INTUBATION**

- **PROS:**
  - Patient maintains spontaneous respiration, able to abandon procedure safely.
  - Allows visualisation of entire airway to bronchi.
  - Good technique for lesions that impede intubation but not gas flow.
  - Indications:
    - Known/ suspected difficult intubation (not all cases)
    - Cervical spine trauma
    - Patient who can’t open mouth.
    - Oral or supraglottic lesion.
    - Mid Tracheal lesions, eg. Goitre.

- **CONS:**
  - Need cooperative patient.
  - Requires excellent topical anaesthesia ± sedation. Inadequate airway anaesthesia results in coughing/ bucking and difficulty performing the procedure.
  - Can be technically difficult to do, need to practise regularly.
  - Relative contraindications:
    - Critical upper airway obstruction.
    - Bleeding/ friable lesions or the presence of pus/ secretions makes this technique very difficult to perform.
    - If tracheal narrowing is suspected then a bronchoscope may worsen the obstruction- ‘cork in a bottle’.
    - Gross airway abnormalities.

**GAS INDUCTION**

- **PROS:**
  - Providing anaesthesia
  - Favoured technique for paediatric cases.
  - Maintenance of spontaneous respiration allows you ability to bail out if encounter difficulty (theoretically- loss of airway leads to lightening of anaesthesia).
  - Allows performance of surgical airway if able to manage airway but unable to intubate.
  - Avoidance of application of positive pressure ventilation.
  - Indications:
    - Favoured technique for inhaled foreign body- avoid IPPV and pushing foreign body further down.
    - Lesions at the level of the cords or below (mediastinal mass, bronchopleural fistula).

- **CONS:**
  - Can be difficult to achieve adequate depth of anaesthesia particularly with an obstructed airway.
  - Should not be 1st option if anticipate difficulty with mask ventilation
  - Possibility of airway loss (worsening of obstruction) and loss of ventilation (apnoea, breath holding) remains.
  - Difficult to perform with a patient who has severe airway obstruction/ patient who can’t lie down- induction may lead to loss of airway.
LARYNGEAL MASK AIRWAY

- **PROS:**
  - There are 5 places where the LMA can be used in the management of the difficult airway:
    1. Elective use as airway device to perform case.
    2. Use as conduit for awake fibreoptic intubation. (Largest ETT that fits in size 3 & 4 LMA is 6.0; 7.0 for size 5 LMA.)
    3. Elective use as conduit for intubation- fibreoptic or blind (eg. Intubating LMA- better success rate than Classic LMA.)
    4. Emergency use (failed intubation) as conduit for intubation.
    5. Emergency use to obtain airway and as a ventilatory device.
  - Familiarity with use.
  - High success rates reported in emergency situations both to obtain an airway and as a ventilatory device.
  - Remarkably versatile.

- **CONS:**
  - Doesn’t protect airway, correct placement can be difficult when cricoid pressure is applied.
  - Ventilation may be inadequate where high airway pressures are encountered, eg. Obese patient, poorly compliant lungs, bronchospasm. Second generation devices are preferred when difficulties ventilating are anticipated because of their higher airway leak pressure.
  - Requires an amount of mouth opening- minimum interdentine distance of 25mm.

**Difficult Intubation Trolley Contents**

ANZCA Guideline PS56 *Guidelines on Equipment to Manage a Difficult Airway During Anaesthesia* comprehensively details the equipment every Department should have on their “Difficult Airway Trolley”. Below I have summarized this equipment with some brief notes.

- **McCoy blade**- has a lever attached intended to elevate the epiglottis. May be helpful with some Grade III laryngoscopic views/ anterior larynx.
- **Long straight blade and short handled laryngoscope blade**
- **Intubating LMA**- sizes 3, 4 and 5.
  - Comes with a dedicated disposable ETT ($50 each). The tube must be well lubricated prior to use.
  - The ETT can be inserted blindly or with the aid of a bronchoscope/ bougie/ airway exchange catheter.
  - Requires slightly greater interdentine distance than standard LMA to allow insertion.
  - Potentially useful for patients:
    - with cervical spine problems who require intubation.
    - Who are a known/ anticipated difficult intubation with adequate mouth opening and ventilation is not expected to be difficult.
- **Videolaryngoscope**: C-Mac. This is the most commonly stocked videolaryngoscope in Queensland Hospitals. It consists of a reusable blade attached to a free-standing video monitor or small screen attached to device.
  - Blades must be autoclaved after use.
Airway Emergencies

- 3 and 4 blades function effectively the same as the equivalent Macintosh blades.
- ‘D’-blade for ‘difficult’ intubations requires use of a bougie or stylet in the tube to direct it into the glottis while looking at the monitor.

- **Airway Exchange Catheters**- for use when changing ETT’s in a known difficult intubation; able to ventilate with them.
- **Bougies, stylets, bronchoscope adapters, wires, oropharyngeal and nasopharyngeal airways.**
- **Epidural kit**- may be used in retrograde intubation.
- **Extubation kit**- soft wire + dedicated single use airway catheter.
- **Surgical Airway Equipment as detailed below.**

**Other airway equipment items**

- **Fibreoptic Bronchoscope**
  - Most Departments will have an adult (4.8mm diameter) and a paediatric (3.4mm diameter) bronchoscope.
  - They are usually kept on a dedicated trolley containing all the equipment required for its use including topical anaesthesia.
- **Rigid bronchoscope**: ENT cases.
  - Don’t forget this device - it may be lifesaving. The surgeon may be able to obtain an airway with it when your attempts have failed and you are about to perform a surgical airway.
  - Bleeding tonsil- the rigid bronchoscope should be available in the OT.
  - Mediastinal mass/ tracheobronchial pathology- because the scope is rigid it acts as a stent and can facilitate ventilation when all other attempts have failed.
- **Ambuscope**
  - A single use bronchoscope. Doesn’t have suction channel and image quality not as good as a regular bronchoscope.
  - Connect to dedicated video monitor on stand.
  - Appropriate for elective cases only.
- **Heliox**
  - 28% O₂, 72% Helium gas mixture stored in large cream coloured cylinder kept in alcove outside OT 5 & 6 (near operating microscope).
  - May ‘buy you time’ when managing a patient with stridor- can decrease the work of breathing and may improve oxygenation.
  - O₂ tubing can be connected directly to the cylinder.
  - Fixed O₂ content may limit usefulness in hypoxic patient.
  - Other options to be considered to reduce airway swelling while making preparations for definitive management are:
    - **Adrenaline Nebs**
    - **Anti-sialagogue: glycopyrrolate 400mcg IV**
    - **Dexamethasone**- this will take hours to have any effect.
The details of the surgical equipment relate to Toowoomba Hospital only- your theatre should have dedicated surgical airway equipment and you should familiarize yourself with it.

- **Surgical Airway**: Each theatre has the following equipment velcroed to a whiteboard behind the anaesthetic workstation:
  - 14 gauge IV cannula
  - COOK cuffed emergency cricothyrotomy catheter set: this contains a 5.0 mm ID tube with introducer, a guidewire and scalpel and two 18g needles- 50 and 70mm long.
  - Leroy device for jet insufflation of oxygen.
  - COOK Enk O₂ flow modulator set: this is a needle cricothyrotomy set and is appropriate for use in children. It includes oxygen tubing to allow ‘jet’ insufflation of oxygen.
  - Frova Airway Intubating Catheter + Rapi-fit Adapter: this is a hollow blue plastic tube 65cm long. It is 5mm wide and the adapter allows connection to a standard circuit. It can also be used as a bougie.
  - 6.0 cuffed ETT + disposable scalpel: alternative tools to perform a cricothyrotomy as per ATLS teaching.

- It is a mandatory requirement of anaesthetic trainees and JCCA registrars to demonstrate use of surgical airway equipment in a CICO scenario.

**Prophylactic cricothyroid cannula**
- Placement of a cannula in the airway +/- a wire prior to inducing the patient should be considered in patients who are being anaesthetized and have a high likelihood of failed intubation as well as failed bag mask ventilation.
- Confirmation of intratracheal placement of the cannula should be done with capnography.
- Jet ventilation equipment should be readily available, the neck should be prepped and a surgeon scrubbed and ready.

**VORTEX Optimisation Strategies**
- This is a graphic cognitive aid devised by Melbourne anaesthetists and emergency physicians to help conceptualize the approach to the difficult airway. I think it is perhaps more useful for the non anaesthetist managing the difficult airway but have reproduced some of the diagrams for completeness.
### Vortex Optimisation Strategies

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<tr>
<th></th>
<th>FACE MASK</th>
<th>LARYNGEAL MASK AIRWAY</th>
<th>ENDOTRACHEAL TUBE</th>
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<tbody>
<tr>
<td><strong>1. Manipulation</strong></td>
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<tr>
<td>Head &amp; Neck</td>
<td>Sniffing Position/Jaw Thrust/Bed Height</td>
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<td></td>
<td>Dentures In</td>
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<td>Dentures Out</td>
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<tr>
<td>Larynx</td>
<td>Laryngeal Manipulation (incl. ease cricoid)</td>
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<tr>
<td>Device</td>
<td>2 hands</td>
<td>Twist Cuff Inflation</td>
<td>Rotate</td>
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<tr>
<td><strong>2. Adjuncts</strong></td>
<td>OPA</td>
<td>Introducer Bougie</td>
<td>Stylette Bougie</td>
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<td></td>
<td>NPA</td>
<td>Laryngoscope</td>
<td>Magill Forceps</td>
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<td><strong>3. Size/Type</strong></td>
<td>FM</td>
<td>LMA</td>
<td>Blade/Handle/ETT</td>
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<tr>
<td><strong>4. Suction</strong></td>
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<tr>
<td><strong>5. Pharyngeal Muscle Tone</strong></td>
<td>Prospect of recovery: consider reverse BZD’s, opioids, NMBD’s GZ or No prospect recovery: consider adequacy anaesthesia/m. relaxation</td>
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PAEDIATRIC AIRWAY EQUIPMENT

- Most Departments have a dedicated trolley for paediatric airway equipment as well as one for paediatric emergency equipment.
- These contain an assortment of airway equipment for both routine and difficult airways eg. OPAs, NPAs, LMAs, ETTS, stylets, masks, Ayres T-piece circuit.
- They also contain other equipment- eg. IV access, intraosseous needle, oximetry probe.
- ANZCA PS56 documents the recommended equipment for paediatric airway equipment.
Reproduced on the next pages are airway management guidelines produced by the UK Difficult Airway Society. The adult algorithms were first published in *Anaesthesia*, 2004, **59**, 675-694. There have been several revisions of the guidelines since then with the most recent adult algorithms published in the *British Journal of Anaesthesia* 2015, 115:827-48. The paediatric guidelines were produced in 2013. All the algorithms are available on their website: [www.das.uk.com](http://www.das.uk.com) I personally think they are good but I don’t commend them as the *only* airway algorithms to use. Of more importance is that you have a well established fall back algorithm that you know and have practised.

**Basic Airway Algorithm** - this has four elements:
- Maximum 2 attempts intubation
- Best attempt BMV (*practice on every patient*)
- LMA as rescue airway
- Surgical Airway if this fails

See also algorithm for *Failed Intubation LSCS*.

**Best attempt at bag mask ventilation** -
- The incidence of failed intubation/ failed ventilation is generally quoted at 1 in 10,000 (*in experienced hands*)
- A ‘best attempt’ entails-
  - Optimal head and neck position with the neck flexed and the head extended (putting a pillow under the patient’s shoulders *doesn’t* facilitate this).
  - Appropriately sized facemask and oropharyngeal airway.
  - Two-handed ventilation with assistant squeezing bag (APL valve closed and high FGF).
  - Maximal jaw thrust- applied by an assistant if necessary (3rd pair hands).
  - Use of bilateral nasopharyngeal airways- risk of precipitating epistaxis though.

**Intubation attempts using direct laryngoscopy:**
- Optimize patient position- decent pillow, top of head level with top of bed, chin up but neck not hyper extended, reverse trendelenburg if obese.
- Avoid prolonged and repeated attempts- this causes airway trauma and makes matters even more difficult, priority is oxygenating the patient.
- Use BURP- this can further distort your view if applied poorly however. Consider placing your hand over your assistant’s to adjust external laryngeal pressure and optimise your view.
- Have a low threshold to use the bougie, particularly if you can see the glottis but are having difficulty passing the ETT.
  - If having difficulty railroading the tube- leave laryngoscope in, rotate tube 90˚ anti-clockwise, pull tongue forward, maximal jaw thrust. Don’t force it.
- Change something between attempts- position, blade, use aid. Consider using a smaller tube- the MLT is the smallest cuffed adult ETT in stock, it has an internal diameter of 5mm.
- Videolaryngoscope may be very helpful and are often the device of first choice for a suspected difficult intubation.
Airway Emergencies

DAS Difficult intubation guidelines – overview

Plan A: Facemask ventilation and tracheal intubation
- Laryngoscopy
  - Succeed: Tracheal intubation
  - Failed intubation: Supraglottic Airway Device

Plan B: Maintaining oxygenation: SAD insertion
- Failed SAD ventilation: Final attempt at facemask ventilation
  - Succeed: Wake the patient up
  - Failed: Tracheostomy or cricothyroidotomy

Plan C: Facemask ventilation
- Final attempt at facemask ventilation: Wake the patient up

Plan D: Emergency front of neck access
- Cricothyroidotomy

STOP AND THINK
Options (consider risks and benefits):
1. Wake the patient up
2. Intubate trachea via the SAD
3. Proceed without intubating the trachea
4. Tracheostomy or cricothyroidotomy

Management of unanticipated difficult tracheal intubation in adults

Plan A: Facemask ventilation and tracheal intubation
- Optimise head and neck position
- Preoxygenate
- Adequate neuromuscular blockade
- Direct/Videolaryngoscopy (minimum 3+1 attempts)
- External laryngeal manipulation
- Troubleshoot
- Remove cricoid pressure
- Maintain oxygenation and ventilation

If in difficulty → call for help
- Confirm tracheal intubation with capnography
- Post-operative care and follow up:
  - Formulate immediate airway management plan
  - Monitor for complications
  - Consult the patient in person and in writing
  - Send written report to CP and exist database

Plan B: Maintaining oxygenation: SAD insertion
- 2nd generation device recommended
- Change device or size (maximum 3 attempts)
- Oxygenate and ventilate

Plan C: Facemask ventilation
- If facemask ventilation impossible, paralytics
- Final attempt at facemask ventilation
- Use 2-person technique and adjuncts

If in difficulty → call for help
- Wake the patient up

Plan D: Emergency front of neck access
- Cricothyroidotomy
Failed intubation, failed oxygenation in the paralysed, anaesthetised patient

CALL FOR HELP

Continue 100% O₂
Declare CICO

Plan D: Emergency front of neck access

Continue to give oxygen via upper airway
Ensure neuromuscular blockade
Position patient to extend neck

Scalpel cricothyroidotomy

Equipment:
1. Scalpel (number 10 blade)
2. Bougie
3. Tube (cuffed 6.0mm ID)

Laryngeal handshake to identify cricothyroid membrane

Perforable cricothyroid membrane
- Transverse stab incision through cricothyroid membrane
- Turn blade through 90° (sharp edge caudally)
- Slide coudé tip of bougie along blade into trachea
- Railroad lubricated 6.0mm cuffed tracheal tube into trachea
- Ventilate, inflate cuff and confirm position with capnography
- Secure tube

Impalpable cricothyroid membrane
- Make an 8-10cm vertical skin incision, caudad to cephalad
- Use blunt dissection with fingers of both hands to separate tissues
- Identify and stabilise the larynx
- Proceed with technique for palpable cricothyroid membrane as above

Post-operative care and follow up
- Postpone surgery unless immediately life threatening
- Urgent surgical review of cricothyroidotomy site
- Document and follow up as in main flow chart
Airway Emergencies

Difficult mask ventilation (MV) – during routine induction of anaesthesia in a child aged 1 to 8 years

**Step A** Optimise head position
- Consider:
  - Adjusting chin lift (age, thrust)
  - Inserting shoulder roll if >2 years
  - Neutral head position if >2 years
  - Adjusting ociloid pressure if used
  - Ventilating using two person bag mask technique

**Step B** Insert oropharyngeal airway
- Assess for cause of difficult mask ventilation
  - Light anaesthesia
  - Laryngospasm
  - Genioglossus – pass O2/NG tube

**Step C** Second-line: Insert SAD (e.g. LMA™)
- Insert SAD (e.g. LMA™) – not >3 attempts
- Release cricoid pressure

**Difficult direct laryngoscopy** – during routine induction of anaesthesia in a child aged 1 to 8 years

**Step A** Initial tracheal intubation plan when mask ventilation is satisfactory
- Direct laryngoscopy – not > 4 attempts
  - Check:
    - Neck flexion and head extension
    - Laryngoscopy technique
    - External laryngeal manipulation – remove or adjust
    - Vocal cords open and immobile (adequate paralyser)
  - If poor view – consider bougie, straight blade laryngoscope and/or smaller ETT.

**Step B** Secondary tracheal intubation plan
- Insert SAD (e.g. LMA™) – not >3 attempts
- Consider increasing size of SAD (e.g. LMA™) once if ventilation inadequate

**Consider:**
- Modified anaesthesia and surgery plan
- Assess safety of proceeding with surgery using a SAD (e.g. LMA™)

**Follow-up intubation attempts:**
- Trauma to the airway
- Evaluation in a controlled setting

*Consider using indirect laryngoscope if experienced to their use*
Airway Emergencies

Cannot intubate and cannot ventilate (CICV) in a paralysed anaesthetised child aged 1 to 8 years

Failed intubation inadequate ventilation

- FiO₂ 1.0
- Optimise head position and chin lift/jaw thrust
- Insert oropharyngeal airway or SAG (e.g., LM4™)
- Ventilate using a two-person bag mask technique
- Manage gastric distension with an OSGN tube

Give 100% oxygen

Call for help

Step A Continue to attempt oxygenation and ventilation

- If no muscle relaxant or remifentanil used, consider sugammadex (15mg/kg for full reversal)
- Prepare for rescue techniques in case child deteriorates

Step B Attempt wake up if maintaining SpO₂ >80%

- If rocuronium or vecuronium used, consider sugammadex (15mg/kg) for full reversal

Prepare for rescue techniques in case child deteriorates

Step C Airway rescue techniques for CICV (SpO₂ <80% and falling) and/or heart rate decreasing

Call for help again if not arrived

- Extend the neck (shoulder roll)
- Stabilise neck with non-dominant hand
- Access the cricothyroid membrane with a dedicated 14/16 gauge cannula
- Aim in a caudal direction
- Confirm position by air aspiration using a syringe with saline
- Connect to either adjustable pressure limiting device, set to lowest delivery pressure or 48bar O₂ source with a flowmeter (match flow time to child’s age) and Y connector
- Cautiously increase inflation rate and flow rate to achieve adequate chest expansion
- Wait for full expiration before next inflation
- Maintain open airway patency to aid expiration

- Perform surgical cricothyroidotomy
- Transcutaneous cannula
- Transcutaneous jet ventilation (pressure limited)

Call for specialist ENT assistance

ENT available

Success

- Perform surgical cricothyroidotomy / transcutaneous jet ventilation (pressure limited)

Ent not available

Fail

*Note: Cricothyroidotomy techniques can have serious complications and training is required – only use in life-threatening situations and convert to a definitive airway as soon as possible.
RAPID SEQUENCE INDUCTION (RSI) - OUTLINE OF CONDUCT

Indications
- Patient having GA at risk of aspiration:
  - Not fasted
  - Acute abdomen
  - Obtunded patient
  - Gastric stasis- pain/ opioids/ ESRF/ autonomic neuropathy
  - Significant reflux esp. waterbrash

Preparation
- Perform an airway assessment- if you suspect difficulty intubating the patient, reassess whether you should be doing this: ASK FOR SENIOR ADVICE.
- Give antacid- Na citrate 30mls PO is probably the best as it can be given immediately prior. However, it alone may make the patient vomit. Oral or intravenous ranitidine/ PPI take 30-60 mins to have effect. Metoclopramide 10mg IV may have a brief prokinetic effect but this is of dubious benefit.
- Explain the procedure to the patient, esp. cricoid pressure.
- If NGT in situ- aspirate it and leave it in. Consider inserting one in patient with gut obstruction prior to induction if not already present.
- Prepare drugs and intubation equipment, check machine esp. suction- stylet in ETT. Have low threshold for bringing difficult intubation trolley into OT.
- Ensure your anaesthetic assistant is present and prepared.
- Establish secure IV access and apply all monitoring before starting.
- Position your patient optimally on the OT table, turn on suction and put sucker under pillow.

Conduct of RSI
- Preoxygenate the patient- 3mins by the clock with high flows and a well fitting mask, aim for ET $O_2$ >80%. If time is of the essence- 5 vital capacity breaths.
- Anaesthetic assistant places thumb and index finger over cricoid ring and applies 10 N (1kg) pressure.
- A sleep dose of induction agent is given- some practitioners advocate giving a pre-defined dose but this may cause CVS collapse in an elderly/ septic/ sick pt.
- Assistant increases cricoid pressure to 30 N with loss of consciousness.
- Give Suxamethonium- at least 1mg/kg, ensure it is flushed in well.
  - An alternative muscle relaxant for use in a so-called Modified RSI is Rocuronium 1mg/kg. (Note- STP and rocuronium precipitate if given together, a saline flush must be given between the two agents if used.)
- Intubate the patient after fasciculations have occurred or after 60s; don’t attempt mask ventilation while waiting.
- Cricoid pressure is not released until correct ETT position is confirmed and you have told the assistant to release it.
- In event of failed intubation- follow a practised drill. See DAS algorithm on preceding pages. Cricoid pressure may need to be reduced or released to facilitate oxygenation and ventilation of the patient.
Subsequent Management

- Consider using nerve stimulator to confirm return of twitches prior to giving non-depolarizing muscle relaxant.
- Empty the patient’s stomach again at the end of the case.
- Extubate the patient awake- the highest risk period for aspiration is during extubation.

NOTES ABOUT SUGAMMADEX

- Sugammadex (‘Bridion’) is a novel cyclodextrin compound that rapidly reverses the aminosteroid muscle relaxants. It is most efficacious with rocuronium and less effective with vecuronium and pancuronium.
- It is a very expensive compound, each 200mg ampoule costs approximately $150.
- The dose should be calculated using actual body weight.
- To rapidly reverse an intubating dose of rocuronium, give 16mg/kg of sugammadex. It will take 3mins for T1 to recover to 90% of original.
- The most likely application of this drug is to obtain adequate recovery of muscle strength in a patient who has already been given neostigmine. In this case the dose is one ampoule (2mg/kg).
- Consider the use of sugammadex in a suspected case of anaphylaxis due to an aminosteroid muscle relaxant.
- **You should know where the Sugammadex is kept in your theatre complex.**
  8x 200mg amps or 3x 500mg amps are needed to rapidly reverse roc in a 100kg patient.
- If you use sugammadex you must complete the mandated QH paperwork.
EXTUBATION GUIDELINES

- The period of emergence and extubation is probably even more hazardous in terms of adverse airway events than that of induction.
- Recently there has been renewed awareness and attention paid to extubation culminating in the production of the guidelines reproduced below.
- Generally speaking all patients should be extubated awake.
- All practitioners should be familiar with the criteria for extubation and the use of specialized equipment for use in high risk extubations, eg. Airway Exchange Catheter (AEC).
- An AEC should never be inserted greater than 24cm past the lips.
FIBREOPTIC INTUBATION- SOME NOTES

- Like any complex technical skill that requires a degree of manual dexterity, awake fibreoptic intubation (AFOI) requires ongoing practice to acquire and maintain proficiency in its performance.
- The ANZCA Curriculum identifies it as a core skill and has nominated a minimum VOP of 5 AFOI’s. Most would agree this is a bare minimum.
- Planning is crucial to the timely success of this skill - pts needing AFOI should be identified well ahead of time and your anaesthetic assistant and supervisor if appropriate notified. Plan B also needs to have been made.
- We have the following bronchoscopes in the Department:
  - Adult Storz bronch with video monitor
  - Paediatric Storz bronch
  - Olympus Intubating bronch
  - Ambuscope- single use, no suction, only for elective cases.
- All except the Ambuscope are kept on a dedicated bronchoscopy trolley in the anaesthetic stockroom. The contents of the trolley are listed on a laminated page attached to it. Brochoscopes are expensive and must be handled with care.

Practical tips

- You need consent from the patient- explain what you will do.
- Secure IV access and monitoring applied.
- Best performed in OT, can topicalize the pt in the bay.
- Give glycopyrrolate 0.2mg IV- secretions are your enemy.
- Topicalize meticulously: there is a multitude of techniques described. If you can suction the hypopharynx without them complaining you’re looking good.
- Sedation is usually warranted- small doses incrementally. This is the one time when you want to be giving conscious sedation.
- Give pt supplemental oxygen- Hudson mask pulled down over mouth or nasal insufflation using the fine green 6F tubing.
- Nasal route is easiest to navigate but nasopharynx needs to be numb and not obstructed. If an 8mm NPA passes easily you should be okay. Ask pt which nare is best for them to breathe through.
- Recommend have the patient sitting up and facing you.
- Preload tube over bronch- suggest use armoured or Parker tube.
- Video monitor on, facing you, suction connected and on.
- Always aim for the black. If get pinkout- stop, withdraw and re-orientate.
- To facilitate railroading the ETT- snug fit between tube and bronch (6.0 adult), lubrication, rotate 90° anticlockwise, jaw thrust, deep breaths by pt, don’t force it.
- Don’t induce anaesthesia until you have confirmed intra-tracheal placement of the tube- the only way to do this is
  - ETCO₂ and/or
  - Visualization of trachea-bronchial rings/ carina with bronch through the ETT.
- I recommend performing a direct laryngoscopy once the tube has been secured and the patient is anaesthetized and to document the view on AARK.
**Management of airway fire during laser airway surgery**

Airway fire during laser airway surgery can cause life threatening damage to the both proximal and distal airways and seriously impair gas exchange. Airway fire could occur as a result of a presence of flammable material eg endotracheal tube in an oxygen enriched environment. The laser can act as an ignition source.

To minimize the risk of laser induced airway fires it is recommended to reduce the oxygen concentration of inspired air to 30%, avoid nitrous oxide, use a laser resistant endotracheal tube eg. Laserflex tube with coloured saline in the proximal cuff and placing the cuff sufficiently distal in the trachea to be out of the direct site of the operator. The tube should also be protected with saline soaked pledgets at the operative site.

Most commonly, the first sign of a fire is the presence of smoke in the airway. Other signs include a pop or even an explosion. Inability to ventilate or altered respiratory parameters are a late sign.

If an airway fire occurs the following steps should be implemented:

1. Stop ventilation by disconnecting the ET tube from the breathing circuit and simultaneously stop the laser beam by pressing the emergency stop button on the laser machine

2. Flood the area of fire with normal saline. Several 50ml syringes filled with normal saline should be on standby for every laser procedure

3. Remove the burned endotracheal tube (with or without an airway exchange catheter) Call another anaesthetist for help if not already present in theatre.

4. Reintubate with a smaller endotracheal tube

5. Perform flexible bronchoscopy to visualize and evaluate the distal airways. If rigid bronchoscopy is indicated to remove debris it should be performed.

6. Perform tracheostomy if indicated preferably below the level of damage

7. Administer steroids and antibiotics

8. Chest x ray and blood gases should be performed

9. Arrange ICU admission for subsequent management

10. Complete PRIME and Anaesthetic Incident form
Follow up of the patient with a difficult airway

» REVIEW THE PATIENT CLINICALLY
- to check for ‘minor’ morbidity such as bruised lips, sore throats
- to check for morbidity such as chipped, loosened teeth that may need a dental referral
- to check for serious morbidity such as laryngeal oedema, laryngeal damage or perforation of the larynx, pharynx, oesophagus. The triad of pyrexia, retrosternal pain and surgical emphysema indicates oesophageal perforation. This has a high mortality and early treatment with antibiotics, nil orally and ENT review should be initiated early.

» TALK TO THE PATIENT
- express regret/apologise for morbidity
- minor morbidity will resolve in a few days
- persistent hoarseness will need ENT review
- persistent problems need your involvement
- describe the problem
- indicate how serious a problem it was/is
- ask them to tell the next anaesthetist of the problem

» MAKE ADEQUATE NOTES
- in the anaesthetic record +AARK, in the chart
- Put warning label on front of patient’s chart
- indicate the precise problem and how you solved it
- specifically address whether facemask ventilation is easy/difficult; PERFORM DIRECT LARYNGOSCOPY once ETT secured and document view.

» WRITE TO THE PATIENT
- back up your oral explanation with details of problem/solution
- copy to the GP
- copy to any Department file or register
- consider whether the patient should be advised to obtain a Medic Alert bracelet
CARDIAC ARREST

Important Concepts
- Call for help and the defibrillator early.
- Check the leads and feel the pulse- verify the arrest.
- There are only 3 interventions that have been validated by scientific evidence:
  - Basic CPR: 30 chest compressions to 2 breaths, 5 cycles in 2 minutes. Chest compressions over lower ½ sternum with 2 hands to ½ chest depth at rate 100/minute.
  - Defibrillation for VF/VT arrest, perform as early as possible. Place one electrode below right clavicle and other in the left mid-axillary line 5ICS.
  - Oxygenation and ventilation through a secure airway.
- Cardiac arrest rhythms are divided into two subsets- VF/ pulseless VT and Non VF/VT (this includes asystole, PEA/ EMD). Defibrillation is only indicated for the first group.
- Amiodarone is the antiarrhythmic drug of choice. The dose is 300mg (2 ampoules) in 20mls 5% dextrose given as a slow push over 1-2mins.
- Most resuscitation drugs may be given down the ETT- they should be given at double dose and preferably via a suction catheter. Drugs not suitable for ETT use are:
  - Calcium
  - Sodium Bicarbonate
- Many of the causes of perioperative cardiac arrest can be reversed with specific interventions. Consequently the context of the arrest becomes crucial:
  - Hypoxaemia- ventilation with 100% O₂ via secure airway
  - Hypovolaemia- fluid bolus
  - Drug effect- allergy, CVS depression, CVS stimulation, side effect.
  - Hyperkalaemia- calcium chloride 5-10ml of 10% solution, Na HCO₃ 50-10 mmol, hyperventilation
  - Hypokalaemia (documented) – KCl 5mmol IV
  - Sympathetic blockade- vaspressors, fluid
  - Tension pneumothorax- needle decompression
  - ‘Lazarus’ phenomenon (breath stacking causing high intrathoracic pressure)- disconnect patient from breathing circuit
  - cardiac tamponade- pericardiocentesis.
- You should be familiar with the location and operation of your defibrillators: See APPENDIX- Defibrillators for some details re the operation of the LIFEPAK 12, the most commonly used device in Qld.

After the arrest
- Carefully document all interventions performed. There is a dedicated form kept with the defibrillator for this purpose.
- Cancel elective list.
- Inform supervisor and preferably take rest of the session/ day off
- Take an opportunity to debrief with a peer and seek counselling if required. Counselling services can be accessed through ERU.
- You may be asked to participate in a formal critical incident analysis/ RCA.
Advanced Life Support for Infants and Children

Start CPR
- 2 breaths, 15 Compressions
- Minimise Interruptions

Attach Defibrillator / Monitor

Assess Rhythm

Shockable
- Shock (4 J/kg)
- CPR for 2 minutes

Non Shockable
- CPR for 2 minutes

Return of Spontaneous Circulation?

During CPR
- Airway adjuncts (LMA/ETT)
- Oxygen
- Waveform capnography
- IV / IO access
- Plan actions before interrupting compressions (e.g. charge manual defibrillator to 4 J/kg)

Drugs
- Shockable
  - Adrenaline 10 mcg/kg after 2nd shock (then every 2nd shock)
  - Amiodarone 6 mg/kg after 3 shocks
- Non Shockable
  - Adrenaline 10 mcg/kg immediately (then every 2nd shock)

Consider and Correct
- Hypoxia
- Hypovolaemia
- Hyper / hypokalaemia / metabolic disorders
- Hypothermia / hyperthermia
- Tension pneumothorax
- Tampónade
- Toxins
- Thrombosis (pulmonary / coronary)

Post Resuscitation Care
- Re-evaluate ABCDE
- Treat precipitating causes
- Re-evaluate oxygenation and ventilation
- Targeted Temperature Management
Newborn Life Support

At all stages ask: do you need help?

1 minute

Term gestation? Breathing or crying? Good tone?

YES

Maintain normal temperature. Ongoing evaluation

NO

Maintain normal temperature, Ensure open airway, Stimulate

HR below 100? Gasping or apnoea?

YES

Positive pressure ventilation SpO₂ monitoring

NO

Laboured breathing or persistent cyanosis?

YES

Ensure open airway SpO₂ monitoring Consider CPAP

NO

Post-resuscitation care

Ensure open airway
Reduce leaks
Consider:
Increase pressure & oxygen intubation or layngeal mask

HR below 60?

YES

Three chest compressions to each breath
100% oxygen
Intubation or layngeal mask
Venous access

NO

Targeted pre-ductal SpO₂, after birth

<table>
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<th>Time (min)</th>
<th>SpO₂ %</th>
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<tr>
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</tr>
<tr>
<td>5</td>
<td>80-90%</td>
</tr>
<tr>
<td>10</td>
<td>55-90%</td>
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</tbody>
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HR below 60?

YES

IV Adrenaline 1:10,000 solution

Consider volume expansion

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<th>Dose</th>
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<tr>
<td>27-37</td>
<td>0.25 mL</td>
</tr>
<tr>
<td>38-43</td>
<td>0.5 mL</td>
</tr>
<tr>
<td>10-30 mcg/kg (0.1-0.3 mL/kg)</td>
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</tbody>
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Cardiovascular Emergencies
INTRAOPERATIVE TACHYARRHYTHMIA

Presentation
- Cardiac arrest
- Rapid and/or irregular pulse
- Hypotension
- ECG- loss of p waves, abnormal or retrograde p waves, flutter waves, narrow or broad complex tachycardia.

General Management Approach
- Below is outlined an approach to perioperative arrhythmias by Dr Robert Gray, specific arrhythmias will be dealt with subsequently.

Is this an arrest? Feel the patient’s pulse- if pulseless treat as for VF with defibrillation with unsynchronised shocks.
Where did we start? Does the patient have any predispositions to an arrhythmia eg. IHD, Pre-excitation syndrome, electrolyte disorder, sepsis.
What have I done? Recent surgical or anaesthetic interventions eg. intubation, drug errors, tourniquet release.
Should I be shocking now? Yes if compromised- HR>200, BP<80, heart failure, evidence of ischaemia.
Do I need to give K+ or Mg2+? Check U&E’s, ABG, what is the clinical scenario, is pt on a diuretic.

Is amiodarone the drug? Indicated for AF, shock resistant VF, narrow and broad complex SVTs and VT. Dose 300mg in 20mls 5% dextrose iv over 10 mins.
Other drugs? Final consideration after the above questions have been answered. This will be principally determined by the specific nature of the tachyarrhythmia. Often a 12 lead ECG or inspection of several ECG leads +/- at an increased waveform speed will aid diagnosis.

Treatment of specific tachyarrhythmias

VF/ PULSELESS VT
- Treat as for cardiac arrest with immediate defibrillation. See CARDIAC ARREST

VENTRICULAR TACHYCARDIA/ BROAD COMPLEX TACHYCARDIA
- Treat broad complex tachycardia as VT unless pt has known or suspected SVT with aberrant conduction (Wolff-Parkinson-White syndrome, pre-existing BBB). Adenosine 6mg has been used to differentiate VT from SVT with aberrant conduction but this is not recommended.
- If pulseless, treat as for cardiac arrest.
- In presence of CVS compromise (SBP<80, HR>150, heart failure or ischaemia) treat with immediate synchronized cardioversion- start at 100J and increase in 100J increments.
- If no CVS compromise or cardioversion fails then give amiodarone 150mg iv as a slow push.
Cardiovascular Emergencies

- If this fails then give a further 150mg amiodarone AND consider further attempts at electrical cardioversion.
- Correct hypokalaemia and hypomagnesaemia if present or suspected (pt on diuretics). Generally, it is safe to give magnesium anyway.
- In cases of refractory VT seek expert cardiological assistance- often the patient will have severe ventricular dysfunction. Options include:
  - Further amiodarone
  - Other anti-arrhythmic agents such as sotalol 1mg/kg (Procainamide no longer available in Australia), caution as these agents can cause profound myocardial depression as well as being pro-arrhythmic.
  - Overdrive pacing.
- Polymorphic VT = Torsade de pointes, give Magnesium 2g (30mg/kg) iv as bolus and correct hypokalaemia if present- maximum rate 30mmol KCL/hr.

SUPRAVENTRICULAR TACHYCARDIA / NARROW COMPLEX TACHYCARDIA

- Irregular SVT- treat as for AF
- Presence of normal P waves implies sinus tachycardia- treatment is directed at the underlying cause which may be:
  - Light anaesthesia/ inadequate analgesia
  - Hypoxia/ hypercarbia
  - Hypovolaemia
  - Sepsis
  - Stimulation due to airway manipulation
- SVT with CVS compromise (sick heart, HR>200, SBP<80)- treat with synchronized DC shock starting at 100J increasing to 360J. If electrical cardioversion is not successful give amiodarone 300mg iv slowly.
- SVT without compromise- give adenosine 6mg as rapid bolus followed if necessary by up to 3 doses of 12mg. Adenosine will revert most re-entry SVTs and will temporarily slow the ventricular rate in other SVTs such as atrial fibrillation. Common side effects include transient asystole, flushing, dyspnoea and headache. *Caution with use of adenosine in the following situations:*
  - Asthmatic patients- may provoke bronchospasm
  - Heart block or sick sinus syndrome- adenosine contraindicated unless have pacemaker.
  - Theophylline blocks the effect of adenosine whereas pts on dipyridamole or carbamzepine have an exaggerated effect.
  - Wolff-Parkinson-White Syndrome- adenosine is ineffective in AF and may convert AF with aberrant conduction to very fast ventricular rates due to rapid conduction down the accessory pathway.
- SVT without compromise unresponsive to adenosine or adenosine contraindicated, drug options available include:
  - Esmolol 0.5 mg/kg bolus + infusion 4mg/min
  - Amiodarone 300mg over 1 hour
  - Verapamil 5-10mg iv *not if patient on beta-blockers*
  - Digoxin 500mcg iv over 30min
### ATRIAL FIBRILLATION/ FLUTTER

- Irregularly irregular rhythm, commonest perioperative arrhythmia seen requiring treatment. 12 lead ECG or long rhythm strip usually makes the diagnosis.

- Acute treatment depends on three factors:
  - Presence of CVS compromise, i.e. HR>150, heart failure, valvular heart disease (especially aortic and mitral stenosis), severe ventricular dysfunction, hypotension - cardioversion should be attempted with synchronized shocks beginning at 50-100J and increasing strength up to 360J. Subsequent heparinization is usually warranted.
  - Whether acute onset - if AF is pre-existing caution is warranted before electrical cardioversion, as there is a risk of embolism. Patients should be anticoagulated for 4 weeks prior to cardioversion in the non-emergency setting.
  - Presence of structural heart disease - amiodarone is the drug of choice, dose 300mg over an hour then 900 mg over next 23 hours.

- If electrical cardioversion is not warranted acutely the treatment goal is control of ventricular rate <100/min. Drug options for this include:
  - Amiodarone - dose as above
  - Esmolol 0.5mg/kg then infusion 0.0-0.2mg/kg/min
  - Metoprolol 1-2mg increments up to 15mg
  - Digoxin 500mcg over 30 mins and repeat if necessary, particularly if co-existing cardiac failure.

- Special note re patients with Wolff-Parkinson-White and AF:
  - Avoid Digoxin and Verapamil - these agents decrease AV nodal conduction and may lead to very fast ventricular rates due to conduction down the accessory pathway.
  - Adenosine is generally ineffective and may accelerate the rate for similar reasons to above.
  - Procainamide 50mg/min until rate controlled or hypotension is considered the drug of choice but no longer available. Amiodarone is a reasonable alternative.

- Correct precipitating reversible causes, these include:
  - Hypokalaemia and hypomagnesaemia. It is not unreasonable to give these patients Magnesium 10mmol prior to blood levels being available.
  - Myocardial ischaemia
  - Sepsis, acidosis
  - Hypovolaemia
  - Alcohol binge

### Subsequent Management of Patient with Tachyarrhythmia

- Treat precipitating reversible causes (electrolyte abnormalities, hypovolaemia, sepsis, ischaemia, drug interactions/ overdose). Baseline U&E’s± ABGs ± TFTs
- 12 lead ECG - document arrhythmia; look for underlying abnormality such as prolonged QT syndrome, WPW.
- HDU/ CCU bed - contact medical registrar
- Exclude ischaemia - ECG, serial troponins, supplemental oxygen, cardiology/ physician referral as appropriate.
Cardiovascular Emergencies

- Decide whether anticoagulation is indicated - this will involve liaison with the surgeon as well as the treating medical team. Usually unfractionated heparin infusions are more appropriate as they are relatively short acting and can be acutely reversed with protamine.
- Patients with life threatening ventricular tachyarrhythmias should be considered for electrophysiological studies ± placement of an implantable cardiodefibrillator.
INTRAOPERATIVE MYOCARDIAL ISCHAEMIA

Pathophysiology
- Ischaemia results when myocardial oxygen demand exceeds myocardial oxygen supply.
- The main determinants of myocardial oxygen demand are:
  - Heart rate
  - Contractility
  - Left ventricular wall tension (SBP x radius/2Thickenss)
- The main determinants of myocardial oxygen supply are:
  - Coronary perfusion pressure = mean diastolic aortic pressure – LVEDP
  - Duration of diastole
  - Coronary artery resistance - atherosclerosis, acute thrombus formation on plaque, vasospasm, coronary steal.
  - Coronary artery oxygen content - [Hb] and SpO₂
- Tachycardia is bad because it:
  - Increases demand
  - Decreases supply as less diastolic time for LV perfusion
  - Also increases risk of plaque disruption.

Presentation
- ECG:
  - ST depression horizontal, downsloping >0.1mV 60msec after J point
  - ST depression upsloping >0.1mV 80 msec after J point
  - ST elevation >0.1mV.
  - T wave changes (peaked, biphastic, inverted), tachycardia, new conduction abnormalities.
- Haemodynamics:
  - Heart rate changes
  - Dysrhythmias
  - Labile BP, hypotension
  - ↑CVP and PAOP.
- TOE:
  - RWMAs
  - Change in mitral regurgitation, ↑LAP - atrial bowing
  - Decrease in global contractility, diastolic dysfunction.

Immediate Management
- Confirm diagnosis:
  - Pt risk factors, is pre test probability high?
  - Look at multiple ECG leads, look at ST trends
  - Compare with baseline ECG if available
  - Apply 5 lead ECG, look at II and V₅ using diagnostic mode; consider 12 lead ECG.
- Ventilate with high FIO₂, turn off N₂O if using it.
- Ensure patient is adequately anaesthetized and has adequate analgesia - Fentanyl 50mcg bolus, Remifentanil infusion.
Cardiovascular Emergencies

• Optimize haemodynamics:
  - Treat hypotension with vasopressors- α agonists preferable metaraminol 0.5-1mg, phenylephrine 50-100mcg bolus or infusion.
  - Treat hypertension- deepen anaesthesia, remifentanil infusion, GTN infusion (GTN spray can be given sublingually while preparing infusion).
  - Treat bradycardia with glycopyrrolate 400mcg.
  - Treat tachycardia with esmolol 0.5mg/kg bolus and infusion 50-200mcg/kg/min (2amps in 20ml syringe at 20-50mls/hr) or metoprolol 1-2mg boluses up to 15mg. If beta blockers contraindicated (asthma, proven reactive airways disease, heart block) use clonidine 0.5-1 mcg/kg as slow bolus or remifentanil. Aim for target HR of <70.

• If ST elevation organize urgent 12 lead ECG (kept in DSSU) and notify surgeon of need to complete surgery ASAP or even abort operation.
• Ensure normothermia
• Give normal saline or colloid if hypovolemic.
• Correct anaemia- aim for [Hb] of 10g/dL.

Subsequent Management
• Establish invasive monitoring- arterial line and central venous line.
• If ischaemia resolves- decide whether to complete operation and arrange admission to CCU. In recovery perform 12 lead ECG, take baseline blood for troponin, FBE and U&Es. Contact medical registrar. Ensure supplemental oxygen is given for next 72 hrs. Serial ECG and troponin measurements should be performed.
• If there is persisting ischaemia despite optimal haemodynamics or persistent ST elevation presume an Acute Coronary Syndrome- give aspirin 300mg PO/NGT and organize urgent medical involvement. Give GTN with vasopressor support if necessary. Liaise with surgical team re anticoagulation with heparin.
• In the setting of an evolving STEMI urgent cardiological assessment and percutaneous coronary intervention is the preferred option as thrombolysis is contraindicated. This is only available in some tertiary units.
• Persisting hypotension or cardiac failure despite correction of volume status etc warrants use of inotropes. If patient is hypertensive, increase GTN and consider use of an inodilator like Dobutamine 2-5mcg/kg/min.
• Document interventions and management on anaesthetic record and in chart.
• Follow up is important- visit patient next day and explain what happened. Anaesthetist shares responsibility that appropriate follow up occurs, eg. Medical referral, letter to GP, risk factor management.
INTRAOPERATIVE HYPOTENSION

Presentation
- Low measured BP
- NIBP unable to perform measurement (See note below)
- Poor peripheral perfusion- damped or decreased SPO$_2$
- Often tachycardia- but severe bradycardia is a cause
- Nausea/ vomiting post spinal anaesthetic
- Confusion, stupor in awake patient

Immediate Management
- ABC- ensure adequate oxygenation and ventilation
- Check BP again (if arterial line, check line and pressure bag)
- Look at patient’s colour and feel pulse (nature, rate, rhythm)
- Scan monitor- ECG, SPO$_2$, capnogram
- Administer vasopressor- metaraminol 0.5mg or phenylephrine 60mcg (caution if bradycardic), ephedrine 9mg.
- If severe hypotension and not responding to vasopressor: inform surgeon, raise pt legs if able, give adrenaline iv in 50-100mcg increments
- Optimize preload- 10ml/kg bolus crystalloid
- Consider decreasing anaesthetic depth

Subsequent Management
- Consider differential or use HPV mnemonic (below) to diagnose cause
- Consider placement of arterial line
- Assess blood loss, consider Hemocue®
- Treat tachyarrhythmias with synchronized DC cardioversion
- Treat myocardial ischaemia as appropriate- care with GTN if hypotensive
- Persistent hypotension- invasive + non-invasive monitoring: arterial line, central line, non-invasive cardiac output monitor if available, urinary catheter. Consider vasopressor/ inotrope infusion- Noradrenaline 1st choice if vasodilation thought to be the problem.

Differential Diagnosis
- ↓Preload- absolute (hypovolaemia, dehydration)
  - relative (caval compression, sympathetic block, PEEP, cardiac tamponade, tension pneumothorax, pneumoperitoneum)
- ↓Afterload- anaesthetic agents, sympathetic block, sepsis, anaphylaxis
- ↓Contractility- anaesthetic agents, ischaemia, acidosis, ↓T
- Rate- too slow or fast
- Rhythm- dysrhythmia, esp. nodal rhythm.
- Spurious- AF, cuff problem, DINAMAP dysfunction.

HPV Mnemonic
- Hypovolaemia- commonest cause
- Heart- rate/ rhythm/ contractility
- Pneumothorax/ Pericardial tamponade
- Pulmonary Embolism- air/ gas/ fat/ thrombus/ cement/ amniotic fluid
Cardiovascular Emergencies

- Vasodilation- Drugs Anaphylaxis Sympathectomy/ steroid lack Endotoxin
- Vasovagal

Another Algorithm:
PATIENT FACTORS- something wrong with heart? Look at patient/monitors
SURGICAL FACTORS- what is the surgeon doing? Blood loss?
ANAESTHETIC FACTORS- what drugs have I given? Anaphylaxis?
EQUIPMENT- is the measurement correct? Manual reading

Note re NIBP measurement by DINAMAP
In the event of marked hypotension or atrial fibrillation the DINAMAP may take several measurement cycles before producing a reading. Even then, this reading may be inaccurate. If you suspect severe hypotension it warrants prompt recognition and treatment. Do not persist with the DINAMAP, take a manual reading or palpate the systolic pressure as it cycles.
INTRAOPERATIVE HYPERTENSION

Presentation
- Elevated reading
- Measurement error- check arterial line if present
- Inadequate depth of anaesthesia
- Bradycardia (baroreceptor response)

Immediate Management
- ABC
- Look at patient and feel pulse- cool vasoconstricted vs warm vasodilated
- Scan monitors- exclude hypoxaemia (↓SpO2) and hypercapnia (↑ETCO2), ET [volatile agent].
- Confirm BP reading- repeat, consider manual reading (each OT has sphygmomanometer available)
- Chart and drug review- have normal anti-hypertensive medications been given?
- Deepen anaesthesia
- Consider giving more analgesia

Subsequent Management
- Determined by cause
- Consider placement of arterial line.
- Is there a tourniquet in use? - If so can it be released?
- If this is not a physiological response to a correctable cause: consider pharmacological methods to prevent myocardial ischaemia/ haemorrhagic stroke-
  - Beta blockade- esp. if tachycardic, esmolol 0.5mg/kg bolus followed by 20-30mg increments or infusion 50-200mcg/kg/min or metoprolol 1-2 mg increments
  - Vasodilators- esp. if cold, vasoconstricted hydralazine 5mg increments q15mins or GTN or phentolamine 1mg increments. May cause reflex tachycardia
  - Clonidine 1mcg/kg as slow push or infusion. Can cause bradycardia and sedation.
  - Remifentanil 0.5mcg/kg bolus and infusion titrated to effect. Caution with bradycardia, muscle rigidity and rapid offset of action.
- Recovery- consider ECG, troponin, HDU.

Differential Diagnosis
- Essential hypertension- check history and medication chart
- Secondary hypertension- renal disease, pregnancy induced hypertension.
- Sympathetic stimulation- light anaesthesia, hypercapnia, hypoxia, anxiety.
- Pain- surgery, arterial tourniquet, bladder distension
- Drug related: expected pharmacodynamic effect eg ketamine, ergometrine, absorption of adrenaline containing solutions; drug error eg. syringe swap; drug interaction eg. MAOIs + pethidine; drug abuse eg. amphetamines.
- **Rare causes of severe hypertension requiring specific therapies:**
  - Phaeochromocytoma – deepen anaesthesia, abandon surgery, **phentolamine 1mg increments, Magnesium Sulfate 5g loading dose, may need GTN/SNP and esmolol 1mg/kg bolus** for tachydysrhythmias.
  - Malignant Hyperthermia- see separate entry, raised ETCO$_2$, dysrhythmias, hyperthermia.
  - Raised Intracranial pressure- examine pupils, CT scan, see separate entry for specific management.
  - Thyroid Storm- expect hyperthermia, tachydysrhythmias and CNS dysfunction. Immediate management includes iv fluids with dextrose, **paracetamol 1g iv, hydrocortisone 200mg iv, esmolol** for tachycardia. Subsequent management involves use of specific anti-thyroid medications eg. **propylthiouracil 1g NGT** followed by **sodium iodide 500mg iv.**
**INTRAOPERATIVE BRADYCARDIA**

Defined as ventricular rate<60, absolute bradycardia is <40, relative bradycardia is rate inappropriate for haemodynamic state of patient. May be sinus bradycardia or associated with AV block.

### Immediate Management

- Nil treatment may be necessary if no CVS compromise. Does patient have slow resting heart rate? Are they beta-blocked?
- Correct underlying causes:
  - Children- hypoxia is usual cause of bradycardia and this needs to be immediately corrected.
  - Stop surgical stimulation that may be causing vagal stimulation eg. Insufflation of peritoneum (tell surgeon to decompress abdomen), traction on mesentery, perineal manipulation, oculocardiac reflex.
  - Drug causes- fentanyl and its derivatives, succinylcholine, anticholinesterases, beta-blockers (glucagon is antidote for beta blocker overdose), amiodarone, clonidine.
  - Others- hypothermia, raised intracranial pressure (expect marked hypertension), myocardial ischaemia, electrolyte disorders.
- Drug treatment:
  - Atropine 600mcg iv up to total of 3mg.
  - Glycopyrrolate 200-600mcg
  - Ephedrine 6-9mg, especially if hypotensive.
- Bradycardia unresponsive to above:
  - Adrenaline infusion 2-10ml/hr of standard infusion (3mg/50ml)
  - Isoprenaline 2mg in 50ml 5%dextrose (40mcg/ml)- give 0.5ml bolus and infusion 2-10 ml/hr. Isoprenaline is kept in the fridge supplied as 1mg in 5ml amps. It may be ineffective and can cause hypotension due to β2 stimulation.
  - Glucagon may be effective in a beta-blocked patient.
  - If poor cardiac output/ asystole- commence CPR, give adrenaline.
  - Pacing- temporary until definitive treatment
    - Percussion pacing- perform precordial thump using ulna side of fist.
    - Transcutaneous using defibrillator, SEE INSTRUCTIONS on following page.
    - Transvenous, need central access (right internal jugular preferred site) + kit + pacing box (kept in CCW)+ x-ray facilities.

### Subsequent Management

- Correct reversible causes, eg. Ischaemia, hypokalaemia.
- 12 lead ECG as baseline.
- Consider Holter tape
- If heart block- permanent pacemaker indicated for complete heart block and most 2nd degree heart block. Need CCU monitoring, transvenous pacing wire in interim.
TRANSCUTANEOUS PACING USING THE LIFEPAK 12
1. Press ON
2. Apply **defibrillator ECG electrodes** (4) to patient, select Lead (usually II)
3. Apply **QUIK-COMBO electrodes** to patient, anterior pad below right clavicle and lateral pad in the 5th intercostal space over the apex of the heart.
4. Connect QUIK-COMBO electrodes to the therapy cable.
5. Press PACER and observe ECG rhythm. A triangle sense marker should appear above each QRS complex. If they don’t appear or are in the wrong place adjust ECG size or select another lead.
6. Press RATE and adjust to desired rate (usually 100).
7. Press CURRENT and adjust until get capture, usually need 50-100mA.
8. Press and hold PAUSE if want to see the underlying rhythm, printing will start automatically.
9. Default mode is DEMAND, if want to change to asynchronous or NON DEMAND mode, enter the OPTIONS button.
10. To stop pacing, reduce current to zero or press PACER.

If need to defibrillate and stop pacing, press ENERGY SELECT or charge the defibrillator. Pacing will automatically stop.
AIR/ CO₂ EMBOLISM

Presentation
- This depends on the volume (1-2ml/kg significant), rate of entry and whether there are small (pulmonary) or large (CVS) bubbles. Air is more harmful than CO₂ because the latter is rapidly absorbed.
- Precordial Doppler- this is an early and sensitive indicator and will alert you to gas embolism before the development of the typical triad- ↓ET CO₂/ ↓SpO₂/ ↓BP.
- Capnograph- sudden and marked decrease in ET CO₂, there may be an initial brief ↑ET CO₂ if CO₂ embolus.
- Desaturation due to V/Q mismatch
- Hypotension due to impaired venous return
- Air alarm sounds on Level 1 rapid infuser (emergency shutdown should occur).
- Tachycardia, confusion and acute deterioration in level of consciousness followed by CVS collapse in an awake patient.

Immediate Management
- Notify surgeon- tell them to flood field with saline and compress bleeding points with wet sponges. If laparoscopy- get surgeon to decompress belly and disconnect gas. If neurosurgical case- compress jugular veins but avoid bilateral carotid compression.
- Turn off pressure infusing device if in use and confirm this is not cause of problem.
- Ventilate with high FIO₂, turn off N₂O if using it.
- Position the patient so that the operation site is below the level of the heart- this increases venous pressure and helps prevent further entrainment of gas. (An alternative position described if an airlock in the RV is suspected is to place the pt head down and in left lateral position- this manoeuvre is no longer recommended.)
- Aggressively treat hypotension with IV fluid bolus and vasopressors- Metaraminol 0.5-1mg boluses, Phenylephrine 50-100 mcg boluses, if slow or poor response give Adrenaline 100mcg (1ml 1:10000 minijet) boluses. If there is loss of cardiac output treat as for cardiac arrest and commence cardiac compressions.
- If have CVL in situ- aspirate from the distal lumen.

Subsequent Management
- Usually gas embolism is a short-lived event and responds well to prompt intervention. However, a prolonged stay in recovery is appropriate.
- Document the event on the anaesthetic record. Complete an anaesthetic incident report and PRIME incident report if equipment/ anaesthetic mishap.
- Controversial- consider the application of CPAP/ PEEP. This will increase CVP and may limit progression of the embolus but it also increases risk of paradoxical embolus.
- Bone wax can be applied to exposed bone sinuses.
- If the patient has delayed emergence- suspect cerebral embolism. Hyperbaric Oxygen therapy is effective in this event and dexamethasone 10mg should also be given.
Differential Diagnosis

- Anaphylaxis- rash, temporal relationship to drug administration, marked hypotension, allergies.
- Pulmonary Thromboembolism- similar presentation but slow/ partial response to therapy. May need inotropic support, CT pulmonary angiogram fastest and best diagnostic tool (if no TOE). Discuss with surgeon/ physician/ radiologist- whether anticoagulation or embolectomy indicated.
- Pneumothorax- chest signs will usually be diagnostic.
- Hypovolaemia- look for signs of recent massive blood loss, ask surgeon. In the event of CVS collapse during a laparoscopic procedure where the cause is not clear- instruct the surgeon to remove the ports, decompress the abdomen and convert to laparotomy. Perform Hemocue measurement, assess filling pressures and capillary refill.
- PEA cardiac arrest, manage as per arrest.
MASSIVE HAEMORRHAGE

Clinical scenarios where major blood loss can be anticipated
- Major trauma
- Obstetrics- placenta praevia, postpartum haemorrhage
- Major vascular surgery
- Revision joint arthroplasty
- GI haemorrhage
- Anticoagulated patient
- Major head and neck/ plastic surgery

Assessing blood loss
- Difficult, blood loss tends to be underestimated.
- Anaesthetist needs to be vigilant and regularly reassess blood loss. Hypotension is a late sign of hypovolaemia especially in otherwise healthy individuals- often the patient will have lost half their blood volume at this stage.
- Methods include- sucker bottles, weighing swabs, noting bloody drapes, surveying surgical field. **Objective measures of [Hb] are more useful**- Hemocue is kept in OT4, or send purple topped tube to lab for FBE- takes minutes and get a platelet count.

MANAGEMENT OF SEVERE BLOOD LOSS

Priorities:
- Restore blood volume to maintain tissue perfusion and oxygenation
  - Normal saline is the crystalloid of choice, give 3 x blood volume lost
  - Voluven and Albumin are appropriate colloid choices- give in same volume as blood loss.
  - Oxygen delivery = C.O. x SpO\textsubscript{2} x [Hb] x 1.34. C.O. and [Hb] are most amenable to manipulation, high FIO\textsubscript{2} should be administered.
- Achieve haemostasis by:
  - Treating surgical causes of bleeding:
    - Direct compression, sutures, immobilization of fractures, bone wax, ligation of vessels, embolization (not currently available at THSD), and meticulous attention to haemostasis.
    - Procedure specific interventions, eg. PPH- empty and compress uterus, B-Lynch suture, intramyometrial PGF2\textalpha, internal iliac artery ligation, hysterectomy. **See separate entry POSTPARTUM HAEMORRHAGE**
  - Correcting coagulopathy with appropriate use of blood products (see below)
  - Reverse anticoagulant medications- FFP/ Prothrombinex for warfarin, protamine for heparin, DDAVP for aspirin 0.3 mcg/kg as infusion.
  - Use of recombinant activated factor VII and Tranexamic acid where indicated (see below).
- Aggressive maintenance of normothermia.
This requires:

- Excellent IV access- 2 large bore IV cannulae at least, Rapid Infusion Cannula (RIC) even better- kit contains wire, scalpel and cannula. Choose a big vein; wire will fit through a 20g cannula if in situ. Large bore Central lines (MAC) are kept in the anaesthetic stockroom.

- Use dedicated blood giving infusion lines (TUTA set)- the standard IV giving set is not suitable for administering blood.

- Prevent delivery related errors- have separate labelled blood and drug lines.

- Fluid warmers and pressure infusers- eg. Level 1

- Forced air warmer applied- will need two; upper and lower.

- Establish monitoring:
  - IDC
  - Temperature
  - Arterial line
  - Central line
  - consider Cardiac Output Monitors- Vigileo, CardioQ.

- Adequate staff- have a low threshold to call in another anaesthetist other than the duty consultant. Ask the anaesthetic assistant to call their reserve also. Useful to allocate one person to fluid/ blood product management alone.

- Early liaison with lab and timely request for blood products

- Good communication with surgeon and scrub team.

- Consideration whether to use cell saver
  - Only takes few minutes to set up
  - Needs a minimum of 300mls collected blood loss to process.
  - There are multiple anaesthetic techs trained in its use.
  - Citrate anticoagulant used in collection sucker.

- Baseline investigations and repeat after administration of blood products or earlier as clinically indicated:
  - FBE/ PT/ APTT/ Fibrinogen/ ABGs/ U&Es inc. Calcium.

Specific Blood Component Therapy

- Haemorrhage is a dynamic process and invariably the anaesthetist must make an educated guess and order blood products before the results of formal tests are available.

- All hospitals have a Massive Transfusion Protocol (the Toowoomba protocol for adults is reproduced below)- the predominant purpose of this protocol is to ‘free up’ blood products once it is activated. Blood products are automatically delivered in a stepwise fashion once the protocol is activated.

- If you have a patient who has lost a half to one whole blood volume and is still actively bleeding- I suggest transfusing the patient with the equivalent of whole blood, i.e. 3U RBCs/ 6U FFP/ polybag platelets.

RBCs

- Concept of individualized transfusion trigger. Although transfusion almost always indicated when [Hb]<7g/dL and almost never when >10g/dL.

- ATLS recommends in trauma scenario that persisting haemodynamic instability after two 20ml/kg crystalloid boluses warrants commencement of blood.

- Despite lacking evidence most would have lower threshold to transfuse patients with ischaemic heart disease, renal impairment and severe respiratory disease.
• As well as absolute blood loss, other factors that may alter the transfusion trigger are:
  o Ability to control bleeding- bleeding from bone, pelvic veins may be technically very difficult to control.
  o Anticipated ongoing blood loss
  o Consequences of uncontrolled bleeding (eg. neurotrauma)
• A formula that may help:
  o Maximal allowable blood loss= Estimated blood volume (70 x bodyweight kg) x (starting Hb- lowest acceptable Hb)/starting Hb.
• The lab effectively instantly converts a group and hold into a crossmatch when requested. To get type specific blood takes less than 10 minutes from when a sample is sent. A supply of O negative blood is often held in your hospital’s ED.

Platelets
• Generally scarce and come as a polybag: equivalent to 4-5 units.
• Indicated in intraoperative haemorrhage scenario when count <50. Expect count to fall to this after 2 x blood volume replacement
• Aim for >100 in multitrauma, neurotrauma, abnormal platelet function (renal failure, clopidogrel) . need to order before count falls <100
• 1 unit increases count by about 5.
• Don’t use if ITP, DIC as platelets will quickly be non-functional.

Fresh Frozen Plasma
• Lab has rapid thawing device. 200mls/ bag.
• Indicated for emergency reversal of warfarin therapy (see below for guidelines)
• Indicated to correct microvascular bleeding in presence of elevated APTT/ PT or patient transfused > 1 blood volume.
• Subsequent FFP should be given in a 1:2 (FFP:RBC) volume ratio so that coagulation factor levels are maintained at approximately 30%. PT and clinical response are also useful guides.

Cryoprecipitate
• Only indication is treatment of hypofibrinogenaemia <1g/L in a bleeding patient. Expect this after 1.5 blood volume loss.
• Dose is 1 unit (30mls) per 10kg bodyweight.

NOTES RE USE OF RECOMBINANT ACTIVATED FACTOR VII, Novoseven
• Expensive but potent and potentially lifesaving haemostatic agent.
• Efficacy proven in RCTs for blunt trauma, intracerebral haemorrhage and radical prostatectomy.
• Case reports of efficacy in obstetric haemorrhage, uncontrolled surgical bleeding and wide range of clinical scenarios.
• May be accepted for use by some Jehovah’s Witnesses
• Main adverse effect is thrombotic events- these are rare in trauma pts
• Relatively short half life so give when bleeding, not as prophylaxis.
• Needs platelets >50, fibrinogen and treatment of acidosis to work best.
• Use is protocol driven- see QH protocol below.
QH rVIIa protocol August 2006

Exclusion Criteria:
1. severe acidosis < 7.15
2. temperature < 34°C
3. gun shot wound to head

Inclusion criteria:
1. Ongoing life-threatening haemorrhage that surgical and mechanical efforts have failed to control
2. Eight or more units of packed red blood cells have been administered in the last six hours, along with coagulation factor replacement:
   a. 8 units FFP
   b. 8 units platelets; and
   c. If available 10 units cryoprecipitate if fibrinogen low.
3. Aggressive attempts to correct acidosis and hypothermia have been performed
4. Persisting coagulopathy despite appropriate factor and platelet replacement
5. When appropriate specific pharmaceutical agents have been used to reverse warfarin and heparin.

Recommended Dosing:
- For reversal of anticoagulation 20-40 mcg/kg and assess response.
- For all other scenarios- give initial dose of 70-90mcg/kg. If no response after 30mins consider giving repeat dose of 90mcg/kg. Maximum of 2 doses to be given.

Guidelines for emergency reversal of warfarin therapy
- Prothrombinex-HT 30 IU/kg for INR<3 and 50 IU/kg for INR>3. This works rapidly (within 15 minutes) and the effect of Prothrombinex persists for several hours.
- If Prothrombinex-HT unavailable: Vitamin K 5-10 mg IV + FFP 10-15ml/kg

Notes on the use of Tranexamic Acid
- Tranexamic Acid is indicated for use in all major trauma/ bleeding patients. It is an antifibrinolytic drug. The main precaution with its use is thrombosis and it should not be used in patients with active thromboembolism or a thrombophilia.
- It is best given early and the dosing recommendation as per CRASH2 Trial is:
  - Tranexamic acid 1g in 100mls saline over 10 minutes. Consider repeating bolus dose or giving 2nd dose as infusion.
TRANSFUSION REACTION

Presentation
- Fever, flushing
- Hypotension, tachycardia
- Anaphylactic shock- rash, wheeze
- Haemoglobimuria, oliguria
- Bleeding from IV sites, ooze in surgical field.
- An awake patient may complain of rigors, dyspnoea, anxiety, nausea, and back and chest pain.

Immediate Management
- STOP the transfusion and keep IV line open with saline in new giving set (circulatory collapse may make further IV access impossible).
- Check patient’s vital signs including temperature and record them.
- Check for respiratory signs- wheeze, tachypnoea, and cyanosis.
- If severe reaction- treat as per ABC and give 100% O₂
- Recheck ID of patient and unit of blood and blood documentation.
- Check drug error hasn’t occurred.
- Be prepared to manage full-blown anaphylactic shock. See also ANAPHYLAXIS

Subsequent Management
- Collect new blood samples for blood bank to re-check ABO and crossmatch (pink topped tube). Also collect blood for U&Es/ FBE/ coags and haemolysis tests (white, purple and blue topped tubes).
- Clamp tubing on giving set and send unit with attached filter to the lab with above blood tubes.
- Notify lab of incident 6518 and discuss with pathologist on duty.
- Take blood cultures from a different IV site.
- Insert IDC if haven’t already done so and send urine for analysis.
- A major reaction will warrant CCW admission.
- Complete PRIME incident report- this will be sent to the hospital transfusion committee.

Special Considerations
- If fever or an urticarial rash are the only features present:
  - Recheck that correct blood is being transfused.
  - Give paracetamol for fever
  - Give antihistamine for urticaria
  - Recomence transfusion at a slower rate using a leukocyte depleting filter.
  - Monitor the patient closely
- A major reaction that occurs shortly after the commencement of blood most likely represents an acute haemolytic reaction. The commonest cause of this is clerical error. DIC and renal failure from haemoglobinuria result and require aggressive management to support BP and renal output.
- Bacterial contamination (most common with platelets 1/12000) may present as septic shock and is associated with a high mortality.
THE PATIENT WITH PULMONARY HYPERTENSION

Causes of pulmonary hypertension
- Secondary- related to cardiac pathology (mitral valve disease, LVF, L to R shunt), lung pathology (COPD, pulmonary fibrosis) or OSA—pulmonary vasculature relatively ‘fixed’ with variable and unpredictable response to pulmonary vasodilators.
- IPAH- rare disease with high perioperative morbidity, high risk thrombosis.

Features of pulmonary hypertensive crisis/ acute RVF
- Precipitated by ↓contractility (RV ischaemia), pressure overload (↑PVR) or volume overload (tricuspid regurgitation).
- Pressure overload commonest as RV unable to compensate for acute rises in PVR/afterload.
- A downward haemodynamic spiral results as the RV dilates, output falls and coronary perfusion pressure (CPP) is further reduced. The cardinal haemodynamic findings are low CO and high CVP.
- Echo is the best diagnostic tool to confirm perioperative RV failure.

Principles of perioperative management
- Maintain regular medications, consider premedication with prostacyclin neb and/or sildenafil po.
- Avoid factors known to increase pulmonary vascular tone, namely:
  - Hypoxia
  - Hypothermia
  - Acidosis
  - Atelectasis, High airway pressures
  - Sympathetic stimulation (pain, anxiety)
  - Nitrous oxide
- Maintain coronary perfusion pressure- hypertrophied RV behaves similarly to LV in terms of being primarily perfused during diastole. For severe cases it would be prudent to commence a vasopressor infusion prior to induction.
- Monitoring- arterial line, CVL allows measurement CVP + administration vasoactive agents. PAC cannot be recommended.
- VTE prophylaxis.
- No good evidence to favour volatile-based or TIVA anaesthetic but desflurane is probably best avoided because of its sympathomimetic properties. Neuraxial anaesthesia is not contraindicated.
- All perioperative therapies are supported by expert opinion at best.
- High dependency environment until have no vasopressor requirements and exacerbating factors ((listed above) are no longer a concern.

Specific Pharmacotherapy (may not be available in regional/ rural centre)
- Haemodynamic aims are to reduce pulmonary pressure if it is raised, maintain RV contractility and preload and maintain systemic arterial pressure, i.e. CPP.
- Pulmonary Vasodilators- Sildenafil po, Prostacyclin (inhaled delivery avoids problem of hypotension and platelet dysfunction with IV route).
- **Vasopressors**- all agents will affect pulmonary tone to a degree. The preferred agents are *noradrenaline* and *phenylephrine*. *Vasopressin* may be useful for patients who poorly respond to these agents.

- **Inotropes/ Inodilators**- *dobutamine*, *noradrenaline*, *adrenaline* and *milrinone* are all effective agents. *Milrinone* causes systemic as well as pulmonary vasodilation and so needs to be used in conjunction with a vasopressor. It has also been given as a nebulised solution. Tachycardia often limits the dose of *dobutamine* that can be given.

**Pulmonary Hypertension Kit for Toowoomba Hospital- contents and dosing guidelines**

- **Sildenafil 1X 100mg tablet**: break in half, crush tablet and give via NGT if anaesthetized. Avoid if patient is on nitrates.

- **Iloprost** (prostacyclin analogue) 5 amps (20mcg/2ml)- give as Nebuliser 5-10mcg over 5 mins.

- **Milrinone 1 amp (10mg in 10mls)** – 2-5mg via nebuliser or as infusion: Loading Dose 50mcg/kg over 10mins then maintenance infusion 0.375-0.75mcg/kg/min.

- **Vasopressin 2 amps (20U in 1ml)**- infusion 0.01-0.04 U/min. One method to achieve this dose is to put 2 amps (40U) in 40mls and start at 2ml/hr.

- **Octreotide 1 amp (100mcg in 1ml)**- may be useful for pulmonary hypertensive crisis/ bronchospasm in carcinoid syndrome, give IV in 25mcg increments.
HYPOXIA

Presentation
- \( \text{SpO}_2 < 90\% \)
- Cyanosis
- Confusion and restlessness in sedated patient
- Bradycardia in children

Immediate Management= HYPOXIA DRILL
- Believe your monitors. The pulse oximeter is a lag monitor- you are already behind.
- Look at the patient- what is their colour? Are they breathing/ being ventilated? Is their airway patent? Check the pulse oximeter is properly attached.
- Feel the pulse- is this an arrest? Hit the BP button to do a reading. Do they have an adequate cardiac output?
- Give 100% \( \text{O}_2 \) at a high flow rate and hand ventilate- look for chest expansion. Assess the compliance of the patient’s lungs and of the anaesthetic circuit. If you are having difficulty ventilating, disconnect the circuit from the tube and squeeze the bag to quickly exclude a circuit problem.
- Look at your monitors- check the \( \text{O}_2 \) analyzer to confirm that you are delivering oxygen, look at the capnograph to confirm that you are ventilating the patient.
- Inspect and auscultate the chest- are there wheezes or crepitations? Bilateral air entry? Check the airway device again- if in doubt, remove and replace it.

The above drill will alert you to >95% of causes of hypoxia and lead you towards correcting them. The commonest causes seen intraoperatively are:
- Airway problems- obstructed, LMA/ ETT malposition/ blocked.
- Hypoventilation
- V/Q mismatch- this is less readily corrected but if suspected a trial of alveolar recruitment using large tidal volumes and high PEEP should be performed. Recruitment manoeuvres should correct hypoxia at least transiently- if they don’t and you have eliminated the other causes it suggests the presence of a large shunt.

The COVER algorithm is an alternative that can be applied for use in the event of hypoxia. A laminated copy is attached to each anaesthetic machine (See APPENDIX for a full description). In brief, COVER stands for:
C Circulation
  Colour
O Oxygen
  \( \text{O}_2 \) analyzer
V Ventilate by hand
  Vapourizer
E ETT/ LMA
  Eliminate anaesthetic machine
R Review monitors
  Review equipment
Subsequent Management
- Dictated by cause of hypoxia
- In situations of prolonged hypoxia it is usually appropriate to:
  - Call for help
  - Intubate and ventilate if you haven’t already done so
  - Order a CXR and perform ABGs
  - Exclude methaemoglobinemia- ABG for co-oximetry analysis.

Differential Diagnosis
- In the OT I find it is most useful to think of causes of hypoxia in a stepwise manner following the path of oxygen from the pipeline to the alveolus:
  - Wall to airway- wrong gas, O₂ pipeline supply failure, O₂ not turned on, circuit has leak/ is disconnected/ is blocked, forgot to turn ventilator on.
  - Airway- LMA/ ETT malposition/ blockage, laryngospasm.
  - Chest: from the trachea to the alveolus and back out to the chest wall-
    - Large airway compression/ trauma
    - Lung vasculature- embolism, shunt, anaemia
    - Alveoli- collapse, oedema, sepsis
    - Diaphragm and chest wall- restrictive deficit
  - CNS- hypoventilation from drugs/ pain/ hypothermia.
- This is graphically represented below
- Carbon Monoxide and Cyanide poisoning are rare but potent causes of hypoxia-their pulse oximetry readings may be normal or even elevated.
LARYNGOSPASM

Presentation
- Stridor, typical high-pitched inspiratory ‘crowing’ with partial obstruction
- Respiratory distress- tachypnoea, recession, tracheal tug
- Severe laryngospasm- apnoea, inability to ventilate, rapidly progressive desaturation
- May be vomitus, blood or mucus in the oropharynx

Immediate Management
- Stop the stimulus that precipitated laryngospasm (see Risk Factors).
- Clear the airway:
  - Apply jaw thrust
  - Suction blood, mucus if visible; avoid blind insertion of sucker.
  - If vomit present and aspiration suspected revert to aspiration drill (cricoid pressure, lateral position, suction, intubate)
  - Remove airway devices that may be stimulating the larynx
- Apply CPAP with 100% O₂ via bag and mask
- If winning: maintain CPAP and airway support until spasm is totally relieved
- Not winning: Call for help, deepen anaesthesia (Propofol 2-4 ml boluses) and continue CPAP.
- If continues to desaturate: give Suxamethonium 20mg (adult); beware of bradycardia with 2nd dose of sux especially in children. Have Atropine 20mcg/kg available. If no iv access give Suxamethonium 2-3 mg/kg im or into the tongue. Decide whether to bag-mask ventilate or establish an airway with LMA/ ETT.
- If all else fails a surgical airway may be lifesaving.

Subsequent Management
- Recover/ extubate in theatre
- Document episode in anaesthetic record
- Consider passage of NGT to decompress stomach if intubated.
- Monitor for development of negative pressure pulmonary oedema if episode was prolonged.

Risk Factors
- Light anaesthesia
- Soiling of larynx with blood, pus, gastric contents
- Surgical stimulation esp. anal stretch, cervical dilatation
- Reactive airways- asthmatics, smokers, URTI
- Infants
- Instrumentation of airway
- Desflurane> Isoflurane> Sevoflurane
BRONCHOSPASM

Presentation
- ‘Tight’ bag progressing to difficulty to ventilate. High airway pressure alarm, decreased expiratory tidal volume. Severe bronchospasm presents most commonly immediately after intubation. Delayed onset should make you suspicious of another diagnosis (see Subsequent management).
- Up-sloping expiratory capnogram, markedly reduced ET CO\(_2\), may be no trace with severe bronchospasm. (Don’t forget other causes of no trace, eg. No C.O.)
- Wheeze or even silent chest
- Desaturation
- Tachypnoea, tachycardia, hypotension (↓ venous return from ↑ intra-thoracic p).

Immediate Management
- Exclude problem with airway (kinked, blocked, malposition- esp. near carina or endobronchial) or circuit (kinked, HME filter clogged, valve problem). If in doubt- remove and replace the airway. Disconnect the circuit from the most distal point and squeeze the bag to confirm easy emptying- if suspect a problem with the circuit, use the AIR-VIVA bag attached to the anaesthetic machine.
- Give 100% oxygen, hand ventilate.
- Deepen anaesthesia- Propofol 2-5ml bolus; increase F\(_I\) volatile agent (NOT if using Desflurane), consider changing to Sevoflurane.
- Further Management:
  - Give Salbutamol 6-8 puffs through red-topped adapter kept in top of 2\(^{nd}\) drawer of anaesthetic machine. Adapter is placed distal to the HME filter. Metered aerosol can be inserted directly into the adapter. Repeat this q3mins as required.
  - Consider Glycopyrrolate 400mcg IV or intra-tracheal.
- If unresponsive:
  - Salbutamol IV 250mcg as slow bolus (children 5-10mcg/kg) then infusion 5-20mcg/min. This is supplied in 500mcg/1ml amps kept in the crash trolley. It can be diluted in water/saline/dextrose.
  - And/ or Aminophylline 5mg/kg over 15mins
- In extremis:
  - Adrenaline IV 10mcg increasing to 100mcg (Can also give down ETT). Expect tachycardia and hypertension. Risk of arrhythmias especially if hypoxic and hypercarbic. Commence infusion once responding to treatment.
  - Ketamine 1mg/kg then infusion
  - Magnesium 2g over 5 mins
  - External chest compression to assist expiration
  - Heliox –but low FIO\(_2\) (28%) limits its usefulness in hypoxic patient. See also Other Airway Equipment Items in APPROACH TO THE DIFFICULT AIRWAY.
- Ventilation Strategy- you may be forced to hand ventilate but if able to use ventilator the principles are to:
  - Slow respiratory rate with prolonged expiratory time, I:E ratio of 1:4
  - Permissive hypercapnia
  - May need to disconnect from ventilator to prevent excess auto-PEEP.
Subsequent Management

- Give hydrocortisone 100mg IV
- Decide whether it is appropriate to extubate or not. Extubate/recover in theatre. Consider extubating deep.
- Avoid use of anticholinesterase if possible. Avoid histamine releasing drugs and NSAIDs.
- Caution with hypokalaemia from use of sympathomimetics.
- Document in anaesthetic record
- Exclude important differential diagnoses:
  - Anaphylaxis - 15% may present with bronchospasm, marked hypotension is invariably also present.
  - Pneumothorax - consider CXR
  - Aspiration
  - Pulmonary oedema
  - **Don’t forget circuit/airway problem again**
- Medical review is generally warranted; write pt up for supplemental oxygen and regular Salbutamol/Ipratropium Nebs.
ASPIRATION

Presentation
- Gastric contents in airway device/ oropharynx
- High airway pressure, wheeze
- Laryngospasm
- Respiratory distress
- Desaturation

Immediate Management
- Apply cricoid pressure unless pt is actively vomiting
- Put pt in left lateral position- only if practicable and can do quickly
- Suck out pharynx/ larynx
- Intubate the pt and suck out ETT with suction catheter (size= 2 x ETT size)
- Ventilate with 100% O₂ as necessary to prevent hypoxia during above procedures
- Expect bronchospasm and treat as appropriate
- Insert NGT and empty stomach
- Cancel elective surgery if occurs on induction
- Decide whether aspiration is significant or not:
  - Solid material suctioned from trachea
  - Contaminated aspirate
  - Metabolic acidosis
  - Ongoing hypoxia/ chest signs/ need for ventilatory support
- If significant:
  - Perform bronchoscopy +/- lavage and send for gram stain.
  - ICU admission

Subsequent Management
- Document episode in anaesthetic record and chart
- Arrange medical review and ensure pt receives supplemental oxygen
- Order CXR- may be normal initially
- No evidence to support the routine administration of antibiotics or steroids in cases of aspiration. Most would give antibiotics if evidence of infection- preferably guided by results of bronchial lavage. Empiric therapy would be broad spectrum with gram negative and anaerobe cover.
DOUBLE LUMEN TUBE

Indications for use

- A double lumen tube (DLT) facilitates the isolation of each lung and allows for their independent ventilation and/or collapse.
- This may be indicated electively for: surgery involving the thorax where lung deflation is required to optimize surgical exposure e.g., Video assisted thorascopy, lung resection, pleurodesis, oesophagectomy. This is a relative indication for a DLT.
- This may be indicated emergently in two situations:
  - To prevent contamination of the other lung by blood or pus, e.g., Pulmonary haemorrhage.
  - To control the distribution of ventilation as in a bronchopleural fistula or tracheobronchial trauma.
- DLTs are large, rigid, and are relatively difficult to insert. The use of a fibreoptic bronchoscope to check their position is mandated as there is a high incidence of malposition using clinical signs alone.

Options to achieve lung isolation

- Advancing a single lumen tube (SLT) into a mainstem bronchus. A SLT will most commonly go down the right main bronchus. This will often also cause obstruction of the right upper lobe bronchus. The MLT tube is the best for this as it is longer than a standard tube and small enough to fit in the bronchus (5.0mm internal diameter). Use of the bronchoscope allows confirmation of which side it is down and it may be used to direct it preferentially to a side. A SLT doesn’t permit access to the other lung and is suitable for short term use only.
- Use of a bronchial blocker (BB): this is generally advanced through an existing SLT in the trachea. The Univent tube is a SLT with a BB incorporated. We have an Arndt catheter BB which can be placed through an existing SLT through an adaptor with the use of a flexible bronchoscope. A Fogarty catheter is another device that can be used as a BB. All of these devices are difficult to place correctly and cannot be recommended to the novice practitioner.
- DLT- we stock Mallinckrodt Broncho-Cath and Sheridan tubes in varying sizes and sides. This is the best option, especially for cases of pulmonary haemorrhage as it allows inspection and ventilation of either lung.

Sizing and placement of a DLT

- Look at the CXR and determine whether there is distortion or narrowing of the trachea. A CT chest (if done) will demonstrate this.
- For males >170cm 41F <170cm 39F
- For women >160cm 37F <160cm 35F (this has an outer diameter of 11.7mm)
- Insert it to a predetermined length or stop if meet resistance. The predetermined length is 30cm per 170cm then 1cm per 10cm height after that.
- Use a left sided DLT- these are easier to place correctly and avoid the problem of occluding the right upper lobe bronchus. The tube has 2 curves, a proximal and distal one. Insert it through the glottis with the distal curve concave anteriorly, remove the stylet and twist it 90 degrees anticlockwise as it is advanced down the trachea.
• Inflate the tracheal cuff 1st to confirm you are in the lung. Do not use more than 
3mls to inflate the bronchial cuff, use the minimum amount to achieve a seal.
• Check position with the bronchoscope- through the tracheal lumen you should just 
be able to see the top of the blue bronchial cuff below the carina.
• Recall that the cartilaginous rings of the trachea are anterior.
• For the patient requiring a DLT who is also a suspected difficult intubation. One 
option is to place a SLT orally and exchange it for a DLT over a bougie or airway 
exchange catheter. The blue Frova bougie should be used as it is longer than a 
standard bougie and it permits ventilation via the attached rapi-fit adapter.

Management of hypoxia during one lung ventilation (OLV)

• A large shunt develops during OLV as one lung is being perfused but not 
ventilated. Increasing the FIO₂ will minimally help with shunt, nevertheless 
patients are usually already receiving a high FIO₂ during OLV.
• The goal is to deliver oxygen to the ventilated lung that is being met with an 
adequate cardiac output.
• Check the position of the tube clinically and with the bronchoscope- malposition 
is common, especially with changes in patient position. Suction both lungs, check 
the cuffs. Treat bronchospasm, ensure adequate paralysis.
• If the patient is desaturating- resume dual lung ventilation until you have rectified 
the hypoxia.
• Subsequent options are then:
  o Insufflate oxygen to the non-dependent (unventilated) lung- easiest way to 
do this is to place a fine green oxygen catheter into the bronchus and 
insufflate 2-4l/min of oxygen. This is all that is needed usually.
  o Apply CPAP to non-dependent (up) lung- there are commercial devices 
available to achieve this
  o Apply PEEP to dependent lung- this way worsen shunt
  o Getting the surgeon to ligate the pulmonary artery to the non-dependent 
lung.
POWER FAILURE

Presentation
- Depends on whether it is an isolated theatre failure, mains power supply failure ± emergency generator supply failure.
- Workstation monitoring screens may go blank before backup battery leads to system booting up. (See below)
- Theatre lights may go off, blink, go off and then come back on.
- AC power failure alarms will sound on devices with charged back-up batteries.
- Failure of other devices without charged back-up batteries eg. syringe drivers, warming blankets, diathermy, laparoscopy stacks.
- Theatre air-conditioning fails.

Immediate Management
- Check workstation hasn’t been accidentally unplugged.
- Call for help; notify theatre coordinator and get them to contact hospital engineer.
- If dark- call for torches (there are two for each theatre- one ‘Dolphin’ type torch on the top shelf in the anaesthetic bay and another is kept in the cupboards outside the theatre exit doors), open up blinds and doors, laryngoscope can be used as a light source.
- Check the patient- feel their pulse, are they breathing? Have they been electrocuted?
- Switch to manual and hand ventilate the patient if not breathing spontaneously.
- Ensure O₂ supply is intact- feel for gas flow at end of circuit, check pipeline pressure (O₂ analyser will not function). Turn on O₂ cylinder if unsure.
- Confer with surgeon- decide whether to continue or abandon surgery. If continue-finish operation as soon as possible.
- Establish patient monitoring- finger on pulse, chest rise and fall, stethoscope, manual BP. Bring in battery powered transport monitor kept in anaesthetic bay.

Subsequent Management
- Call for information about nature and duration of power failure.
- Don’t commence new operation until problem corrected.
- See if circuit breaker has tripped (located beside theatre lights switch)- if so there may be a dangerous electrical fault in a piece of equipment.
- Reallocate personnel and resources to areas where they are needed, eg. Shining light on operative site.

Notes re Anaesthetic Machines in event of power failure
- Most modern machines have a battery back-up and function normally even in the event of a mains power failure.
- Not uncommonly a power lead can be dislodged and this may lead to a transient loss of function before the battery kicks in and the machine reboots itself.
- In the unlikely event (it has happened though- powerboard failure) that all power is lost the machine can still be used- you will have to hand ventilate though. Most machines have an auxiliary manual flowmeter control. The Aespire GE machine has manual rotameters so these can continue to be used normally even with complete power failure.
Equipment Emergencies

- Remember that the Desflurane vaporizer is electrically powered and will fail. It should be turned off and another vaporizer used.
- Gas supply will be maintained and it is not necessary to turn on your oxygen cylinder in the event of a power failure.
VENTILATOR FAILURE

Presentation

- Loss of capnograph, apnoea
- High airway pressure alarm
- Low expired tidal volume, low MV alarm
- Failure to deliver set $V_T$ if VCV

Immediate Management

- Exclude power failure- blank screens
- Check manual/ ventilator selection switch is set correctly
- Switch to manual ventilation, close APL valve and hand ventilate.

**Further management depends on the response to hand ventilation:**

- If hand ventilation adequate- continue to manually ventilate or use alternative breathing system until have rectified problem with ventilator (see below).
- If bag won’t fill or empties quickly, exclude:
  - O$_2$ supply failure (drives the ventilator)- multiple alarms active.
  - Disconnection or large leak in breathing system ([see separate entry](#)). If you suspect this and can’t rectify it quickly use the AIR VIVA bag as an alternative means of ventilation.
  - ETT/LMA problem- dislodged, cuff leak, cuff above cords

- If bag fills but feels tight when ventilating- manage as per high airway pressure ([see separate entry](#)).

Subsequent Management

- Clearly label and remove anaesthetic workstation if ventilator is faulty.
- Notify anaesthetic technician supervisor and theatre manager so alternative arrangements can be made.
- Arrange repair by suitably qualified person.
- Complete Anaesthetic Incident Report form.
- If a design or system fault is detected a formal report needs to be logged with the manufacturer and the appropriate authorities.

Common ‘ventilator’ problems with modern anaesthetic workstations

- Flow sensor malfunction-
  - Presents with ↑ET CO$_2$, low expired tidal volume and low MV.
  - The problem results from moisture contaminating the flow sensors and the ventilator delivers an inappropriately decreased volume. It is seen with volume-controlled ventilation particularly during a long case.
  - To correct the problem: switch ventilator to PCV mode, remove moisture from circuit. Calibrate and dry flow sensors- this requires temporary interruption of ventilation ([See APPENDIX- Workstation Checkout](#)).

- Bellows doesn’t rise to top, Alarm: circuit leak/ bellows unable to be filled-
  - Commonest cause is a leak in the circuit distal to the machine, most commonly around the airway device esp. if LMA, uncuffed tube.
**PIPELINE O₂ SUPPLY FAILURE**

**Presentation**
- Multiple alarms will be activated including:
  - O₂ supply pressure low
  - Ventilator has no drive gas
  - P peak low ?leak
  - System leak
  - Apnoea alarm if IPPV
- Ventilator failure (See separate entry) as O₂ is the drive gas.
- Inability to deliver O₂
- Hypoxaemia may rapidly ensue unless an alternative oxygen supply is secured.

**Immediate Management**
- Make sure have started gas flows on workstation.
- CALL FOR HELP and extra oxygen cylinders.
- Turn on the reserve oxygen cylinder.
- Check the O₂ analyser confirms the return of O₂ flow. Check the cylinder pressure reading on the machine monitor.
- Check for disconnection between pipeline and wall outlet (forgot to reconnect after one gas test).
- Manually ventilate the patient at low FGF to conserve O₂ unless patient is hypoxic.
- Options for gas supply in event of pipeline failure:
  - Reserve O₂ cylinder- may control using the Alternate Oxygen Control if there is an electronic workstation failure also.
  - Used pipeline AIR supply if intact (check pipeline pressure reading on workstation).
- In the event of O₂ supply fail the machine will alert you to two options on the screen: Open an O₂ cylinder or connect the O₂ pipeline OR Select YES to use Air Only.
  - Ventilate using alternate breathing circuit attached to alternative O₂ supply eg. Cylinder. Note- this is unnecessary in the event of an isolated pipeline O₂ failure.
- Vaporizers can continue to be used normally.
- Inform the surgeon and ask them to complete surgery ASAP.

**Subsequent Management**
- Call for information re the nature of the problem- is it isolated to the OT or throughout the theatre complex or hospital wide.
- Check gas supply panels in theatre complex- Green signifies all OK, orange signifies decreased pressure but still functional, red signifies dangerous reduction in pipeline pressure.
- Inform the theatre manager and Hospital Engineering Department.
- Disconnect the pipeline supply- re-establishment may result in a flow of contaminated gas or the wrong gas may be connected at the source.
- Don’t recommence surgery until the problem has been definitively corrected.
Equipment Emergencies

- Ensure you have adequate O₂ cylinder supply to finish the case. (A full E cylinder with a FGF of 2l/min will last over 4 hours).
- Ensure the reserve O₂ cylinder is replaced with a full cylinder.
BREATHING SYSTEM DISCONNECTION/ LEAK

Presentation
- If spontaneous ventilation- bag empties, altered or absent capnograph, fall in FIO₂, desaturation, patient may wake up.
- If IPPV- ventilator bellow empties, no or ↓ET CO₂, alarms sound for low airway pressure/ apnoea/ low expired tidal and minute volumes.

Immediate Management
- Switch to manual ventilation with high FIO₂ and close APL valve.
- Press O₂ flush button to fill reservoir bag.
- Squeeze bag and check for adequate chest expansion, observe the capnograph for a normal waveform.
- Quickly scan the circuit from the CGO to the airway device to detect an obvious disconnection.
- If ventilation is adequate- check for leaks (see subsequent management).
- If ventilation is inadequate- abandon the breathing circuit and ventilate with the AIR-VIVA bag attached to the workstation. Connect O₂ tubing from auxiliary flowmeter. May need to institute IV anaesthesia while the problem is rectified if you were using a volatile based anaesthetic.
- If you still can’t ventilate- check the ETT/ LMA for displacement. If necessary remove the airway device and ventilate with a face mask while you prepare to re-establish the airway.

Subsequent Management
- Perform a methodical inspection of the tubing and all connections in the breathing system from the airway device to the ventilator. Common causes of a leak are:
  - Disconnection of gas sampling line from HME filter
  - Soda lime canister not seated or missing rubber seal
  - Loose connection of tubing at CGO/ ventilator
  - Vaporizer not seated on back bar correctly
- You may need to change the circuit. In this event perform the circuit check process prior to commencing a new case.
HIGH AIRWAY PRESSURE

Presentation
- High airway pressure alarm- machine default setting is 40cm H₂O.
- Low tidal volume/ minute volume alarm if IPPV
- Difficult manual ventilation
- Abnormal or even absent capnograph trace
- ‘fluttering’ of expiratory valve
- Hypotension due to raised intrathoracic pressure impeding venous return

Immediate Management
- Switch to manual ventilation using high FIO₂.
- Squeeze bag to confirm difficult ventilation.
- Scan breathing system and airway device for obvious obstructions, eg. kinked tube/tubing.
- If signs of light anaesthesia (laryngospasm/ coughing/ biting on tube) deepen anaesthesia with IV propofol.
- Check muscle relaxation using nerve stimulator.
- Check circuit is okay by disconnecting from airway device and:
  - Confirming reservoir bag empties easily while disconnected and
  - When attach 2nd bag to end of circuit you can easily fill each bag in turn by squeezing them alternately. (This assesses the integrity of the inspiratory and expiratory valves—see special considerations*)
  - If bag doesn’t empty easily or the 2nd bag is abnormally distended, abandon the circuit and use an alternative means of ventilation, i.e. AIR VIVA bag.
- If ventilation is still difficult the problem is with the airway device or the patient.
  - Check the ETT/LMA is positioned correctly and patent:
    - Remove/ reposition/ replace as necessary.
    - Consider passing a suction catheter down the ETT to assess patency.
  - Examine the patient:
    - Auscultate chest for: wheezes/crepitations (?bronchospasm), bilateral air entry (?endobronchial intubation).
    - Inspect chest for movement/ feel tracheal position/ look for distended neck veins (?pneumothorax)
    - Look for rash (?anaphylaxis)

Special Considerations
- There is a large list of possible patient-related causes of high airway pressures but commoner causes are:
  - Return of muscle power
  - Bronchospasm
  - Lung/ lobar collapse
  - Aspiration
  - Pneumothorax
  - Pulmonary oedema
- In some situations the raised airway pressure may be appropriate for the clinical scenario, eg. Obese patient, Trendelenburg position, pneumoperitoneum,
restrictive lung disease. Nevertheless common causes of high airway pressure need to be searched for and excluded before accepting elevated airway pressures. A common example is migration of the ETT down the right main bronchus in an obese patient undergoing a laparoscopic procedure.

- Ventilator strategies to limit airway pressure in clinically appropriate scenarios include:
  - Decrease tidal volume and respiratory rate
  - Increase I:E ratio to 1:1
  - Turn off PEEP
  - Avoid steep Trendelenburg
  - Use PCV but check minute volume ventilation is adequate; may have to accept a degree of hypercapnia.

- If using PCV- lower expired tidal volumes may be the first and only indication of a problem. ET CO\(_2\) takes some time to rise.

- *Increased expiratory resistance in the breathing system can be very difficult to diagnose unless you test the circuit with a 2nd bag attached.
  - Causes include a malfunctioning APL valve, expiratory valve sticking or stuck closed, ventilator expiratory valve stuck, scavenging system malfunction
  - It may be a diagnosis of exclusion when there is difficult manual ventilation despite excluding airway and patient problems.
  - Management entails disconnecting the patient from the circuit to release the high intrathoracic pressure and using an alternative ventilation system.
# INTUBATE BUT CAN’T VENTILATE

## Immediate Management
- CALL FOR HELP - the patient will rapidly become hypoxic unless the problem is rapidly corrected.
- Switch to manual ventilation, close the APL valve and hand ventilate with 100% O₂.
- Further management is dependent on determining in which of the 4 areas described below the problem resides. Each area should be assessed in the order described below until the problem is rectified.

## 1. Anaesthetic Workstation/ Breathing Circuit
- Disconnect the circuit from the most distal point (including HME filter) and test circuit integrity by either connecting another reservoir bag to the end or quickly squeezing the bag to ensure it empties easily.
- If circuit suspect use a separate means of ventilation, i.e. AIR VIVA bag connect O₂ tubing from auxiliary O₂ flowmeter.

## 2. ETT (LMA)
- It may be: down too far, not in the trachea, kinked, lumen obstructed, cuff above cords or cuff herniated.
- Check position of the tube, listen for air entry, perform direct laryngoscopy, pass suction catheter down ETT, deflate the cuff.
- If in doubt - remove and change the tube.
- Bag mask ventilation should be effective in this situation.

## 3. Distal to ETT
- There may be obstruction in the trachea, bronchi or small airways.
- Auscultate and inspect the chest - is this bronchospasm? See also BRONCHOSPASM
- May be able to push the ETT further down past the obstruction or pass a smaller diameter MLT tube.
- Changing patient position to lateral or supine is valuable if bronchial compression is suspected.
- Rigid bronchoscope may facilitate ventilation if bronchial compression.
- Consider performing bronchoscopy.

## 4. Chest Wall
- Muscle rigidity - has the relaxant worn off, is the patient fighting the ventilator or biting on the tube, is this an opioid induced adverse effect eg. remifentanil bolus - this is reversible with naloxone.
- Pneumothorax:
  - Signs of pneumothorax during IPPV - ↑ airway pressure, ↓ET CO₂, hypotension, desaturation, neck vein distension, tracheal deviation, reduced AE and hyper-resonance on affected side, asymmetric chest expansion.
  - Management entails high flow O₂; needle decompression with a 14G cannula in the 2nd intercostal space in the midclavicular line followed by placement of an intercostal catheter - preferably by the surgeon.
ANAPHYLAXIS/ ANAPHYLACTOID REACTION

Presentation
- Most commonly at ‘end of the needle’ but may be delayed up to 30-60 mins as is seen with latex allergy (see Approach to latex sensitive patient below).
- Cutaneous- urticaria, flushing/ erythema, pallor, angio-oedema
- CVS- hypotension, tachycardia, CVS collapse often preceded by bradycardia, cardiac arrest.
- Respiratory- cough, bronchospasm, laryngeal oedema, pulmonary oedema.

Immediate Management
- Cease agent, CALL FOR HELP & CRASH TROLLEY & ANAPHYLAXIS KIT. notify surgeon of need to terminate surgery ASAP.
- Airway- secure airway with intubation if necessary
- Breathing- ventilate with 100% O₂
- Circulation- IV access, 20ml/kg fluid bolus of saline or colloid, elevate patient’s legs, commence chest compressions if no output.
- Drugs- Adrenaline is the drug of choice.
  - Adult- give IV 50-100mcg increments as slow push (0.5-1 ml of 1:10,000 minijet).
    - If no IV access give 0.3 to 0.5mg IM.
  - Child- give 10mcg/kg IV or IM
    - 1ml 1:10,000 solution/ 10kg bodyweight.
  - In CVS collapse may need to give Adrenaline 0.5-1mg IV in divided doses.
  - If further adrenaline required, commence infusion 3mg in 50mls saline, start at 5mls/hr.
  - Never give undiluted 1:1000 adrenaline IV.
  - Patients on beta blockers may be resistant to adrenaline, in this case give increased dose of adrenaline ± noradrenaline infusion 3mg in 50mls
    - Also give: Glucagon 1 amp every 5 minutes until response.

Subsequent Management
- Establish invasive monitoring
  - Insert arterial line and IDC.
  - CVL if adrenaline infusion running.
- Give Hydrocortisone 200mg IV (4mg/kg child). This will not help in the acute stage.
- Consider antihistamines: oral agents only are recommended.
- Treat bronchospasm – see separate entry.
- Investigations: take blood for Tryptase level as soon as initial resuscitation has occurred and repeat at 1 and 6 hours post episode.
  - Collect 5-10 mls in white-topped tube. Ring lab and notify them of sample as it must be frozen at -20⁰C and sent to RBH for processing.
  - Tryptase levels peak 1 hr after the reaction and increase in both anaphylactic and anaphylactoid reactions. Levels >20ng/ml are diagnostic.
- Arrange admission to ICU.
Miscellaneous Emergencies

- Carefully document in the anaesthetic record all drugs that were given to the patient as well as the time course and nature of events.
- Put ALERT sticker on patient chart and medication sheets.
- Counsel the patient and refer them for formal allergy testing (skin prick, RAST) after 4 weeks. The PAH has an allergy testing clinic.
- Patient should wear a MedicAlert bracelet.
- Send letter to patient and their GP.
- Report the event to ADRAC, Adverse Drug Reactions Advisory Committee. This can be done on a ‘blue card’ or electronically through the website: [www.tga.gov.au/adr](http://www.tga.gov.au/adr)

ANAPHYLAXIS KIT

- ANZCA mandates that every theatre carry an anaphylaxis kit on their crash trolley.
- It contains the ANZCA endorsed ANZAAG Guidelines as well as other equipment that may be required for managing anaphylaxis.
- The Immediate and Refractory Management cards for Adults are reproduced on the following page as well as an excellent Differential Diagnosis cognitive aid.

Approach to latex sensitive patient

- Identify as ‘Anaesthetic Alert’. Risk groups are:
  - Hx Latex allergy
  - Hx rash/swelling/wheeze with balloons, condoms, gloves.
  - Repeated catheterisation, eg Spina Bifida
  - Hx allergy to fruit, pinenuts.
- 1st on list, OT to be empty for at least 2 hrs prior to minimize latex dust in theatre.
- Remove all latex containing gloves from OT. Staff to thoroughly wash hands before putting latex free gloves on.
- Cover any essential latex containing equipment which may come into contact with patient, for example:
  - Cotton sheet over mattress and arm boards
  - Velband over limbs prior to BP cuff, tourniquet.
- Put up warning signs ‘LATEX SENSITIVE PATIENT’ outside OT entrances.
- Induce patient in OT and recover them in OT.
- Maintain the latex free environment on the ward postoperatively.
Anaphylaxis during Anaesthesia

Immediate Management

**Adults 12+**

IF Adult CARDIAC ARREST
Pulseless Electrical Activity, PEA

- ALS GUIDELINES for non-shockable rhythms
- 1 mg I.V. Adrenaline, Repeat 1 - 2 minutes pm
- Immediately start CPR. Elevate legs. 2 L Crystalloid

DR
Danger and Diagnosis
Response to stimulus

- Unresponsive hypotension or bronchospasm
- Remove triggers e.g. chlorhexidine, synthetic colloid
- Stop procedure. Use minimal volatile if GA

S
Send for help and organise team

- Call for Help and Anaphylaxis box
- Assign a designated Leader and Scribe
- Assign a Reader of the cards

AB
Check/Safe Airway
Breathing - 100% oxygen

- Consider early intubation: airway oedema
- Confirm FiO₂ 100%

C
Rapid fluid bolus
Plan for large volume resuscitation

- If hypotensive: Elevate legs
- Bolus 2 L Crystalloid, Repeat as needed
- Large bore I.V. access. Warm I.V. fluids if possible

D
Adrenaline Bolus
Repeat as needed
Prepare Infusion

**I.M. Adrenaline (Adult)**
No I.V. access or haemodynamic monitoring OR awaiting Adrenaline infusion

- 1:1000 1mg/mL
- 500 mcg lateral thigh
- Every 5 minutes pm

**Initial I.V. Adrenaline Bolus (Adult)**

- Dilution 1 mg in 10 mL = 100 mcg/mL
- Give dose below every 1-2 minutes pm
- Increase dose if unresponsive

<table>
<thead>
<tr>
<th>Grade</th>
<th>Moderate</th>
<th>Life Threatening</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20 mcg = 0.2 mL</td>
<td>100-200 mcg = 1-2 mL</td>
</tr>
</tbody>
</table>

**Adrenaline INFUSION (Adult)**

- >3 boluses of Adrenaline start infusion
- Can be administered peripherally

- 3 mg Adrenaline in 50 mL saline
- Commence at 3 mL/hr = 3 mcg/min
- Titrate to max. 40 mL/hr = 40 mcg/min
- (Infusion rate 0.05 - 0.5 mcg/kg/min)

If NOT RESPONDING see ‘Refractory Management’
### Miscellaneous Emergencies

#### Anaphylaxis during Anaesthesia

**Refractory Management**

<table>
<thead>
<tr>
<th>Section</th>
<th>Details</th>
</tr>
</thead>
</table>
| Request more help | - Consider calling arrest code  
- May require assistance with fluid resuscitation |
| Triggers removed? | - Chlorhexidine including impregnated CVCs  
- Synthetic Colloid disconnect and remove  
- Latex remove from OR |
| Monitoring | - Consider Arterial line  
- Consider TOE/TTE |
| Resistant Hypotension | **Adult Recommendations**  
- Norepinephrine Infusion 3 – 40 mcg/min  
(0.05 - 0.5 mcg/kg/min) and/or  
- Vasopressin bolus 1 - 2 units then 2 units per hour  
If neither available use either  
- Metaraminol or Phenylephrine Infusion  
- Glucagon 1 - 2 mg i.V. every 5 min until response  
Draw up and administer i.V. (Counteract β blockers) |
| Resistant Bronchospasm | **Adult Recommendations**  
- Salbutamol  
- Metered Dose Inhaler 12 puffs (1200 mcg)  
- I.V. bolus 100-200mcg +/- infusion 5-25mcg/min  
- Magnesium 2 g (8 mmol) over 20 minutes  
Consider Inhalational Anaesthetics and Ketamine |
| Pregnancy | - Manual Left Uterine Displacement  
- Caesarean within 4 minutes if arrest or peri-arrest |
| Consider other diagnoses | See *Differential Diagnosis Card* in Anaphylaxis Box |
## Anaphylaxis during Anaesthesia

### Differential Diagnosis Card

### Possible Causes & Actions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Possible Causes/Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cardiac Arrest</strong></td>
<td>• Hypoxia</td>
</tr>
<tr>
<td></td>
<td>• Hypovolaemia</td>
</tr>
<tr>
<td></td>
<td>• Hypo/hyperkalaemia/metabolic disorders</td>
</tr>
<tr>
<td></td>
<td>• Hypo/hyperthermia</td>
</tr>
<tr>
<td></td>
<td>• Tension pneumothorax (Decompress)</td>
</tr>
<tr>
<td></td>
<td>• Tamponade</td>
</tr>
<tr>
<td></td>
<td>• Toxins</td>
</tr>
<tr>
<td></td>
<td>• Thrombosis; pulmonary or coronary</td>
</tr>
<tr>
<td><strong>High Airway Pressure/Airway Compromise</strong></td>
<td>Dyspnoea, wheeze, stridor, difficulty inflating lungs</td>
</tr>
<tr>
<td></td>
<td>• Circuit malfunction → Check using Self Inflating Bag</td>
</tr>
<tr>
<td></td>
<td>• Misplaced/kinked Airway device → Check with suction catheter/Consider changing device</td>
</tr>
<tr>
<td></td>
<td>• Tension pneumothorax → Decompress</td>
</tr>
<tr>
<td></td>
<td>• Exacerbation of Asthma → Treat as per Refractory Management</td>
</tr>
<tr>
<td></td>
<td>• Foreign Body → Consider bronchoscopy</td>
</tr>
<tr>
<td></td>
<td>• Acid aspiration → Consider bronchoscopy</td>
</tr>
<tr>
<td><strong>Hypotension</strong></td>
<td>• Hypovolaemia</td>
</tr>
<tr>
<td></td>
<td>• Sepsis</td>
</tr>
<tr>
<td></td>
<td>• Drug overdose</td>
</tr>
<tr>
<td></td>
<td>• Vasodilatation by drugs</td>
</tr>
<tr>
<td></td>
<td>• Neuraxial blockade</td>
</tr>
<tr>
<td></td>
<td>• Embolism: Thrombotic, Air or Amniotic</td>
</tr>
<tr>
<td></td>
<td>• Vasovagal</td>
</tr>
<tr>
<td><strong>Skin and Mucosa</strong></td>
<td>• Direct Histamine Release</td>
</tr>
<tr>
<td></td>
<td>• Venous obstruction</td>
</tr>
<tr>
<td></td>
<td>• Head down position</td>
</tr>
<tr>
<td></td>
<td>• C1-esterase deficiency (Angioedema only)</td>
</tr>
<tr>
<td></td>
<td>• Mastocytosis</td>
</tr>
<tr>
<td></td>
<td>• Cold induced anaphylaxis</td>
</tr>
</tbody>
</table>

### Absence of tachycardia or cutaneous signs does not exclude anaphylaxis
Anaphylaxis is usually rapid in onset but is occasionally delayed

<table>
<thead>
<tr>
<th>Severity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mild</strong> (Grade 1)</td>
<td>Generalised mucocutaneous signs: Erythema, Urticaria +/- Angioedema</td>
</tr>
<tr>
<td><strong>Moderate</strong> (Grade 2)</td>
<td>Moderate – Multi-organ manifestation may include:</td>
</tr>
<tr>
<td></td>
<td>• Hypotension, tachycardia</td>
</tr>
<tr>
<td></td>
<td>• Evidence of bronchospasm, cough, difficult ventilation</td>
</tr>
<tr>
<td></td>
<td>• Mucocutaneous signs</td>
</tr>
<tr>
<td><strong>Life Threatening</strong> (Grade 3)</td>
<td>Life Threatening and requiring immediate and specific treatment:</td>
</tr>
<tr>
<td></td>
<td>• Severe hypotension</td>
</tr>
<tr>
<td></td>
<td>• Bradycardia or tachycardia, arrhythmias</td>
</tr>
<tr>
<td></td>
<td>• Severe bronchospasm, and/or airway oedema</td>
</tr>
<tr>
<td></td>
<td>• Cutaneous signs may be absent, or present only after correction of hypotension</td>
</tr>
<tr>
<td><strong>Arrest</strong> (Grade 4)</td>
<td>Cardiopulmonary Arrest</td>
</tr>
</tbody>
</table>
DELAYED AWAKENING AFTER ANAESTHESIA

There is a large list of possible causes. They can be broadly classified into five groups:
1. Life threatening- the 4 H’s
   a. Hypoxia
   b. Hypercarbia
   c. Hypotension
   d. Hypoglycaemia
2. Drug related
   a. Overdose
   b. Pharmacodynamic interaction
   c. Pharmacokinetic interaction (absorption, metabolism, excretion)
   d. Adverse reaction
3. Metabolic Causes
   a. Hypothermia, Hyperglycaemia
   b. Electrolyte abnormality
   c. Renal/ hepatic/ adrenal failure
4. Neurologic causes
   a. Seizure, status epilepticus
   b. Intracerebral event
   c. Psychiatric disorder (diagnosis of exclusion)
5. Sepsis- acidosis, multiple organ dysfunction.

Approach to management
- Check patient response to verbal and tactile stimulation (replace hearing aids)
- Ensure adequate oxygenation and ventilation via secure airway.
- Scan monitors; reapply standard monitoring if these have been removed:
  - Check BP, ECG, Temperature, ET [ ] volatile agent.
  - Treat hypotension and warm patient if indicated.
- Review anaesthetic record and all drugs given to patient. Check drug ampoules if available.
- Review patient’s chart-? co-morbidities, drug history including recreational drugs.
- Confirm reversal of anaesthetic drugs:
  - Muscle relaxant- nerve stimulator
  - Opioids- check pupils, give Naloxone 100mcg increments IV
  - Benzodiazepines- Flumazenil 200mcg, then 100mcg increments up to maximum dose of 1mg (2 ampoules).
- Examine patient for cause of postoperative confusion- focal neurological signs, bladder distension, evidence of haemorrhage.
- Check BSL ± Hemocue. Take and send urgently ABG + blood for U&Es/ FBE. Consider blood/ urine screen for toxins.
- Consider applying BIS monitor- low reading suggests CNS problem.
- Consider performing a CT scan ± CXR.
- Consider a small dose of midazolam, haloperidol or droperidol if patient is agitated. Give small dose opioid if pain suspected.
- If patient remains unconscious, discuss with duty consultant plans for further management.
LOCAL ANAESTHETIC TOXICITY

Presentation
- Tingling in lips and tongue, metallic taste, dysphoria, blurred vision and tinnitus.
- Restlessness, confusion, loss of consciousness, seizure.
- Respiratory arrest
- Hypotension, dysrhythmias, CVS collapse, cardiac arrest
- See separate entry for TOTAL SPINAL.

Immediate Management
- Cease administration of agent.
- CALL FOR HELP AND THE CRASH TROLLEY
- Airway- intubate if ↓LOC, give high flow O₂.
- Breathing- ensure adequate ventilation, hyperventilate if possible as acidosis increases cardiotoxicity of local anaesthetics.
- Circulation-
  - Treat hypotension with vasopressors and IV fluids
  - Give atropine for bradycardia
  - Cardiac Arrest- treat as per ARC algorithm (see separate entry CARDIAC ARREST) and if unresponsive give Intralipid (see below for dosing protocol).
  - Ventricular tachyarrhythmias- if unresponsive to cardioversion and amiodarone 300mg give Intralipid (see below for dosing protocol).
- Seizures- treat with midazolam 5mg IV ± propofol 50mg increments ± sodium thiopentone 50mg increments.
- Prilocaine may cause methaemoglobinaemia if given in high doses (>8mg/kg)- treat with methylene blue 1-2mg/kg.

Differential Diagnosis
- Vasovagal episode- may have convulsion with this but rapidly self-limiting.
- Anxiety Attack, eg. needle phobic patient.
- Anaphylaxis, allergic reaction- this is rare.
- Epilepsy- check patient chart, treat as for seizure above and assess BP/ pulse/ ECG.
ANZCA endorsed dosing protocol for Intralipid - this is kept in OT crash trolley and the epidural trolley in Birthing Suite.

---

**AAGBI Safety Guideline**

**Management of Severe Local Anaesthetic Toxicity**

<table>
<thead>
<tr>
<th>No.</th>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
</table>
| 1   | Recognition              | Signs of severe toxicity:  
  • Sudden alteration in mental status, severe agitation or loss of consciousness, with or without tonic-clonic convulsions  
  • Cardiovascular collapse: sinus bradycardia, conduction blocks, asystole and ventricular tachyarrhythmias may all occur  
  • Local anaesthetic (LA) toxicity may occur some time after an initial injection  |
| 2   | Immediate management     |  
  • Stop injecting the LA  
  • Call for help  
  • Maintain the airway and, if necessary, secure it with a tracheal tube  
  • Give 100% oxygen and ensure adequate lung ventilation (hyperventilation may help by increasing plasma pH in the presence of metabolic acidosis)  
  • Confirm or establish intravenous access  
  • Control seizures: give a benzodiazepine, thiopental or propofol in small incremental doses  
  • Assess cardiovascular status throughout  
  • Consider drawing blood for analysis, but do not delay definitive treatment to do this |
| 3   | Treatment                | IN CIRCULATORY ARREST  
  • Start cardiopulmonary resuscitation (CPR) using standard protocols  
  • Manage arrhythmias using the same protocols, recognising that arrhythmias may be very refractory to treatment  
  • Consider the use of cardiopulmonary bypass if available  
  • Give intravenous lipid emulsion (following the regimen overleaf)  
  • Continue CPR throughout treatment with lipid emulsion  
  • Recovery from LA-induced cardiac arrest may take >1 h  
  • Propofol is not a suitable substitute for lipid emulsion  
  • Lidocaine should not be used as an anti-arrhythmic therapy  |
|     | WITHOUT CIRCULATORY ARREST | Use conventional therapies to treat:  
  • Hypotension,  
  • Bradycardia,  
  • Tachyarrhythmia  |
|     | CONSIDER INTRAVENOUS       | LIPID EMULSION (following the regimen overleaf)  
  • Propofol is not a suitable substitute for lipid emulsion  
  • Lidocaine should not be used as an anti-arrhythmic therapy  |
| 4   | Follow-up                |  
  • Arrange safe transfer to a clinical area with appropriate equipment and suitable staff until sustained recovery is achieved  
  • Exclude pancreatitis by regular clinical review, including daily amylase or lipase assays for two days  
  • Report cases as follows:  
    - In the United Kingdom to the National Patient Safety Agency (via www.npsa.nhs.uk)  
    - In the Republic of Ireland to the Irish Medicines Board (via www.imb.ie)  
  If Lipid has been given, please also report its use to the international registry at www.lipidregistry.org. Details may also be posted at www.lipidrescue.org |

---

Your nearest bag of Lipid Emulsion is kept...
IMMEDIATELY

Give an initial Intravenous bolus injection of 20% lipid emulsion
1.5 ml.kg⁻¹ over 1 min

AND

Start an intravenous infusion of 20% lipid emulsion at 15 ml.kg⁻¹.h⁻¹

AFTER 5 MIN

Give a maximum of two repeat boluses (same dose) if:
- cardiovascular stability has not been restored or
- an adequate circulation deteriorates
Leave 5 min between boluses
A maximum of three boluses can be given (including the initial bolus)

AND

Continue infusion at same rate, but:
- Double the rate to 30 ml.kg⁻¹.h⁻¹ at any time after 5 min, if:
  - cardiovascular stability has not been restored or
  - an adequate circulation deteriorates
Continue infusion until stable and adequate circulation restored or maximum dose of lipid emulsion given

_Do not exceed a maximum cumulative dose of 12 ml.kg⁻¹_
SICK LAPAROTOMY

Potential Problems
- Acute abdomen- aspiration risk, splinting of abdominal wall, decreased respiratory reserve.
- Septic patient- tachycardic, hypotensive, hypovolaemic.
  - Septic patients are invariably inadequately resuscitated when they come to OT.
- ↑ Risk perioperative cardiac event, eg. ischaemia, atrial fibrillation, PMI. See also INTRAOPERATIVE MYOCARDIAL ISCHAEMIA.
- Multiple organ dysfunction- inc. renal impairment, co-morbidities.
- Possible major blood loss esp. if trauma. See also MASSIVE HAEMORRHAGE.
- Will need ICU postoperatively: ORGANIZE THIS BEFORE YOU START THE CASE.

Preparation
- Assess the patient:
  - Airway- a RSI is indicated
  - Have minimum baseline investigations been done?
    - FBE, E/LFTs, amylase, coags, G&Hold
    - ECG and CXR
    - ABGs+lactate are valuable aids to assess the severity of respiratory impairment and acidosis.
  - Are they adequately resuscitated- can surgery be delayed to allow optimal resuscitation? Consider your resuscitation goals- criteria are individualized but typical goals are:
    - HR<100
    - MAP>70, have a low threshold to start inotropes if hypotensive despite aggressive fluid therapy.
    - CVP 10, Hb>90
    - Normal pH, lactate falling.
    - UO> 0.5mls/kg/hr
  - Will they need to be ventilated post-op?
  - Is an epidural appropriate- may allow extubation when otherwise would struggle but numerous potential relative contraindications (sepsis, coagulopathy, consent).
  - Explain your anaesthetic plan and perioperative risks with the patient and family if appropriate and document this discussion.
- Prepare OT:
  - Arterial line and CVL setup, ? cardiac output monitors
  - ?Pressure fluid infusion system primed
  - Drugs- fresh Suxamethonium, vasopressors, Noradrenaline infusion if septic.
- Clarify the PDx and planned operation with the surgeon.
- Senior Staff involvement is warranted: Surgeon, Anaesthetist, Intensivist- ensure bed available or that appropriate alternative arrangements have been made.
Perioperative Management

- Establish secure large bore IV access and connect to standard giving set.
- Place arterial line prior to induction ± CVL.
- 5 lead ECG, BIS Monitor and temp probe. Even febrile patients will tend to become hypothermic during the course of a long operation. The BIS monitor may help guide your anaesthetic maintenance - less drug induced CVS depression without patient being aware.
- RSI- See RAPID SEQUENCE INDUCTION, induction agent choices include propofol, thiopentone and ketamine. There is some evidence to suggest propofol causes more hypotension than thiopentone in these circumstances. Be cautious with the use of midazolam and fentanyl prior to induction. These patients are on maximal sympathetic drive and these agents may cause rapid decompensation due to drug-induced sympatholysis. Ketamine will tend to cause an elevated BIS reading at least transiently.
- Expect hypotension on induction and treat it aggressively.
- Don’t use N₂O- it is of no benefit and may be potentially harmful (bowel distension, impaired B12 metabolism, cognitive impairment, CVS morbidity).
- Ventilatory strategy- PEEP is useful but needs to be applied at the start of ventilation, a degree of permissive hypercapnia may be necessary to avoid excessively high airway pressures.
- Haemodynamics- if adequate preload and still hypotensive use inotropes. Noradrenaline if septic, otherwise Adrenaline is a good choice.
  - Echocardiography gives excellent quality information to both assess and guide haemodynamic therapy but requires expertise in its use.
  - The VIGILEO and CARDIO Q are non-invasive cardiac output monitors and will demonstrate trends in the preload as measured by LV stroke volume.
  - Generally speaking, trends and the response to fluid boluses give more useful information than absolute values per se.
  - Arguably the simplest and most easily available surrogate measure of adequate preload is systolic pressure variation (SPV) with respiration. This can be done using the oximeter waveform or preferably the arterial trace. By changing the waveform sweep speed to 12.5mm/s it is easier to objectively assess SPV.
  - Albumin is arguably the colloid of choice in septic patients.
- Don’t forget antibiotic therapy.
- Perform regular ABGs + BSLs as a guide to your therapy. Electrolytes should be done also.
RAISED INTRACRANIAL PRESSURE

Presentation
- Anaesthesia for patient with known or suspected raised ICP for elective surgery other than neurosurgery, eg. Meningioma, hydrocephalus.
- Neurotrauma- isolated head injury or as part of multitrauma, 10-15% of these have cervical spine injury.
- Patient who has suffered intracerebral event requiring surgery, eg intracerebral haemorrhage.
- Clinical symptoms include:
  - PDPH-like headache
  - Nausea, vomiting
  - Diplopia
  - Behavioural changes, drowsiness
- Clinical signs include:
  - Altered LOC
  - Cushing’s reflex- hypertension, bradycardia, altered respiration
  - CN III and VI palsies- dilated pupil or sluggish reflexes
  - Papilloedema, loss of venous pulsations in retinal veins
  - Focal neurological deficit, hemiparesis, posturing, coma.
  - Under anaesthesia severe hypertension and bradycardia may be the only signs of ↑ICP.
- Signs on CT scan- compression basal cisterns/ ventricles, flattened sulci, loss of grey-white matter differentiation, midline shift >10mm.

General anaesthetic approach
- In neurotrauma, assume unstable C-spine until cleared- if don’t have conscious, alert patient, it may be difficult to clear spine with plain C-spine films alone. Preferably CT imaging of the upper and lower C-spine should be performed also. If in doubt maintain C-spine immobilization and keep head and neck in a neutral position. Sandbags taped to the side of the head are probably the most effective immobilization technique. Involvement of an experienced assistant (eg. Surgeon) to maintain manual in-line immobilization during intubation is also desirable.
- Aims of anaesthesia are a smooth induction and emergence with maintenance of cerebral perfusion pressure (CPP) and a relaxed brain.
- Excellent large bore IV access + IDC is a minimum pre-requisite. Anticipate major blood loss and Xmatch blood.
- An arterial line should be sited prior to induction.
- Arguably, the preferred anaesthetic is a TIVA- O₂ + AIR + Propofol TCI + Remifentanil.
- A rapid sequence induction should be performed if plan on a conventional induction.
- Normal saline is the intravenous fluid of choice. Hyperglycaemia is associated with a worse outcome.
- Have vasopressors drawn up and aggressively treat hypotension. Have a low threshold to use infusion of phenylephrine or noradrenaline.
- Have ready agents to counter a pressor response- remifentanil, esmolol and lignocaine.
- Aim for normothermia- warming blankets will be necessary.
• Aim initially for a low normal PaCO$_2$ of 35mmHg.
• If neurotrauma institute seizure prophylaxis with phenytoin 15mg/kg or Kepra 1g.

**Intraoperative management of ↑ICP**

- Correct anaesthetic factors:
  - Hypoxia, hypercarbia
  - BP outside autoregulatory limits- aim for CPP ~70
  - Inadequate muscle relaxation
  - Raised venous pressure- tube ties, neck compression, PEEP
  - Use of volatile agents and N$_2$O
  - Fever- IV paracetamol or ketorolac effective anti-pyretics.

- 10-15° head up positioning.
- Hyperventilation to PaCO$_2$ 25-30 mmHg, confirm this on ABG.
- Give Mannitol 0.5g/kg over 20mins (100g Mannitol in 500mls 20% solution), an alternative is Hypertonic Saline (3N) 100ml bolus preferably via central line. Aim for serum osmolality of 300-310 mOsmoles.
- Consider use of Frusemide 0.5mg/kg IV, this has a synergistic action with mannitol and is best given 15min after it.
- Dexamethasone 10-15 mg IV, takes several hours to have effect.
- Intravenous anaesthetic agents- reliably decrease CBF and CMRO$_2$. STP is possibly more potent than propofol, initial dose 5-10mg/kg over 20 mins then infusion 1-4mg/kg/hr. Be wary of hypotension, may need to run concomitant vasopressor infusion (phenylephrine, noradrenaline).

- If above measures fail:
  - Induce moderate hypothermia
  - Surgical measures:
    - Evacuate haematoma, drill burr holes
    - Drain CSF- ventricular or lumbar drain
    - Cranial decompression- duraplasty
  - Consider repeating Head CT to exclude surgically remediable causes.
AUTONOMIC DYSREFLEXIA

Presentation
- Condition seen in patients with chronic spinal cord injury (SCI), most common in high SCI, rare if below T10. Due to massive autonomic discharge below level SCI in response to certain stimuli.
- Severe hypertension with reflex bradycardia. If untreated this may lead to intracerebral haemorrhage, acute pulmonary oedema and convulsions.
- Headache
- Sweating, flushing above the level of the lesion.
- Others- nausea, anxiety, Horner’s syndrome.

Immediate Management
- Treat or Stop any precipitating stimuli:
  - Bladder distension is the commonest- check IDC not blocked.
  - Surgical stimulation
  - Uterine contractions
- Position patient head up if able.
- Treat hypertension with rapidly acting vasodilators. Drug options include:
  - GTN- sublingual spray while prepare infusion 50mg in 500mls 5% dextrose, titrate rate OR GTN patch OR 100mcg IV boluses (1ml of infusion).
  - Sublingual nifedipine
  - Hydralazine 5mg bolus
  - Phentolamine 1mg boluses (kept in OT drug fridge).
- Do not use beta blockers as a first line agent as this may precipitate cardiac failure in face of high afterload.
- If GA- deepen anaesthesia.

Special Considerations
- Spinal anaesthesia reliably obliterates autonomic dysreflexia and is not contraindicated in these patients.
- If using GA- generally prudent to intubate these patients. It should be recalled that Suxamethonium is absolutely contraindicated in patients with SCI.
MALIGNANT HYPERTHERMIA

Presentation
- May present during or several hours post anaesthetic.
- Earliest features are tachycardia, dysrhythmias and unstable BP.
- Generalized skeletal muscle rigidity occurs in 75% cases.
- Severe masseter spasm after suxamethonium (defined as excess and prolonged jaw rigidity for 2-4 mins) may be the first sign of MH. If the spasm resolves with a non-depolarising muscle relaxant it is not an MH reaction.
- Tachypnoea is seen in a spontaneously breathing patient and a progressive rise in ET CO$_2$ is seen in a ventilated one. This results from the hypermetabolic state and severe respiratory and metabolic acidosis of MH.
- Fever and profuse sweating are later signs.
- Signs seen with progression of the reaction include:
  - Skin mottling, desaturation and cyanosis
  - Myoglobinuria, oliguria
  - Coagulopathy due to DIC

Immediate Management
- Declare an emergency
- CALL FOR HELP, CRASH TROLLEY and the MH KIT kept in PACU pharmacy cupboard
- Inform the surgeon and tell them to complete surgery ASAP.
- Cease the trigger agent (Sux, volatile agents) and hyperventilate with 100% O$_2$; call for a new breathing circuit and soda lime canister. Take the vaporizers off the back bar and remove sux from the OT. Don’t waste time changing the anaesthetic machine.
- Maintain anaesthesia with a propofol infusion.
- Organize and delegate people to perform the following tasks:
  - These are detailed on flash cards in the MH Kit.
  - Give Dantrolene – this is the antidote and top priority,
    - Allocate one person to prepare all the dantrolene vials. Each vial contains 20mg of dantrolene and must be mixed with 60mls of sterile water.
    - 18 vials of dantrolene are kept in the MH Kit. This is enough for initial dose and a single further dose. A further 18 vials are kept in pharmacy and 12 vials in both St Andrew’s and St Vincent’s Hospital.
    - Initial dose Dantrolene 2.5mg/kg IV (1 amp per 8kg) repeat dose every 5 minutes until symptoms improve or up to maximum dose of 10mg/kg. Rarely a total dose >10mg/kg is required.
- Cool the patient:
  - Insert temperature probe
  - Fully expose the patient
  - Turn OT temperature down to minimum
  - Cover body with crushed ice- get this from Hospital kitchen.
  - Give cooled IV fluids
  - Peritoneal lavage using chilled saline is an effective form of cooling- ask surgeon to place peritoneal catheter.
  - Stop cooling when T<38, don’t induce hypothermia.
- Establish invasive monitoring and take urgent bloods:
Miscellaneous Emergencies

- Insert arterial line and IDC
- Take blood for ABG, U&Es+BSL+Ca+CK, FBE and coagulation studies. Send runner with bloods and ring lab to notify them of urgent specimens.

Expect and treat the following problems:
- Acidosis- give Sodium Bicarbonate 1-2mmol/kg as guided by ABGs.
- Hyperkalaemia- treat with hyperventilation, Sodium Bicarbonate, Actrapid 10U + 50ml of 50% dextrose. May need to give Calcium Chloride 5-10mls if severe.
- Dysrhythmias- treat above two conditions and appropriate anti-arrhythmic drug if required. Do not use calcium channel blockers.
- Oliguria/ Myoglobinuria- give fluids to maintain at least 2ml/kg/hr urine output. May need to force alkaline diuresis with Mannitol 0.5g/kg + Sodium Bicarbonate 1ml/kg (when PaCO₂ controlled).

Subsequent Management
- Patient will need an ICU bed- intubated and ventilated. Don’t transfer until satisfactory response to treatment has been seen.
- Patient will need to be observed in CCW for a minimum of 24 hrs.
- Watch for recurrence, may need to give further Dantrolene 2.5 mg/kg.
- Ongoing management issues in ICU:
  - Acidosis
  - Hyperkalaemia
  - Renal function
  - Potential for DIC
  - Was surgery completed?
- Counsel the patient and their family. The surgeon and anaesthetist should both be present with the intensivist. Explain the implications of the diagnosis and the importance of follow up.
- Arrange for muscle biopsy testing (In Vitro Contracture Test) of the patient and relevant family members (consult the malignanthyperthermia.com website for testing centres and contact details). Arrange MedicAlert bracelet.
- Send letter to patient and their GP.
- Place ALERT label on patient’s chart.
- Complete anaesthetic incident and PRIME forms.

Differential Diagnosis
- Inadequate anaesthesia- check ET agent [ ], TCI syringe pump, apply BIS if unsure.
- Sepsis- don’t expect to see as marked a rise in PaCO₂. ABGs show mixed respiratory and metabolic acidosis in MH.
- Tourniquet ischaemia- can cause ↑HR ↑BP ↑T but will resolve with release of tourniquet.
- Anaphylaxis- expect hypotension/ cardiovascular collapse.
- Neuroleptic Malignant Syndrome- similar clinical features and treatment, triggered by antipsychotic drugs.
- If in doubt send off an ABG.
**Anaesthesia for MH susceptible patient**

- This includes: known MH susceptible individuals and their relatives (autosomal dominant inheritance); patient with a Hx of an unexpected death under anaesthesia of a relative; patients with myopathies; possibly also patients with muscular dystrophy.

- Complete an Anaesthetic Alert
- 1st case on list, notify all theatre staff including recovery.

**Prepare OT:**
- Put up signs “MH SUSCEPTIBLE PATIENT” outside OT entrances.
- Use fresh soda lime and new breathing circuit.
- Remove vaporizers and sux
- Flush the machine and circuit with O₂ at 10l/min for 20 mins.

- Use a regional technique or a trigger free anaesthetic, i.e propofol TIVA.
- Monitor the patient's temperature in the perioperative period up to least 4 hours post procedure.
- There is no role for prophylactic dantrolene.

**MH Kit**

- Most Departments have a dedicated kit- you should know where it and the dantrolene are kept.
- Contains dantrolene + flash cards + other equipment inc. Arterial line, blood tubes, catheter.
- Contents are as recommended in the malignanthyperthermia.com website including the flash cards for the delegation of tasks.
FIRE IN THEATRE COMPLEX

Important points
- It is a mandatory requirement for all staff to annually attend Fire and Emergency Training workshops. These are held regularly throughout the year.
- Theatre staff should be familiar with the location of the following:
  - Fire exits
  - Fire extinguishers and fire hoses
  - Manual call points
  - Internal and external assembly points
- The Fire Warden coordinates the response to the fire and the evacuation if required. They are identified by their yellow hat and bright orange vest.
- A small fire that is easily contained/ extinguished that doesn’t pose a threat to personal safety may not require evacuation of the theatre.

**Immediate action in event that you see/ smell/ suspect fire or smoke- R.A.C.E.**

**R Remove** Check the immediate area for safety and remove/ rescue any persons in immediate danger of the fire. *Only do this if it is safe to do so.*

**A Announce** the alarm by:
- Breaking the glass of a manual call point
  - AND
- Ring 6666 and state: CODE RED, give specific location of the fire, nature of the fire (electrical, gas, combustible), the extent of the fire and possible evacuation time. *Be the last person to end the call.*
- Switch will notify the fire brigade, the EDMS, the Nurse Manager and the Hospital Fire and Security Coordinator.

**C Contain** the fire and smoke by:
- Remove air by closing doors in the immediate area. Fire doors will automatically shut but persons are still able to push these open to facilitate escape.
- Remove potential sources of fuel for the fire, eg. O₂ cylinders, unplug electrical equipment.

**E Extinguish** the fire *only if it is safe to do so.*
- Water- red fire extinguisher, fire hose reel; for ordinary combustibles.
- Carbon Dioxide- red extinguisher with black band; use for flammable liquids and electrical fires.
- Dry Chemical Powder- red extinguisher with white band; can use for all fires.

**Evacuate** *(see below)* 3 stages of evacuation:
- Stage 1 – removal from immediate danger area
- Stage 2- removal to safer area, internal assembly point
- Stage 3- complete evacuation to area outside of building.
Miscellaneous Emergencies

Ambulant patients should be moved before non-ambulant patients.

**Immediate action if you hear a fire alarm**
- Secure your workplace and go to the area assembly point. If you are with an anaesthetized patient send another person and get them to report back to you.
- If fire is confirmed, follow R.A.C.E. procedure.
- If fire is not confirmed remain on standby until Hospital Fire Coordinator or the Fire Service has given all clear.
- Do not commence an operation after the fire alarm has sounded until an all clear is given.

**Evacuation of theatre complex**
- This is only to be done on direction of the Fire Warden, the CNC or a senior staff member.
- Each surgical team is to remain with their patient. The surgeon and anaesthetist are to supervise evacuation of the patient after receiving instructions from the Fire Warden as to when to evacuate and through which exit.
- Preparations for evacuation include:
  - Anaesthetic equipment- drugs, propofol, AIR VIVA bag, O₂ cylinders
  - Pack/ cover/ close the wound and cover the patient.
  - Place patient so they can be carried or dragged down stairs- two evacuation pods and slings are kept near the fire exit outside OT1. Non-ambulant patients should be dragged down stairs feet first on a sling/ mattress/ blanket or carried on a pod.
- If a code red is confirmed medical gases will only be turned off after each anaesthetist has been informed. The manual shutoff controls for the gas supplies to theatre are located on the right hand side of the main theatre corridor just past the theatre manager’s office.
- The Fire Warden will delegate instructions to other staff members. Some of these tasks include:
  - Recording names of those leaving theatre- theatre list, staff list.
  - Runner to assist with directions
  - Assist with evacuation of patients in recovery and holding bays
- All emergency evacuation equipment is kept in the recovery nurses bay and will be collected by the recovery RN.
- **DO NOT USE LIFTS IN THE EVENT OF FIRE.**
EMERGENCY IV ACCESS

General Considerations

- If CPR is in progress and need to give resuscitation drugs- consider giving them down the ETT:
  - Recommend give double IV dose down a suction catheter and flush it with saline.
  - Don’t give calcium or bicarbonate via ETT.
- Consider giving drugs IMI- upper outer quadrant of buttock.
- Consider giving drugs into or beneath the tongue, eg. Suxamethonium. This is a highly vascular area and the drug will be rapidly absorbed.

Tips with difficult peripheral IV access:
- Ask for assistance- you will rapidly become frustrated after multiple failed attempts.
- Look at inner wrist, esp. obese patients.
- If small cannula in situ or small vein visible- consider placing a tourniquet and flushing 50mls saline into the vein to distend larger veins.
- Use the ultrasound
- Use local anaesthetic- less patient distress and venoconstriction.
- Encourage vasodilatation in the limb- warm towel, gloves, GTN patch has been used.
- Don’t forget the feet or the scalp.
- If patient is an IV drug addict- ask them what veins they have been using.

- In trauma situation- have low threshold to using the femoral vein or asking surgeon to do cutdown on the saphenous vein. An option in males is the dorsal vein of the penis.
- If central venous access required- vein of 1st choice depends on operator experience and clinical scenario:
  - External Jugular Vein- good as is usually visible, will be accentuated with a Valsalva manoeuvre, valves common hindrance, very easily compressed.
  - Femoral Vein- very reliable, good if neck/ chest trauma, difficult to access in obese patient, often need assistant to retract abdominal wall.
  - Subclavian Vein- avoid if coagulopathy, USS unhelpful, pneumothorax risk very small with good technique.

Large Bore IV Access Options

- 14G cannula, shorter ones best.
- Rapid Infusion Cannula- wire will fit through an in situ 20G cannula. For peripheral veins only. 7 FG.
- ‘MAC’ central line kit- 9FG, double lumen.
- Pulmonary Artery Catheter Sheath- 8FG

Intraosseous Needle

- Can be used on adults as well as children
- Standard needle kept on paediatric trolley in OT
- ED have a drill powered IO needle for use on adults/ older children: EZY-IO
- Don’t use if fracture proximal to site.
- Tibial site insertion- 2cm inferior and medial to tibial tuberosity.
- Femoral site insertion- 3cm above lateral condyle on anterolateral surface of femur.
- Alternative sites- iliac crest, sternum.
- Technique:
  - Aseptic
  - Grasp knee to stabilize limb
  - Insert at 90° and advance with drilling motion.
  - Stop when feel ‘give’ as needle passes through cortex.
  - Inability to aspirate blood or local swelling when give fluid suggests incorrect placement.
  - Secure needle with padding and tape± splint in child.
- Can give all drugs and take blood through needle.
- Notify lab it is a bone marrow specimen.
- Fluids **will not** run passively- need to syringe in, eg. 50ml syringe on a 3-way tap.
- Remove once have established peripheral IV access.
ACUTE CONFUSIONAL STATE

*See also DELAYED AWAKENING AFTER ANAESTHESIA

Differential Diagnosis
- The 4H’s, the 4E’s and the 3D’s-
  - The 4H’s:
    - Hypoxia
    - Hypercarbia
    - Hypertension
    - Hypoglycaemia
  - The 4E’s:
    - Endocrine
    - Electrolyte derangement
    - Endotoxin (sepsis)
    - Elevated ST (myocardial ischaemia)
  - The 3D’s:
    - Drugs and toxins
    - Dementia (principal factor that differentiates delirium from dementia is the level of arousal fluctuates)
    - Diseases of CNS – organic and psychiatric.

Predisposing factors
- Pre-existing cognitive deficit
- Elderly
- Visual/ hearing impairment
- Alcohol withdrawal/ drug abuse
- Severe systemic illness

Immediate Management
- See the patient and review vital signs including temperature.
- If unfamiliar with the patient- review the anaesthetic record and the patient’s medication chart and history.
- Correct the 4H’s (as above) and check BSL where appropriate.
- Reassure and orientate the patient to their environment.
- Prevent the patient from harming themselves or disrupting their wound/ drip/ drains. CALL FOR HELP for extra staff if necessary. Physical restraint is a last resort.
- Treat pain
- Exclude bladder distension as a cause- palpate abdomen, check IDC, do bladder scan.
- Consider bringing family members/ carers/ familiar toys/ blanket as support.
- Perform a rapid neurological examination looking for focal signs. Document GCS as a baseline. Consider CT if exam abnormal.
- If treatable causes have been corrected/ excluded and patient is at risk of harming self or unable to be nursed then sedate:
  - Midazolam 1mg increments IV ±
  - Haloperidol or Droperidol 1mg increments IV.
  - Chlorpromazine 25mg IV is another option.
Ensure supplemental oxygen is given and basic monitoring is intact. Be prepared for the likelihood of drug-induced hypotension.

Subsequent Management
- Consider the following investigations:
  - ABG- hypoxia, CO₂ narcosis, acidosis
  - U&Es + Ca²⁺ - ↓Na, ↑Ca²⁺
  - Hemocue, FBE- anaemia, sepsis ↑WCC
  - ECG- myocardial ischaemia
  - CXR
  - CT Head
- Consider anticholinergic syndrome- signs include mydriasis, tachycardia, peripheral vasodilatation and sweating. Rx Physostigmine 1mg IV
- Decide on plan for subsequent management of patient:
  - Nurse as ‘special’.
  - HDU admission
  - Document need for restraints if used as per QH Guidelines.
  - Arrange appropriate monitoring and medical review.
SEVERE POSTOPERATIVE PAIN

Presentation
- Patient distress, anger, crying, reluctance to move or talk.
- Agitation, confusion. See also ACUTE CONFUSIONAL STATE
- Sympathetic response- ↑HR, ↑BP, sweating, nausea.
- Inadequate respiratory effort with desaturation.

Immediate Management
- See the patient- this can be a difficult problem to manage and is distressing for both the patient and nursing staff.
- Review vital signs and drugs given in recovery so far.
- If patient is unfamiliar to you- review anaesthetic record and medication history. Is pain due to regression of a spinal anaesthetic?
- Specifically question patient whether they have pain and the nature and location of the pain.
- Exclude full bladder as a cause.
- Titrate opioid to analgesia, eg. Fentanyl protocol and repeat if necessary. Morphine protocol and tramadol 50-100 mg IV are also appropriate but have a slower onset of action.
- Give NSAID unless contraindicated- ketorolac 30mg IV/IM, parecoxib 40mg IV, Diclofenac 50mg PO, Indomethacin 100mg PR.
- Consider using the following drugs:
  - Paracetamol 1gram IV over 20mins
  - Clonidine 1mcg/kg IV slowly and repeat if required. Common adverse effects are ↓HR, ↓BP and sedation.
  - Ketamine 20mg IV bolus followed by infusion 4mg/hr (100mg in 100mls saline run in separate Gemstar). Adverse effects include ↑HR, ↑BP and dysphoria but are unlikely at this dose.
  - Midazolam 1mg increments IV
  - Dexamethasone 10mg IV

Subsequent Management
- Ensure supplemental oxygen is given.
- Involve Acute Pain Service with patient management-
- Liaise with duty consultant and registrar so they are aware of problem.
- Consider commencing PCA if not already in situ.
- Consider surgical review to exclude new or untreated pathology, eg. nerve damage, compartment syndrome, tight plaster.
- Consider regional analgesia as appropriate, eg. fascia iliaca block.
- Consider whether this is an atypical presentation of myocardial ischaemia- order ECG.

Special Considerations
- Chronic preoperative opioid use/ abuse:
  - Expect high dose requirements
  - Ensure regular analgesics are given in addition to analgesics for postoperative pain.
  - Regional techniques are preferable in this setting.
- Neuropathic pain:
Described in nature as burning, shooting and electric shock-like.
Characterized by abnormal responses- hyperalgesia and allodynia.
May be pre-existing.
Poorly responsive to opioids and difficult to treat.
Drugs that may be effective in the acute setting are:
- Tramadol 50-100 mg IV slow bolus
- Ketamine- dose as above.
- Clonidine
- Gabapentin- Dose is 300mg tds up to maximum of 2400mg/ day.
  Dizziness and somnolence are the commonest adverse effects.
- Pregabalin
Recovery Emergencies

SEVERE POSTOPERATIVE PONV

Immediate Management
- See patient and:
  o Assess whether nausea, vomiting or both is the problem.
  o Review the patient’s vitals - treat hypotension if present.
  o Review what has been given to the patient and response to this treatment.
  o Review the anaesthetic record and patient history if unfamiliar with the patient.
  o Reassure the patient.
- Treat pain and anxiety if present.
- Ensure patient is adequately hydrated (20 ml/kg bolus crystalloid), has secure IV access and is receiving supplemental $O_2$.
- Consider surgical causes of severe PONV - eg. gut obstruction, internal haemorrhage, bile leak etc. Surgical review may be indicated.
- Consider the following drugs:
  o 5HT$_3$ antagonists - particularly for vomiting, no benefit giving more than 2 doses, i.e. 4mg tropisetron, 8mg ondansetron, 2mg granisetron.
  o Dexamethasone 0.1mg/kg give as slow IV push esp. for nausea.
  o Prochlorperazine 12.5mg IMI
  o Droperidol 1mg IV
  o Antihistamines - promethazine 12.5-25mg slow IV or IMI. Expect sedation with this agent.
  o Midazolam 1mg increments IV
  o Chlorpromazine 25mg IV Expect sedation and hypotension with this agent.
  o Propofol 10-20mg increments IV.

Subsequent Management
- Consider admitting patient to ward for IV rehydration and chart regular anti-emetics.
- Consider placing NGT, eg. bowel obstruction, gas in stomach during bag mask ventilation, blood in stomach, severe vomiting.
- Consider whether this is an adverse drug reaction and document as appropriate.
- Consider use of non-opioid analgesia postoperatively, eg. NSAIDs, ketamine infusion, regional techniques.
ACUTE RESPIRATORY DISTRESS POST NECK SURGERY

Risk factors
- Thyroidectomy/ parathyroidectomy
- Carotid endarterectomy
- Neck dissection
- Neck haematoma can result in fatal airway compression and make direct laryngoscopy impossible.

Immediate management
- CALL FOR HELP
- Notify surgeon to come ASAP.
- Prepare OT urgently- get difficult intubation trolley, bronchoscope, open up tracheostomy tray.
- Sit patient up.
- Remove skin clips/ sutures and manually remove haematoma. Stitch cutter/ staple remover should be taped to the patient’s chest.
  - Haematoma may be beneath muscle layer and simply opening the skin wound may not be sufficient.
  - If surgeon present- perform evacuation in OT under LA while you make preparations to secure airway.
- Patient will need anaesthesia to provide definitive haemostasis.
- Options to secure the airway include:
  - Tracheostomy under LA
  - Awake fibreoptic intubation
  - Gas induction with Sevoflurane and O₂
- In extremis:
  - Trial direct laryngoscopy with topical anaesthetic
  - Emergency tracheostomy
  - If lose airway, attempt bag mask ventilation, if unsuccessful proceed as per failed intubation drill. See DIFFICULT AIRWAY ALGORITHMS

Subsequent management
- Give Dexamethasone 10mg IV.
- Arrange for ICU admission- patient should be kept intubated and ventilated for 24hrs to allow swelling to subside.
- Perform screening direct laryngoscopy at end of case and document view. If need to change ETT- should use an Airway Exchange Catheter, these are kept on the Difficult Intubation Trolley.
POSTPARTUM HAEMORRHAGE

General Comments
- Anticipate and be prepared for massive blood loss. See also MASSIVE HAEMORRHAGE
  - Liaise with blood bank early
  - Large bore IV access
  - Fluid warmer + warmed IV fluids
- Obstetric haemorrhage is usually underestimated and is difficult to quantify.
- Haemorrhage may be overt or hidden- the pregnant patient has a hyperdynamic circulation with an expanded blood volume. Hypotension is a late sign and reflects severe hypovolaemia.
- Ask the obstetrician what the PDx for the cause of bleeding- this aids in prioritizing and planning your management.
- The DDx of causes of postpartum haemorrhage (PPH) can be thought of as the 4 ‘T’s’:
  - Tone- uterine atony is the commonest cause and accounts for over 75% cases.
  - Tissue- retained placenta/ products.
  - Trauma- genital tract including cervical tear.
  - Tendency to bleed- coagulopathy, amniotic fluid embolism.
- Usually these cases require urgent EUA:
  - Senior Obstetric and Anaesthetic involvement is warranted.
  - An early decision to perform a hysterectomy may be lifesaving.
- A GA with RSI is usually the preferred technique- consider using ketamine as the induction agent. Consider invasive monitoring but the priority is resuscitation- don’t delay surgical attempts to stop the bleeding.
  - If a functional epidural is in situ and the patient is haemodynamically stable then it may be reasonable to use it for the case.
  - It takes a minimum of 10mins to ‘top-up’ an epidural and if you decide to commence this in Birth Suite then you need to stay with the patient until they are transferred to theatre.
  - For a patient with a retained placenta who is stable- it may be reasonable to do the case with a spinal. The Obstetrician may still struggle to remove the placenta and ask for uterine relaxation. In this event the drug of choice is:
    - GTN 100mcg boluses IV up to 500mcg. (1ml of 50mg/10ml amp diluted in 50mls saline and give 1ml boluses) or GTN sublingual spray
- Management of PPH can be divided into three main areas:
  - Medical- physical and pharmacological measures
  - Surgical- see below for detailed description
  - Radiological- placement of uterine artery balloon catheters, uterine artery embolization. This is not available at most centres.
- There are multiple case reports of the successful use of recombinant activated Factor 7 where other measures to stop bleeding have failed.
- The use of the Cell Saver is not contraindicated in obstetrics.
**Obstetric Emergencies**

### Immediate Management
- Call for SENIOR HELP
- Cease epidural infusion if running and disconnect it from the epidural filter and bung it.
- Secure large bore IV access x 2 and ensure a Crossmatch specimen has been sent. (Midwives routinely take bloods when they cannulate parturients and keep the tubes in their fridge.)
- Resuscitate with normal saline/colloid until blood is available.
- Give supplemental oxygen and get the nurses to insert an IDC if this hasn’t already been done.
- Assess the patient’s airway and perform a rapid anaesthetic assessment.
  - Give Na Citrate 30 mls PO
- Prepare OT:
  - Inform anaesthetic tech, nurse coordinator
  - Draw up drugs inc. vasopressor
  - Level 1 primed.
- In the situation of massive vaginal bleeding despite syntometrine IMI/Syntocinon infusion/manual ‘rubbing up’ of contractions, options are:
  - Bimanual compression of uterus ±
  - Direct external aortic compression on the way to OT.

### Intraoperative Management
- Monitor temperature, warm patient.
- Consider arterial and central venous lines
- Anticipate the need for FFP/platelets/cryoprecipitate; send baseline bloods but usually need to give blood products before lab results are available.
- If uterine atony:
  - Syntocinon is usually ineffective. **Beware this agent is a direct vasodilator and can cause a precipitous drop in BP if given as a bolus to a shocked patient.**
  - Ergometrine may be effective- give 500mcg (1amp) IMI or dilute in 10mls and give 100mcg IV boluses and assess response. **Caution with hypertension with this drug- avoid in PIH. High incidence nausea and vomiting also.**
  - Dinoprost, PGF$_2\alpha$ is a prostaglandin drug intended for injection directly into the myometrium. **It is supplied as a 5mg/1ml amp. It should be diluted in 10mls saline= 500mcg/ml. It should be injected into each side of the uterus up to a maximum dose of 3mg (6mls). This drug can cause bronchospasm and pulmonary hypertension and is relatively contraindicated in asthmatics.**
  - Misoprostol, PGE$_1$ analogue, give 3-4 200mcg tabs PR. **Slow onset of action. May cause pyrexia.**
- Surgical options include:
  - B-Lynch suture- analogous to trussing the uterus like a rolled roast.
    - Uterus needs to be contracted first for this to be effective.
    - Use described in context of bleeding LSCS, full thickness sutures are placed through the lower segment incision.
  - Foley catheter placed in cervix and inflating balloon.
• Large volume specialized catheters for intrauterine use are also available- i.e. the Bakri balloon.
  - Uterine packing- needs to be removed after 24hrs.
  - Uterine/ internal iliac artery ligation.
  - Subtotal or total hysterectomy- former more commonly done as cervix hard to identify and leaves pedicles.

• Don’t forget antibiotic cover- Cephazolin 2G, Metronidazole 500mg.
• Patient will need to go to ICU/HDU postoperatively or be ‘specialled’ in Birthing Suite at a minimum.
MATERNAL COLLAPSE POST EPIDURAL

Differential Diagnosis
- Simple faint= Vasovagal episode
- Aortocaval compression
- High/ total spinal  See also TOTAL SPINAL in this section
- Local Anaesthetic Toxicity  See also LOCAL ANAESTHETIC TOXICITY
- Anaphylaxis  See also ANAPHYLAXIS
- Seizure  See also MATERNAL SEIZURE in this section
- Embolism- Air/ Fluid / Thrombus  See also AIR/ GAS EMBOLISM
- Hypovolaemia/ Hypoglycaemia/ Hypoxaemia

Immediate Management
- CALL FOR HELP AND CRASH TROLLEY, press buzzer three distinct times.
- Position mother in left lateral position to minimize aortocaval compression. If this is not possible tilt the body or pelvis and displace the uterus to the side.
- Apply high flow O₂.
- Airway Breathing Circulation- Is this an arrest?
  - If cardiac arrest- commence cardiac compressions, roll patient so she is not tilted>25°. Guidelines recommend performing emergency LSCS if no return of circulation has occurred after 5mins of adequate resuscitation.
  - If respiratory arrest or hypoventilation- intubate patient urgently preferably with an assistant applying cricoid pressure. Intubation equipment is on the crash trolley and Suxamethonium is in the fridge.
  - Measure BP and assess for hypovolaemia- use vasopressors to correct hypotension and give fluid bolus 20mls/kg and assess response.
    - Metaraminol is kept in the right hand drawer of the epidural trolley.
- Is this a seizure? Treat as outlined in MATERNAL SEIZURE.
- Look for features of anaphylaxis- hypotension, rash, swelling, and bronchospasm.
- Establish monitoring including oximetry. Check BSL if clinically indicated.

Subsequent Management
- This is largely dictated by the patient’s response to therapy and the nature of the suspected problem.
- Foetal well-being needs urgent assessment by the obstetrician and it is prudent to make preparations for possible urgent LSCS.
- Review the patient’s chart- drug allergies, medications, ? PIH, ? Epilepsy.
- Review what drugs you have given the patient and re-check epidural infusion.
- Consider the following investigations:
  - FBE (occult haemorrhage), U&E’s (hyponatraemia), ABGs, tryptase.
  - CT pulmonary angiogram (PE).

Special Considerations
- Amniotic Fluid Embolism:
  - Rare, high mortality, diagnosis of exclusion.
  - May present with dyspnoea and respiratory distress, cardiovascular collapse, seizure or rarely coagulopathy (although the latter is a feature of AFE).
  - Treatment is supportive, there is no specific therapy.
MATERNAL SEIZURE

Differential diagnosis
- Eclampsia
- Epilepsy
- Hypoglycaemia/ Hypotension/ Hypoxaemia
- Intracerebral event
- Hyponatraemia- Syntocinon, dextrose.
- Drug Withdrawal- alcohol, benzodiazepines
- Poisoning

Immediate Management
- CALL FOR HELP
- Position mother in left lateral position.
- Apply high flow oxygen; don’t attempt to bag the patient while seizing.
- You need to terminate the seizure if it is prolonged; drug options include:
  - Magnesium sulphate 1g over 5-10mins- drug of choice if an eclamptic fit is suspected. Give further ampoule if recurrent seizure.
  - Midazolam 2mg IV boluses up to 10mg
  - Propofol
  - Sodium Thiopentone - expect hypotension with these agents
- Correct the ‘H’s’- don’t forget hypoglycaemia especially.
- Establish continuous monitoring.

Subsequent Management
- Organize urgent obstetric review and assess foetal well-being.
  - If decision for urgent delivery is made- stabilize mother prior to delivery. The mother is the priority.
- If eclampsia suspected (may fit ante/intra/post-partum):
  - Commence magnesium infusion- 10g Magnesium (20mls 50% solution) diluted with saline up to 50mls in a 50ml syringe. Run at 5mls/hr= 1g/hr and continue for 24hrs.
    - Monitor knee jerk and serum magnesium levels. Loss of reflexes, hypotension and widening QRS/ AV block are features of magnesium toxicity- treatment is Calcium Chloride.
  - If still has seizures, consider Phenytoin- loading dose 10-15 mg/kg in saline IV.
  - Treat hypertension SBP>170, DBP>110 with one of:
    - Nifedipine sublingual 20mg up to 80mg.
    - Clonidine
    - Hydralazine- 20mg amp diluted in 20ml syringe to 1mg/ml. Give initial dose of 5mg. May need to run infusion- 4 amps up to a volume of 40mls (2mg/ml), start at 1ml/hr. Causes reflex tachycardia, don’t over treat hypertension as hypotension is just as dangerous.
- Perform a neurological assessment- order CT if focal signs present.
- Send bloods for U&E’s, FBE, LFTs, urate, coags and consider blood/ urine drug and toxin screen.
- Organize appropriate post-operative environment for monitoring.
Anaesthesia for Eclampsia/ Severe Pre-eclampsia

- Senior staff involvement
- GA if coagulopathy, regional contraindicated (check platelets).
- Site arterial line, IDC.
- Magnesium infusion should be in progress.
- Anticipate potential difficult intubation, there may be significant airway oedema.
- Options to blunt the pressor response to intubation include:
  - Remifentanil 1mcg/kg bolus
  - Alfentanil 10mcg/kg bolus 60s prior to intubation.
  - Further bolus of magnesium 20mg/kg (1 amp)
  - Esmolol 0.5mg/kg
- Expect prolonged duration of action of NDMRs and there may be no fasciculations with Suxamethonium.
- Don’t give ergometrine or NSAIDs.
- Careful attention to fluid balance, tend to run on the dry side.
- ICU post-op.
TOTAL SPINAL

Presentation
- Generally seen as a complication of epidural analgesia/anaesthesia when the catheter is in a subdural/subarachnoid location. It has been reported as a complication of epidural analgesia subsequent to a dural puncture—this is thought to reflect transfer of local anaesthetic through the hole in the dura. It has also been reported with spinal anaesthesia after inadequate epidural block.
- Cardiovascular—hypotension (nausea and vomiting as result of this), bradycardia, cardiac arrest.
- Respiratory—dyspnoea, difficulty breathing, hypoventilation and hypoxaemia progressing to respiratory arrest.
- CNS—tingling of hands, difficulty speaking, seizures, loss of consciousness.
- It may present abruptly as maternal loss of consciousness/collapse or gradually in the context of an ascending block.

Immediate Management
- This is essentially supportive—ABC + O₂ while the effects of the block are allowed to resolve, this generally takes 1-2 hrs but may last up to 6 hours.
- Supplemental O₂ should be given and the patient positioned in the left lateral position.
- If the patient is in respiratory failure or has depressed level of consciousness then apply cricoid pressure and intubate using Suxamethonium.
- Maintain BP with aggressive fluid therapy and vasopressors. Elevate the legs to promote venous return. Give adrenaline boluses if poor or no response to alpha agonists.
- Treat bradycardia with atropine.
- Obtain urgent obstetric assessment and determine whether there is foetal distress necessitating emergent delivery.
- It may be worth trying to aspirate CSF from an epidural catheter in an attempt to remove some local anaesthetic. In addition, consider injecting 20mls saline to dilute the local anaesthetic in the CSF.
- Generally, it is prudent to remove the epidural catheter if in situ.

Subsequent Management
- If emergent delivery not indicated transfer to ICU for ventilation, sedation will need to be maintained while the block resolves. BIS monitoring may be useful to titrate sedation.
- Carefully document events in chart and complete Anaesthetic Incident report form.
- Exclude other causes of maternal collapse, eg. hypoglycaemia, anaphylaxis, aortocaval compression. See also MATERNAL COLLAPSE.
FAILED INTUBATION- CAESAREAN SECTION

General comments
- Do not induce general anaesthesia for LSCS without an Anaesthetic Consultant being present.
- The safety of the mother is your priority.
- A ‘rapid sequence spinal’ is an option for rapid anaesthesia in a patient who has a potentially difficult airway. This entails:
  - Pt on operating table being preoxygenated.
  - Put on gloves, draw up 3.0 mls heavy marcaim only
  - Wipe intended puncture site with alco-wipe.
  - Perform spinal- no skin infiltration.
  - Lie down with tilt on bed
- Don’t give a second dose of suxamethonium
- Don’t have multiple or protracted attempts at intubation. Your first attempt is your best attempt.
- There is a size 3, 4 & 5 “Supreme” Proseal LMA kept in the draw of all the Anaesthetic Workstations in Toowoomba Hospital.
- It is generally advisable to wake the mother if failed intubation.
- If able to get a good airway and ventilate easily with LMA- it may be reasonable to proceed with LSCS if it is a genuine emergency.
- If you are unable to oxygenate the mother despite attempts at a surgical airway then peripartum Caesarean section should be performed.
- See also RAPID SEQUENCE INDUCTION
- The DAS Obstetric Failed Intubation Algorithm is below. It was first published in Anaesthesia 2015; 70: 1286-1306.

**Algorithm 2 – obstetric failed tracheal intubation**

Declare failed intubation
Theatre team to call for help
Priority is to maintain oxygenation

Supraglottic airway device
(2nd generation preferable)
Remove cricoid pressure during insertion
(maximum 2 attempts)

Facemask +/- oropharyngeal airway
Consider:
- 2-person facemask technique
- Reducing/removing cricoid pressure

Is adequate oxygenation possible?
No
Follow Algorithm 3
Can’t intubate, can’t oxygenate

Is it essential/safe to proceed with surgery immediately?
No
Wake
Yes
Proceed with surgery
Failed Intubation Drill

Failed Intubation
CALL FOR HELP

Bag Mask Ventilation
Possible

Bag Mask Ventilation
Impossible

Release Cricoid Pressure

Ventilation Impossible

Insert LMA (Proseal)

Ventilation Impossible

Surgical Airway

Wake Patient

Ventilation Easy

Is this a true emergency?

No
Wake Patient up
Left Lateral Position
Head Down
Consider regional/
awake intubation

Yes
Continue GA with
spontaneous ventilation
Reapply cricoid p if able
Consider passing NGT
APPENDIX

1. DEFIBRILLATORS
2. PERIOPERATIVE MANAGEMENT ANTITHROMBOTICS
3. COVER ABCD ALGORITHM
4. PAEDIATRIC FORMULAE
5. ANAESTHETIC MACHINE CHECKLIST*

*Thanks to Gail McDonald and Barbara Lindbergs for permitting me to reproduce this.
DEFIBRILLATORS

1. All staff should be familiar with the location and operation of defibrillators.
2. All staff are expected to attend a Life Support workshop; use of the defibrillator is a component of the workshop.

How to defibrillate with the LIFEPAK 12 – AED Mode

1. Press ON
2. Connect electrodes- come in packs already lubricated with gel, connect to therapy cord, apply in anterolateral position. The CONNECT ELECTRODES message and voice prompt will appear until this is done.
3. Press ANALYZE. You will see and hear ANALYZING NOW, STAND CLEAR. Don’t touch the patient until analysis is complete, this takes 6-9 seconds.
4. If the AED detects a shockable rhythm, you will see and hear SHOCK ADVISED. AED will start charging. When charging is complete, AED will display the available energy (Pre-programmed).
5. You will see and hear STAND CLEAR, PUSH TO SHOCK followed by a ‘shock ready’ tone. The SHOCK LED flashes. Press SHOCK to discharge the AED. (If you don’t press SHOCK within 60s the AED disarms the SHOCK button and removes the charge.)
6. If AUTO ANALYZE is on, the AED will automatically start analysis. If AUTO ANALYZE is off, the PUSH ANALYZE message and voice prompt appears.
7. The second analysis and sequence is the same. Again, the energy settings have been pre-programmed.
8. If AED detects a non-shockable rhythm, you will see and hear NO SHOCK ADVISED. It will then generate prompts to check the pulse and commence CPR. If you wish to perform further ECG analysis you can press ANALYZE at any time.

How to defibrillate with the LIFEPAK 12 – Manual Mode

To change to manual mode when the defibrillator is in AED mode, press one of the following:
   a. ENERGY SELECT
   b. CHARGE
   c. PACER
   d. ADVISORY
The machine will generate a message: Enter Manual Mode
   Yes  No
   Push Selector knob to confirm

1. Press ON
2. Connect QUIK-COMBO electrodes to therapy cable and apply them onto patient.
3. Press ENERGY SELECT.
4. Press CHARGE.
5. The defibrillator makes a ramping tone as it charges and when it is fully charged an overlay appears:
   Manual Mode
   200J Available
   Push SHOCK Button!
Push Selector knob to disarm

6. When personnel are all clear and you have confirmed the ECG rhythm press the SHOCK button.

6. If you need to give further shocks, repeat the procedure from step 3.
Recommendations for Perioperative Management of Antithrombotic Medications

Preoperative Management- general considerations

- Perioperative management of these drugs is a balance between the risk of thrombotic events and the risk of bleeding. There is poor evidence to guide this risk assessment process. An approach using consensus guidelines tailored to the individual patient undergoing a specific procedure is the current standard of care.
- Check (if anaesthetist) and document (if surgeon) on the elective surgery bookings form any orders relating to antithrombotic medications.
- Generally speaking it is not necessary to cease low dose aspirin or NSAID monotherapy in the perioperative period. Consideration may be given to ceasing low dose aspirin three days preoperatively in patients at low risk of thrombosis but high risk of bleeding as per the POISE 2 trial.
- Does the drug have to be stopped? -for surface/ minor surgery it may be reasonable to proceed without stopping the drug. It is recommended to liaise with the consultant/ operating surgeon if you are considering not stopping antithrombotic medication.
- Patients who attend PAC will have a perioperative regimen instigated by the attending anaesthetist. It is strongly recommended that patients on these medications are referred and seen in the anaesthetist Preadmission Clinic.
- Patients who have an antithrombotic medication ceased by the anaesthetic team will have a ‘WARNING Antithrombotic medication’ sticker placed on their medication chart to remind the treating medical team of this and for the need to recommence it postoperatively.

Preoperative Management of specific drugs if they are to be stopped

**Clopidogrel (Iscover, Plavix)** - cease 7 days preoperatively; consider aspirin cover in this period-100mg daily and if on dual antiplatelet therapy patient should remain on aspirin.

**Prasugrel (Effient)** – same as clopidogrel

**Ticagrelor (Brilinta)** – same as clopidogrel

**Warfarin** - cease 5 days preoperatively (i.e. 4 doses have been withheld) and check INR on the day. Target INR is ≤1.4.

Patients requiring bridging therapy to commence LMWH on day 2. Patients having LMWH to have last dose on day prior to surgery. There are separate guidelines relating to which patients require bridging therapy.
The recommended method to acutely reverse warfarin therapy is with Prothrombinex 50 units/kg if INR>3 and 30 units/kg if INR<3. Complete infusion one hour prior to intended surgery, repeat PT testing is not required. FFP is unnecessary and Vitamin K is slow and unreliable.

SC Unfractionated Heparin- withhold am dose
Clexane (LMWH)- last dose 12 hrs prior if normal renal function and 24hrs if renal impairment or therapeutic anticoagulation dose (1.5mg/kg daily or 1mg/kg bd)
IV Heparin infusion- cease four hours prior, check APTT also if renal impairment.

Dabigatran (Pradaxa)- cease five (5) days prior
Rivaroxaban (Xarelto)- cease three (3) days prior
Apixaban (Eliquis)- cease three (3) days prior

Postoperative Management- general considerations
• Most drugs can be recommenced the next day at the dose they were taking prior to cessation. It is important to recommence these medications prior to discharge.
• Most of these patients will be identified with an ‘Antithrombotic medication’ sticker.
• In cases where the patient has had major surgery and/or there are concerns with bleeding or haemostasis it is prudent to withhold antithrombotics and liaise directly with the surgeon responsible. Most guidelines suggest withholding these for at least 48hrs.
• Most thrombotic events occur in the postoperative period.

Postoperative Management- specific drugs
Warfarin- recommence at normal dose on 1st postoperative day.
For patients on bridging therapy- continue this along with restarting warfarin until INR is therapeutic. This will take several days and require liaison with the primary medical practitioner.
Rivaroxaban – for orthopaedic surgery thromboprophylaxis recommendation is for the 1st dose 6 hours postoperatively (not if concerns with bleeding).
SC heparin- can be given in OT after consultation with surgeon
IV Heparin infusion- recommence after consultation with surgeon.
Clexane (LMWH) - can be given six (6) hours after neuraxial puncture. Antithrombotics including clexane should be withheld for at least two hours after removal of an epidural or nerve/plexus catheter.

Notes re the NOACs- new oral anticoagulant drugs
• There is no effective antidote for any of these drugs*. The best option is to defer surgery. Even a delay of 24 hours will significantly reduce the likelihood of bleeding as a direct result of drug anticoagulant activity.
• Testing for these drugs is unreliable and specific assays are not available at this hospital. Namely thrombin time, factor Xa activity are sent to Brisbane with a 24hr turnaround so do not help with regards to practical management of these patients. If you request a standard coag screen (PT, APTT, fibrinogen) and it is completely normal then it is unlikely that there is significant anticoagulant activity but not guaranteed. Dabigatran (thrombin inhibitor) prolongs TT and APTT, Rivaroxaban (factor Xa inhibitor) prolongs PT and APTT to lesser extent, response to Apixaban (factor Xa inhibitor) is very variable.
• These drugs should not be used in patients with significant renal or hepatic impairment. They have prolonged half-lives in this instance.
• For patients with normal renal function undergoing ‘low risk’ surgery it is reasonable to withhold them for only day.
• In the event of performing emergency surgery on these patients when they have anticoagulant on board:
  o Expect major haemorrhage- XMatch, ICU, liaise directly with anaesthetist, blood bank, haematologist
  o Dabigatran is removable by haemodialysis
  o The following drugs are suggested:
    ▪ Prothrombinex 25-50 units/kg
    ▪ Tranexamic Acid 15-30mg/kg
    ▪ Novoseven (rFVIIa) 50mcg/kg

* A novel antagonist for Dabigatran has recently been made available in Queensland Health via the Special Access Scheme. It is a monoclonal antibody and it is very expensive. The drug is IDARUCIZUMAB and the dose is 5g given as a slow IV bolus over ten minutes (Two 2.5g vials). It works immediately and lasts for 24 hours.

**Selected References**

ASRA 3rd revised Guidelines: Regional Anesthesia in the Patient Receiving Antithrombotic or Thrombolytic Therapy 2010.
Prothrombinex-VF product guidelines October 2014.
This is a generic crisis algorithm developed by Australasian anaesthetists and first published in A&IC in 1993. A revised algorithm was published in 2006. The algorithm was designed to diagnose the vast majority of crises and direct their management.

Although it has its merits the algorithm has fallen out of favour as it is quite large and non-specific. I have reproduced it here as its development reflects an important place in the patient safety heritage of Australasian anaesthetists.
PAEDIATRIC FORMULAE

Airway Equipment
ETT size: \((\text{Age}/4) + 4\)
- Premature 3.0, Term 3.5
LMA size/ recommended pt weight/ maximum cuff volume
- #1, 1-7 kg, 4mls
- #1.5, 5-10 kg, 7mls
- #2, 10-20 kg, 10mls
- #2.5, 20-30 kg, 15mls
- #3, 30-50 kg, 20mls
- #4, 50-70 kg, 30mls

Maintenance Fluids
- 2 ml/kg/hr 1st 10kg
- 1ml/kg/hr 2nd 10 kg
- 0.5ml/kg/hr for the remaining kgs

Estimating Weight
- Weight in kg = \((\text{Age} \times 3) + 10\). Michigan formula.

Apgar Scores

<table>
<thead>
<tr>
<th>Clinical feature</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>COLOUR</td>
<td>Pale/ blue</td>
<td>body pink, extremities blue</td>
<td>Pink</td>
</tr>
<tr>
<td>HEART RATE</td>
<td>nil</td>
<td>&lt;100</td>
<td>&gt;100</td>
</tr>
<tr>
<td>RESPONSE TO STIMULATION</td>
<td>nil</td>
<td>Some movement</td>
<td>Cry</td>
</tr>
<tr>
<td>MUSCLE TONE</td>
<td>limp</td>
<td>Some flexion of extremities</td>
<td>Well flexed</td>
</tr>
<tr>
<td>RESPIRATORY EFFORT</td>
<td>absent</td>
<td>Poor resp. effort or weak cry</td>
<td>Good</td>
</tr>
</tbody>
</table>

SIMPLIFIED FORMULA TO CALCULATE LBW IN MORBIDLY OBESE PT

For males \(\text{LBW} = 22 \times \text{ht}^2\)
For females \(\text{LBW} = 26 \times \text{ht}^2\)
Taken from letter BJA using linear regression model for Janmahasatian equations
AESPIRE VIEW ANAESTHETIC MACHINE LEVEL 2 CHECK

CLEAN FILTERS, CHECK SERVICE DATE, TURN THE SUCTION AND SCAVENGING ON & check functioning.

LOW-PRESSURE LEAK TEST – to be performed with the machine off.
- Attach the leak test device to the auxiliary gas outlet and divert gas flow from circle to the ACGO by turning the switch down.
- Open all flow controls by turning them anti-clockwise.
- Squeeze the bulb until it is collapsed, leak if inflates within 30 secs.
- Turn vapouriser to 1% (Tec 6/Plus at 12%). The bulb may expand. Squeeze the bulb until it collapses and monitor for leaks. Repeat this test for each vapouriser attached to the machine.
- Are the vapourisers filled and within service date?
- Is it possible to turn on both vapourisers at same time?
- Once the low-pressure test is complete ensure that the vapourisers are turned off, disconnect the test device from the auxiliary gas outlet and turn the ACGO switch back to circle or up to its original position. Close flow controls.

CYLINDER LEAK TEST - to be performed with the machine off.
- Disconnect the wall supply of oxygen
- Turn O₂ cylinder on & note pressure
- Turn cylinder off & monitor pressure for 1 minute, leak if pressure drops >690kPa
- Reconnect wall supply of oxygen

ENSURE CO₂ SAMPLING LINE IS CONNECTED & TURN THE MACHINE, THE PATIENT MONITOR ON.#

CALIBRATION OF FLOW SENSORS & O₂ SENSOR CALIBRATION – 21% O₂
- Release the flow sensor module by pulling open the green lever on the insp/expi ports.
- Pull the flow sensor assembly out slowly. Two yellow messages “no insp/expi sensors” will appear on the ventilator screen.
- Unscrew and remove the O₂ sensor from the circuit.
- Press Menu key on ventilator screen & select Setup/Calibration, then O₂ Sensor Cal, & finally 21%.
- Select Start cal on the ventilator screen.
- If calibration passes reinstall O₂ sensor & press menu.(If fail, redo and/or do 100% O₂ calibration*)
- Gently reinsert the flow sensor assembly. The two yellow messages should disappear from the screen. The flow sensors are now also calibrated.
GAS SUPPLY, O₂ FAILURE ALARMS, ANTI-HYPOXIC CHECK

- Turn O₂ onto 5 L/min and analyse gas using gas sampling line, should read 100% O₂.
- Turn on nitrous oxide onto 5L/min and analyse gases, should read 50% N₂O & 50% O₂.
- Reduce O₂ flow and ensure N₂O drops also. Return flow to 5L/min.
- Now turn air onto 5L/min.
- Initiate an oxygen failure by disconnecting the wall supply of oxygen. Observe the gas flows within the rotameters. As the oxygen begins to fall the nitrous oxide should cut off (antihypoxic device) & alarm should sound (O₂ disconnect alarm.) Air remains at 5L/min & analyse gas, should be 21%.
- Turn on O₂ cylinder and gases should return, check cylinder pressure gauge above 9000kpa.
- Close O₂ cylinder & reattach the wall supply. Turn off all gas flows.
- Check wall supply is above 345kpa (Australian Standard), but preferably within 5% of 410kpa.

AVANCE BREATHING SYSTEM (ABS) AND VENTILATOR CHECK.

- Attach rebreathing bag to the patient end of the breathing system and close the APL valve.
- Press O₂ flush to pressurise system to approx 30cm H₂O. Ensure all rotameters are turned off (O₂ basal flow 100ml/min will still be flowing).
- Watch the pressure gauge on the block and the screen on the ventilator for any drops in pressure. The pressure should hold for at least 10 seconds. If the pressure does drop there is a leak within the system. Check that the breathing system is securely attached and that the CO₂ absorber canister is correctly positioned.
- Once the pressure has held for 10 seconds, ensure gas flows freely between bags and open the APL valve to reduce the pressure to ensure APL is working.
- Engage the ventilator by flipping the bag/vent switch to vent.
- Fill the bellows using the O₂ flush button. (Not to be pushed when patient is connected to ventilator.)
- The bellows should rise and fall as it begins ventilation.
- Observe that as the bellows rise it inflates fully against the top of the canister.
- Observe the ventilator screen. The ventilator should reach the pre set tidal volume of 500mls and respiration rate of 10 within 10 breaths or 1 minute.
• **Note:** acceptable levels for the tidal volume are higher than 450mls and lower than 550mls.
• Squeeze the bag firmly to initiate a high pressure alarm, do not squeeze greater than 38kpa or 100cmH₂O, otherwise the manifold pressure sensor failure device will activate and the machine will need to be turned off to reset. Allow ventilator to reset tidal volume.
• Disconnect the bag and observe the disconnect alarms. – cannot drive bellows and low Ve (volume expired)
• Once checked disengage the ventilator by flipping the bag/vent switch back to bag.
• Turn the ventilator off by pressing the end case button and confirming with the green com wheel.
• Remove the bag from the patient end of the breathing system and attach the filter and CO₂ sampling line.

**OTHER**
• Perform function test including leak test on self inflating bag (air viva/ambu bag)
• Monitor CO₂ absorber and change if CO₂ baseline 5mmHg or higher
• Check external O₂ supply is working and O₂ tubing is present

Your machine is now ready for use.
Don’t forget to check intubating tools and emergency equipment.

* O₂ Sensor Calibration must be calibrated to 100% every week on Monday
# Battery back up is checked every Monday, via turning AC power supply off
LACHLAN’S TWENTY TOP TIPS

1. If you’re wondering whether you should tube the patient or not— you should tube the patient.
2. The most useful monitor for a sick patient is an arterial line.
3. Practice bagging every patient before you stick an LMA down— you’ll be glad you’ve honed this skill when you have a failed intubation.
4. Ejection systolic murmurs in #NOF pts are severe aortic stenosis until proven otherwise.
5. Position the table in reverse Trendelenburg for the obese patient on induction.
6. There are only 2 reliable ways to know the tube is in the right place— you must know them and always ensure at least one of them has been satisfied.
7. Try new techniques/ gizmos on elective lists when a consultant’s around— not at night during an emergency.
8. Have (and practice) a backup technique for when the LMA doesn’t fall in eg. Bougie guided technique.
9. The best default ventilation mode is probably SIMV-PC.
10. Don’t trust an IMED line— start a new drip with a standard giving set and make sure it runs before giving any drug through it.
11. Stridor at rest = trache under local.
12. You should be able to put a central line in without an ultrasound machine.
13. The sucker has only two purposes: sucking stuff and stimulating the patient. If there isn’t stuff to suck you must be stimulating the patient.
14. Blood loss is invariably underestimated, have a low threshold to do a hemocue.
15. High airway pressures always have a cause— you should find out what it is.
16. A risk you should warn every CS patient about— the 3% failure rate of a regional anaesthetic.
17. Keeping your patient warm, well oxygenated and well analgesed are the 3 most important ways in which you can contribute to a good outcome for the patient.
18. If in doubt— ask.
19. The drug you are most likely to kill someone with is propofol. The older and sicker the patient— the more slowly you give it.
20. Read my book— it’s full of useful stuff.