ANAESTHETIC HANDBOOK FOR THE NOVICE

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Edited by
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Anaesthetic Handbook for the Novice

A book written for trainees by a trainee

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Introduction

To all novice trainees in Anaesthetics, whether you are ST1s or doing your Acute Care Stem (ACS), welcome to the most interesting speciality in medicine today.

I have written this book for you, because not very long ago, I stood where you stand today. I remember how terrified I was. When I started anaesthetics, I was two years out of medical school with a good foundation in acute medicine, but not a clue about which anaesthetic drugs to use or how to use an anaesthetic machine. Every time something beeped I would fall off my stool! What was even more daunting was how much information was available. I was not sure where to start or the level of knowledge required to gain a solid foundation for safe and competent practice.

I have written this handbook to be your guide using mine and others’ experiences, and what I feel is important for every novice to know from day one. It contains the very basic knowledge you need to achieve your three month competencies. It also gives you a taste of things you should be considering during your everyday practice.

Let it guide you, evoke thoughts and questions which can be discussed with your senior colleagues and most of all, let it be a reference on how to safely manage those 'hairy' situations we all run into even as experienced trainees.

Your aim when reading it should be to understand, recognise and manage everyday situations, remembering to always call for help. Remember to supplement your knowledge from core texts and above all enjoy and learn from every experience. I hope you find this book invaluable as a novice and as a reference tool in your first and second year.

Atika Sabharwal, London 2009
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Part 1
General Assessment

Anaesthetic assessment of the fit patient

The Paediatric patient

The Day case patient

The Obese patient

The Diabetic patient

The Elderly patient

ITU for beginners
ANAESTHETIC ASSESSMENT OF THE FIT PATIENT
The objective of this is to ensure the best medical condition of your patient.

HISTORY

Ask about previous anaesthetics
This is to highlight the following problems:
- Confirm whether general or regional technique performed
- Post operative nausea and vomiting
- Family history of problems (malignant hyperpyrexia)
- taken a long time to wake up resulting in ITU admission (suxamethonium apnoea)
- Difficult intubation
- Awareness
- Other reasons for ITU admission

Relevant surgical problems
- Confirm procedure being performed
- Ask what symptoms the underlying problem has been posing
- Confirm site and document it on the chart.

Past medical history
- Cover all systems
- Ensure no on going coryzal symptoms
- Inquire about GORD- acid taste in mouth, symptoms worse on lying down, coughing or bending over.
- In Afro-Caribbean, Middle Eastern, and Mediterranean patients ask about sickle cell status.

Drugs history
- Allergies- antibiotic/ egg/ latex/NSAIDs in particular- document reactions
- OCP- discuss with surgical team and senior anaesthetist need of discontinuation if surgery poses a risk of thrombosis.

Social history
- Enquire about smoking- remember carbon monoxide will influence oxygen carriage and suggest they abstain for at least 12 hours pre-operatively
- Alcohol intake- associated with relative resistance to anaesthesia, altered hepatic metabolism of drugs and withdrawal.

Starvation
- No solid food 6 hrs prior to surgery
- Clear fluids 2 hrs prior to surgery
- In emergency situations when patient not starved discuss with senior risk/benefit of proceeding immediately with surgery.

EXAMINATION

General
- Does the patient look well
- Do they appear short of breath when talking to you
- Are they obese
- Look at their hands to see if cannulation will be difficult.

Cardiovascular /Respiratory
- Listen for murmurs
- Ensure good air entry bilateral with no evidence of respiratory compromise.

Airway
- Anatomy:
  - Small jaw
  - limited mouth opening
  - large tongue
  - limited neck movement
  - dentition
- Score:
  - Mallampati score
  - Thyromental distance
  - Jaw slide
INVESTIGATIONS

Bloods
- In fit patients unless there is an indication baseline bloods are not essential. E.g. in a fit man undergoing minor surgery Hb is not necessary but in a post-menopausal female there is an indication for measurement.

Radiology
- CXR- poor indicator for pulmonary function. It should only be performed if detection of disease may alter surgical management or for baseline measurement in major surgery e.g. cardiac, thoracic or major abdominal surgery.

ECG
- In patients over the age of 50 years or in patients with a known cardiac history.

Baseline readings
- Heart rate
- Blood pressure
- Temperature
- Saturations on air/oxygen

CONSENT

Finally always tell the patient what to expect when they come to theatre. Explain the environment and the procedure from arrival to the anaesthetic room to recovery. Allow the opportunity for questions.

SCORING SYSTEMS IN ANAESTHESIA

Fitness Score : American Society of Anesthesiologists (ASA) GRADE from the American Association of Anaesthesiologists website (http://www.asahq.org/clinical/physicalstatus.htm)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Healthy patient with no systemic disease</td>
</tr>
<tr>
<td>2</td>
<td>Mild to moderate systemic disease</td>
</tr>
<tr>
<td>3</td>
<td>Severe systemic disease imposing functional limitations on patient</td>
</tr>
<tr>
<td>4</td>
<td>Severe systemic disease which poses a constant risk to life</td>
</tr>
<tr>
<td>5</td>
<td>Moribund patient whose survival is poor regardless of procedure</td>
</tr>
<tr>
<td>6</td>
<td>A brain stem dead patient whose organs are being removed for donor purposes.</td>
</tr>
</tbody>
</table>

Looking into an open mouth assess the Mallampati Score. Increasing score has some association with difficult airways and intubation.

Laryngoscopic view. Increasing score associated with difficult intubation
THE PAEDIATRIC PATIENT

HISTORY AND EXAMINATION

History and examination for paediatric patients require the same considerations as that for fit adults. However the following information needs to be gained on assessment.

- Problems during pregnancy
- Gestation at labour and mode of delivery
- Problems at birth required NICU/SCABU admissions
- Development history
- Recent coryzal symptoms +/- fevers if a child is presenting for surgery with evidence of a respiratory tract infection with fever, surgery may need to be postponed.
- Immunisation status
- Loose teeth
- Starvation time
  - 6 hrs for solids
  - 4 hrs for breast milk
  - 2 hrs for clear fluids
- Explain to parents the procedures of IV/Gas induction
- Consent for suppositories
- Request nursing staff to apply EMLA at least 60 mins prior to theatre.
- Take baseline
  - Heart rate
  - Blood pressure
  - Temperature
  - Saturations on air/oxygen
  - Capillary refill time
  - Weight of child.

IMPORTANT FORMULAE NEEDED FOR PAEDIATRIC ANAESTHESIA

<table>
<thead>
<tr>
<th>Weight</th>
<th>((\text{AGE} +4))*2 kg</th>
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</thead>
<tbody>
<tr>
<td>Tube Size</td>
<td>((\text{AGE}/4) +4)</td>
</tr>
<tr>
<td>Tube Length</td>
<td>Oral ((\text{AGE}/4) +12)CM</td>
</tr>
<tr>
<td>Nasal ((\text{AGE}/4) + 15)CM</td>
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</tr>
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</table>

LMA Sizes in Children

<table>
<thead>
<tr>
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<th>Size</th>
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<tbody>
<tr>
<td>0-5kg</td>
<td>1</td>
</tr>
<tr>
<td>5-10kg</td>
<td>1.5</td>
</tr>
<tr>
<td>10-20kg</td>
<td>2</td>
</tr>
<tr>
<td>20-30kg</td>
<td>2.5-3</td>
</tr>
<tr>
<td>&gt;30kg</td>
<td>3</td>
</tr>
</tbody>
</table>

Maintenance Fluid

<table>
<thead>
<tr>
<th>Weight</th>
<th>Fluid</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10kg</td>
<td>4ml/kg/hr</td>
</tr>
<tr>
<td>10-20kg</td>
<td>40ml/hr+2ml/kg/hr</td>
</tr>
<tr>
<td>&gt;20kg</td>
<td>60ml/hr+1ml/kg/hr</td>
</tr>
</tbody>
</table>

Systolic Blood Pressure

80 +(Age *2)
## PAEDIATRIC DRUG DOSES

Always confirm the protocol within your own department regarding preferred paediatric doses. This is for your reference from the stated anaesthetic texts.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Route</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiopentone</td>
<td>IV</td>
<td>4-5mg/kg for neonates</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7-8mg/kg for infants</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5-6mg/kg for children</td>
</tr>
<tr>
<td>Propofol</td>
<td>IV</td>
<td>3mg/kg</td>
</tr>
<tr>
<td>Ketamine</td>
<td>IV</td>
<td>2mg/kg</td>
</tr>
<tr>
<td></td>
<td>IM</td>
<td>10mg/kg</td>
</tr>
<tr>
<td>Suxamethonium</td>
<td>IV</td>
<td>2-3mg/kg in infants</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.0-1.5mg/kg in children</td>
</tr>
<tr>
<td>Vecuronium</td>
<td>IV</td>
<td>0.1mg/kg (use a third to half the initial dose to increment)</td>
</tr>
<tr>
<td>Atracurium</td>
<td>IV</td>
<td>0.5mg/kg (use a third to half the initial dose to increment)</td>
</tr>
<tr>
<td>Pancuronium</td>
<td>IV</td>
<td>50-100mcg/kg (use a third to half the initial dose to increment)</td>
</tr>
<tr>
<td>Morphine</td>
<td>IV loading</td>
<td>100mcg/kg</td>
</tr>
<tr>
<td></td>
<td>maintenance for anaesthesia</td>
<td>20mcg/kg/hr</td>
</tr>
<tr>
<td></td>
<td>IV loading</td>
<td>25 mcg/kg</td>
</tr>
<tr>
<td></td>
<td>maintenance</td>
<td>5-10mcg/kg/hr</td>
</tr>
<tr>
<td>Pethidine</td>
<td>IV</td>
<td>1mg/kg</td>
</tr>
<tr>
<td>Fentanyl</td>
<td>IV</td>
<td>1-2mcg/kg</td>
</tr>
<tr>
<td>Codeine phosphate</td>
<td>Oral/P.R.</td>
<td>1mg/kg</td>
</tr>
<tr>
<td></td>
<td>6 hrly</td>
<td></td>
</tr>
<tr>
<td>Paracetamol</td>
<td>Oral/P.R.</td>
<td>15mcg/kg</td>
</tr>
<tr>
<td></td>
<td>6hrly</td>
<td></td>
</tr>
<tr>
<td>Diclofenac</td>
<td>P.R.</td>
<td>1.0-1.5mg/kg (over 1yr old)</td>
</tr>
<tr>
<td>Ibuprofen</td>
<td>Oral</td>
<td>5mg/kg</td>
</tr>
<tr>
<td>Atropine</td>
<td>IV</td>
<td>20mcg/kg</td>
</tr>
<tr>
<td>Bupivacaine</td>
<td>Infiltration or epidural</td>
<td>Up to 2mg/kg</td>
</tr>
<tr>
<td>Temazepam</td>
<td>Oral</td>
<td>0.3mg/kg</td>
</tr>
</tbody>
</table>

**Hutton P, Cooper G, James F, Butterworth J. Fundamental Principles and Practice of Anaesthesia.**

| Neostigmine       | IV          | 50mcg-70mcg/kg (max5mg)                                    |
|                   |            | (The most convenient way of making this up is based on 50mcg/kg. 1 ml of 2.5mg neostigmine with 500mcg glycopyrolate made up into 5mls with NaCl and give 1ml for every 10kg up to a max of 5mls.)|
| Cyclizine (6-12yrs) | Oral       | 25mg                                                        |
| Cefuroxime        | IV          | 60mg/kg/day (divide by 3 for 8hrly dose)                    |

**British National Formulary**

| Ibuprofen         | Oral        | 10mg/kg (over 6mths/7kg)                                   |
| Paracetamol       | Oral /PR    | 20mg/kg                                                    |
|                   |             | Rectal loading dose ONCE only                              |
|                   |             | Neonate: 20mg/kg                                           |
|                   |             | Child 30-40mg/kg                                           |
| Oramorph          | Oral 4hrly  | 400mcg/kg                                                  |

**Allman K, Wilson I. Oxford Handbook of Anaesthesia**

Remember the Minimum Alveolar Concentration (MAC) of volatile in children is higher than that of an adult and varies within ages groups.
THE DAY CASE PATIENT

Who is suitable?

- ASA 1, 2 or stable ASA 3 patients - depending on medical fitness
- Patients who have a responsible escort home who can look after them for 24 hours post-operatively.
- Patient must live no more than an hour drive from the hospital.
- The planned procedure should be:
  - Predictable with minimal complication
  - Minimal blood loss
  - Pose minimal post-operative pain

Patients who might be excluded from the day surgery list:

- Ischaemic heart disease (IHD)
- COPD - poor control, oxygen/nebs at home. Poor exercise tolerance test (ETT).
- Diabetics - insulin dependent or has poor control
- Body Mass Index (BMI) >35
- Live alone
- Problematic previous anaesthetics

Before discharging the patient home the following criteria must me met:-

- For regional techniques:
  - The block should have worn off, especially the motor component.
  - The patient must be mobile and have passed urine post caudal, spinal, and epidural.
  - There were no concerns perioperatively and no pain issues currently.

- GA
  - NO PONV and pain well controlled on simple oral analgesia.
  - Patient mobile, passing urine, eating and drinking.

Patient should be discharged to the care of a responsible adult with written discharge instructions and a contact number at the hospital should there be any problems at home.
THE OBESE PATIENT

Body Mass Index (BMI) = Weight (Kg)/ Height squared (m$^2$)

Obesity BMI >30,
Morbid obesity is a BMI> 35.

SPECIFIC CONSIDERATIONS IN THESE PATIENTS

History
- **CVS**
  - Hypertension, IHD, Exercise tolerance, DVTs
- **RESP**
  - Reduced FRC and compliance affect ventilation in theatre. They are prone to quickly desaturate on induction.
  - Be aware these patients are also likely to suffer hypoxic pulmonary vasoconstriction and pulmonary hypertension- (loud P2, left parasternal heave, tricuspid regurgitation) secondary to left ventricular strain from increased cardiac work.
  - Ask about SOBOE, orthopnoea, obstructive sleep apnoea (OSA) +/- requirements of CPAP. The patient may not know this so ask if they snore. Patients with OSA likely to pose a difficult intubation risk.
  - GI= GORD, hiatus hernia increase risk of aspiration. Consideration of pre-medications with antacid. Likely to have fatty infiltration of liver which may interfere with its function and drug metabolism and clearance
- **ENDOCRINE**- likely to have impaired glucose tolerance or Diabetes. Important to ask about diabetic control and end organ damage.
  - Ask about previous problems with anaesthetics.

Examination
- **Look for veins**
- **Thorough airway assessment**- Head and neck movement, mouth opening, mallampati, thyromental distance, large breasts.
- If regional technique to be used look at region and contemplate difficulties.

Investigation
- **Bloods- FBC** (Hb maybe raised as a result of polycythaemia indicating compensation for poor oxygenation.)
- **ECG**- evidence of strain pattern
- **CXR**- cardiomegaly, peripheral pruning of the vasculature.
- **ABG/ Lung function**
- **DM? Check blood glucose. Consider sliding scale.**

Induction

In the anaesthetic room
- Likely difficult venous access
- Consider A-line for more accurate BP monitoring, ABG and blood sampling.
- If central access required consider use of Sonosite.
- Consider position the patient prior to induction
- Pre-oxygenate for 3 mins
- Consider RSI if risk of aspiration high or intubation in a slightly head up position.
- Prepare for difficult intubation
- Remember volume of distribution higher for fat soluble drugs.

Theatre
- **FiO$_2$ >0.5,**
- **PEEP** to reduce the risk of atelectasis,
- **watch airway pressures**
- **Always consider opiate sparing analgesia**
- **Extubate fully awake and head up**

Post-operatively
- Consider HDU care overnight depending on procedure +/- CPAP
- Adequate analgesia
- DVT prophylaxis, calf compression stockings and early mobility.
- Physiotherapy and mobilize early.
- High risk of post-op chest infection, DVT, PE, wound infection.
THE DIABETIC PATIENT

When reviewing diabetic patients always consider and ask about the following co-morbidities that affect your patients:

- **Neurological**: peripheral and autonomic neuropathy
- **Vascular**: IHD, PVD, hypertension, cerebrovascular disease, retinopathy and renal impairment. Retinopathy often precedes nephropathy.
- **Respiratory**: reduced FVC and FEV1 (I don’t know why though??)
- **Gastric**: gastro paresis and risk of regurgitation
- **Renal**: nephropathy
- **Musculoskeletal**: Joint stiffness—check neck movement
- **Increased susceptibility to infection**
- **Risk of hypoglycaemia** in patients on oral hypoglycaemics.
- **Autonomic neuropathy** is present in patients in whom there is a fall in the systolic BP> 30mmHg on standing or ask them to perform the Valsalva Maneouvre. If neuropathy is present there will be a decrease in HR and a drop in BP.

Ask about these in your assessment and always document existing neuropathy especially when considering regional techniques.

- Check FBC, U+Es, BM
- Urinalysis can tell you whether there are renal complications if protein present, ketones and glucose suggest poor hydration as well as glucose control.
- Check ECG for signs of ischaemia. Remember likely to have silent infarct.
- Check drugs—B blocker may mask tachycardic response to hypoglycaemia.

Blood Glucose Control

These patients are typically brought in the night before surgery to monitor and stabilise BMs. They should be first on the list if possible.

**Diet controlled diabetic**

Treat as a normal patient but monitor BMs. The stress of surgery may cause a rise in BM post-op and should be monitored closely. After major surgery consider a sliding scale.

**Patients on oral hypoglycaemics**

**Minor surgery:**

Omit their morning dose and have their BMs measured regularly throughout the day. Oral hypoglycaemic should be started post-op after eating.

**Major surgery:** Omit oral hypoglycaemics and start on sliding scale.

**Diabetics on insulin**

**Minor procedures where patient likely to eat soon after**—omit morning dose, BM <10 and patient not on long acting agent, consider omitting food and insulin. Post op once patient starts eating adjust insulin dose.

**Major surgery**—Sliding scale—you can calculate the baseline infusion rate by using the current BM or taking the patients daily requirement and dividing it by 24hrs. Check the BM every hour to avoid hypoglycaemia. When BM < 10 mmol 5% dextrose commenced at 100ml/hr Replace K+ if required.

**Emergency surgery**—correct fluid losses, correct electrolytes and correct acidosis and stabilise BMs.

**Intra-operative**

- Consider an A-line
- Consider RSI
- Hourly BMs—Keep between 7-10mmol
- Avoid hypotension and myocardial depression
- Remember sweating, tachycardia and hypotension intra-op could indicate hypoglycaemia.
- Avoid using Hartmann’s

**Post-operatively**

- Continue BM monitoring
- Consider antibiotics
- Physiotherapy and early mobilisation
- Always suspect infection if BM control becomes poor
THE ELDERLY PATIENT

The following things need to be considered in this population:

- Physiological changes in the ageing population
- Pharmacological agents

Physiological changes

- **Neuro** - Dementia making history taking more difficult.
- **CVS** - more likely to be hypertensive, suffer with IHD with a degree of cardiac dysfunction. Baroreceptor response less sensitive so auto-correction of hypotensive episodes less likely. Assess cardiac status carefully.
- **Resp** - More likely to have V/Q mismatch, increased RV and closing capacity encroaches on FRC. Compliance will also change depending on underlying disease. If no lung pathology, compliance increases in the elderly.
- **GI** - slow gastric emptying, high level of malnutrition.
- **GU** - renal impairment secondary to hypertensive disease or obstructive uropathy Nephron reserves also decrease with age.
- **Musculoskeletal** - OA/RA of neck can cause unstable C-spine and risk on causing further problems on intubation.
- **Poor ability to thermoregulate**

Pharmacological agents

There is often a degree of polypharmacy in the elderly.

- **B blockers** - will mask signs of changes in HR to hypotension, hypoglycaemia
- **ACEi** - increase risk of hypotension and may also be causing renal impairment
- **Diuretics** - risk of electrolyte abnormalities
- **Tramadol** - likely to cause confusion in the elderly and constipation
- **Oral hypoglycaemics** - increase time of clearance and may increase the risk of hypoglycaemia.

Anaesthetic considerations

- On taking a history if the patient seems confused and there is no documentation of dementia or altered mini-
  mental state in the notes, consider infection or recent cardiac event. Look at the obs chart, ECG, listen to chest and check urine dipstick.
- Consider the option of regional vs. GA. Note that regional anaesthesia can cause profound hypotension and vasopressors should be available.
- If GA- remember slow arm brain circulation time, risk of hypotension with induction agents, use of a muscle relaxant whose clearance will not be affected by liver or renal failure (e.g. Atracurium and Cisatracurium)
- If ventilating keep normocapnic as changes in PaCO₂ will affect cerebral perfusion.
- Use fluids with caution patient at risk of developing congestive cardiac failure and pulmonary oedema.
- Control body temp with Bair hugger, fluid warmer, and monitor temp.
- Be extra careful and protect pressure area- elbows, hips, ankles.

Post-operatively

- Adequate analgesia- avoid large amount of opiates.
- Close input/output monitoring
- Continue supplementing oxygen for 24 hrs post-op
- DVT prophylaxis
- Antibiotics should be considered
- Physiotherapy and early mobilisation
- If patient becomes confused correct reversible causes (correct electrolytes, check for silent infarct, perform a septic screen, treat hypoxia or drug related causes).
ITU FOR BEGINNERS

Criteria for admission
Any patient with a reversible acute or impending organ failure who may require the following:-
- Ventilatory support
- Inotropic support
- Haemofiltration

PATIENT REVIEW

- If patient unstable- CALL FOR HELP ASAP.
- History and Examination as for all patients. In particular:
  - Does the patient have a reversible condition
  - Co-morbidity- and end-stage disease/ functional status
  - Does it require ITU or can it be managed on the MAU/ renal unit
  - Previous ITU admissions, tracheostomy
  - Any known anaesthetic complications
  - Has the admitting team discussed with patient +/- relatives need for ITU +/- intubation.

Note baseline readings:
- GCS
- HR, BP
- RR, saturation on how much oxygen
- Capillary refill time; warm- sepsis, cold- shut down any will require fluid resuscitation.
- Ensure large bore cannula and urinary catheter insitu

- Investigations: Blood, ECG, CXR, ABG, BM, Septic screen, lactate
- Discuss with senior

DRUGS

(remember your own department may have its own protocols so please check)

<table>
<thead>
<tr>
<th>Sedation</th>
<th>Drug</th>
<th>Infusion Dose</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Propofol 1% (10mg/ml)</td>
<td>1-3mg/kg bolus 2-5mg/kg/hr</td>
<td>Clearance ↓ in renal Failure (1mg=1Cal)</td>
</tr>
<tr>
<td></td>
<td>Midazolam (1mg/ml)</td>
<td>2-5mg bolus iv 2-10mg/hr</td>
<td>Elimination half life increases in critically ill</td>
</tr>
</tbody>
</table>

| Analgesia | Fentanyl (50mcg/ml) | 2-6mcg/kg/hr | Shorter acting No accumulation in renal failure |
| Alfentanil (500mcg/ml) | 20-50mcg/kg/hr | May cause ↓ HR Short acting No accumulation in renal failure |
| Remifentanil | 0.1-0.25mcg/kg/min | ↓ HR Offset is rapid and predictable even after prolonged infusion |
| Morphine (1mg/ml) | 2-5mg iv bolus 10-50mcg/kg/hr | Longer acting, accumulates in renal failure. Not removed by dialysis |

<table>
<thead>
<tr>
<th>Inotropes/ vasopressors</th>
<th>Drug</th>
<th>Infusion dose</th>
<th>Receptor</th>
<th>Action</th>
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</thead>
<tbody>
<tr>
<td>Dobutamine</td>
<td>2.5-10mcg/kg/min</td>
<td>β1, β2</td>
<td>↑HR/SV, peripheral vasodilator</td>
<td></td>
</tr>
<tr>
<td>Dopamine</td>
<td>2-10mcg/kg/min</td>
<td>DA, α1, β1</td>
<td>&lt;5mcg/kg/min- positive inotrope/ ↑CO/coronary blood flow, ↑renal blood flow. &gt;5mcg/kg/min vasoconstricts, ↑ venous return and blood pressure</td>
<td></td>
</tr>
<tr>
<td>Dopexamine</td>
<td>0.5-6mcg/kg/min</td>
<td>β2, DA</td>
<td>Peripheral and splanchnic vasodilatator, ↑ HR</td>
<td></td>
</tr>
<tr>
<td>Epinephrine *</td>
<td>0.04-0.4mcg/kg/min</td>
<td>α1, β1, β2</td>
<td>↑ HR/ SV, peripheral vasoconstriction</td>
<td></td>
</tr>
<tr>
<td>Norepinephrine</td>
<td>0.04-0.4mcg/kg/min</td>
<td>α1, α2, β1, β2</td>
<td>↑ peripheral vasoconstriction, reflex ↓HR, coronary vasodilatation increasing coronary blood pressure</td>
<td></td>
</tr>
</tbody>
</table>

Values sedation and analgesia from Whiteley S, Bodenham A, Bellamy M. Churchill’s Pocketbooks Intensive Care

Values from Allman K, Wilson I. Oxford Handbook of Anaesthesia
VENTILATION

Indications to intubate patients in respiratory failure:
- GCS <8
- Exhaustion
- Tachypnoea (RR>30)
- Falling PaO₂ despite oxygen therapy
- Rising PaCO₂ despite therapy
- Worsening acidosis
- Haemodynamic instability

Every hospital will differ but ventilation modes stay the same.

SIMV- Spontaneous intermittent mechanical ventilation
- Allows patient to breath but intermittently will deliver a set number of breathes that has been entered into the ventilator
- Ventilator rate set. Patient may be completely sedated or self ventilating to a degree.
- Can have additional modes
  - PS (pressure support) or ASB (assisted spontaneous breathing) - it is the insufflation pressure to support the patients own breath. Cannot be set at a value above PC. Useful mode in patients with fibrosis as reduces risk of barotrauma.
  - PC (pressure control) - it is the maximum pressure that can be allowed when a patient inspires.
  - VC (volume control) - delivered volume set. If the patient takes a breath the tidal volume may be higher and the ventilator max alarm as pressures high.

Pressure control CPAP or BIPAP
- Used in patients who are completely self ventilating.
- Provides inspiratory pressure support as well as PEEP to prevent airway collapse.

Non- invasive ventilation

BIPAP- Biphasic positive airway pressure
- High inspiratory pressure augments a patient’s own respiratory effort and increases tidal volume, while administering PEEP.
- Useful in patients retaining CO₂ but with a GCS >8/15 and maintaining a reasonable ventilatory effort.
- Starting values:
  - IPAP (inspiratory positive airway pressure) 10-12 cm H₂O
  - EPAP (expiratory positive airway pressure) 4-5 cm H₂O
  - Inspiratory time 1.2 sec
  - FiO₂ as required

CPAP- Continuous positive airway pressure
- Similar to PEEP
- Splints the airways- reducing alveolar collapse thus allowing alveolar recruitment and improving oxygenation.
- Increases functional residual capacity (FRC), improves lung compliance and therefore reduces the work of breathing.

Weaning
This will differ from one unit to another
- Reduced FiO₂ till <0.5
- When patient starts self ventilating slowly reduce ventilator rate.
- Once patient completely self ventilating reduce pressure support if tolerates it and gases maintained.
FLUID RESUSCITATION

Using RIJ CVP measurements you can optimize fluid therapy. Rather than aiming for a CVP value, aim for a sustained response in CVP to fluid boluses which if hypovolaemia is the cause, improves the haemodynamic response for that individual patient:

- Give fluid boluses to improve CVP and measure the increase in CO and SV. Continue fluid therapy until no further improvement in indices or there is worsening of blood gases or evidence of pulmonary oedema.
- Remember that optimal filling may also include fluid restriction, diuretic and vasodilators in patients in pulmonary oedema.

Oesophageal Doppler

The Doppler provides a minimally invasive means of real time continuous cardiac output monitoring. The Doppler probe is passed into the distal oesophagus, where it lies adjacent and parallel to the descending aorta at a depth of 35-40cm. It is adjusted to produce an optimal signal. It works using the ultrasound waves which get reflected off moving erythrocytes in the aorta causing a shift in reflected frequency which is proportional to their velocity. Using the cross-sectional area of the aorta (based on age, height and weight of the patient) and the velocity measurements flow velocity is calculated.

To appreciate the use of Doppler measurements one must appreciate the following equations:

Cardiac output = Stroke volume (dependent on preload, contractility and afterload) \( \times \) Heart Rate
Blood pressure = Cardiac output \( \times \) systemic vascular resistance.

What do the following represent?

Area under the curve - velocity time and represents the distance traveled by a column of blood during each ventricular contraction known as the stroke distance.

Stroke volume is calculated using the stroke distance the cross sectional area of the aorta.

Corrected flow time (FTc) - is the base of the waveform and corresponds to a period of systolic contraction. It is corrected because it is compensated for heart rate and is inversely related to SVR. So FTc is shortened during vasoconstriction and prolonged during vasodilatation (sepsis).

Normal range- 330-360ms

Peak velocity and mean acceleration

The fastest observed velocity of the blood in the thoracic aorta reached during systole represents the peak velocity, while the mean acceleration is the average acceleration of blood flow in systole. They are both markers of left ventricular contractility and afterload.

In humans these values are directly related to the left ventricular ejection fraction. Increase in peak velocity and mean acceleration occur following fluid administration or inotropic stimulation and conversely reduce when there is volume depletion or myocardial depression.

Normal range of Peak Velocity - 20yr old 90-120cm/s
50yr old 70-100cm/s
70yr old 50-80 cm/s
Fluid management using the Doppler:

Use the flow chart to guide use of fluid administration. If there is an indication patient is well filled consider use of inotropes.

**HAEMOFILTRATION**

**Check with your local protocols**

Continuous renal replacement therapy (CRRT) is performed either as haemofiltration (CVVH) or haemodiafiltration (CVVHDF).

**Indications**
- Acidosis
- Hyperkalaemia
- Volume management
- Uraemia >35
- Encephalopathy
- Hyperpyrexia

**Complications**
- Hypotension
- Dysrhythmia
- Haemorrhage
- Platelet consumption
- Infection
- Air embolism

**Filtration rates**—aim for 35 ml/kg/hr, more if the patient tolerates it. A good starting point is 2,000-2,500 ml/hour of CVVH.

**Filtration fluid**

If the patient has a high lactate use lactate free filtration fluid.

**Anticoagulant**

Heparin- 500-1000U/hr. Use with caution in patients with a platelet count of <75.

Prostacyclin is expensive and should be used when heparin is contraindicated, 5ng/kg/min.

Filters can occasionally be run without any anticoagulant, but this is rarely done.

**When filter is stop consider bolus of IV frusemide followed by an infusion.**
PROPHYLAXIS

All ITU patients should be written up for the following, unless CI:
- Ulcer prophylaxis- Ranitidine 50mg IV BD or a PPI
- Thromboprophylaxis- check with your department

- Dalteparin 2500U S/C OD
- Enoxaparin 20mg S/C OD

Patients with evidence of embolic disease consider therapeutic doses.

ACUTE CONFUSIONAL STATE IN ITU PATIENTS

Always correct reversible factors first before administering drugs

<table>
<thead>
<tr>
<th>Causes</th>
<th>Drugs used to treat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elderly patients</td>
<td>Lorazepam 1-3mg bolus iv</td>
</tr>
<tr>
<td>SE of drugs</td>
<td>Clonidine 50-150mcg bolus iv</td>
</tr>
<tr>
<td>Withdrawal of alcohol and other centrally acting drugs</td>
<td>Chlorpromazine 5-10mg bolus iv</td>
</tr>
<tr>
<td>Hypoxia/ hypercarbia</td>
<td>Haloperidol 5-10mg bolus (can cause ↓ BP)</td>
</tr>
<tr>
<td>Renal/hepatic encephalopathy</td>
<td></td>
</tr>
</tbody>
</table>

Values from Whitely S, Bodenham A, Bellamy M. Churchill’s Pocketbooks Intensive Care

WHAT TO WRITE IN YOUR ITU DAILY REVIEW

- Date, time, and name of the person reviewing patient
- Patient age
- Day _____ in ITU
- A brief note of background of admission
- Current Issues
- Current state- here you will need to document the following:
  - Appearance
  - Sedation
  - Sedation score
  - Has there been a sedation hold? This will highlight any neurological deficit off sedation and whether a CT head is warranted.
  - CNS- GCS, pupil size and response to light

- CVS- HR, Invasive BP, CVP
  - Document inotropes, GTN doses
  - Document cardiac studies

- RESP- Ventilator mode and settings, FiO2, Sats, RR
  - Auscultate chest and document findings
  - ABG
  - CXR findings

- GI- document scars, stomas, wound, NG tube, drains
  - Is the wound healing? Signs of infection
  - Is there a stoma output?
  - Is the patient being NG fed? Rate and absorption
  - Is the patient opening their bowels? Bowels sounds
  - Drain outputs

- Renal- look at renal function and their trends.
  - Is the patient on renal replacement therapy?

- Sepsis- temperature, WCC, CRP. Lactate and trends.
  - Document antibiotic therapy
  - Document culture results.

- Daily plan documented and handed over to nursing staff.
- When presenting a patient on the ward round break it down in a similar fashion. Keep it simple and concise.
Part 2
The Anaesthetic room and anaesthetic problems

What to do on entering an anaesthetic room

What is a rapid sequence induction (RSI)?

Preparing the room for a regional technique

SHO “bread and butter” cases
  o Appendicectomy/Ectopic
  o I+D abscess
  o Sick Laparotomy
  o ERPC
  o The fracture neck of femur
  o Laparoscopic surgery

Difficult Airway Society (DAS) guidelines

Why is my patient not breathing at the end of the case?

Hypoxia

Bradycardia / tachycardia

Hypotension/hypertension

Aspiration

Life threatening airway obstruction

High airway pressures

Malignant Hyperpyrexia

Severe Laryngospasm

Local anaesthetic

Total spinal

Acute Transfusion reaction
WHAT TO DO ON ENTERING THE ANAESTHETIC ROOM AT THE START OF YOUR SESSION

Anaesthetic Machine check

General
- Turn on machine
- Take note of any information or labelling on the anaesthetic machine referring to current status of the machine.
- Note the last service carried out. This should be marked on the back of the machine and in the service book.
- Do not use a machine that has gone past its service date.

Equipment
- Ensure that all the monitoring equipment (oxygen analyser, pulse oximeter and capnograph) are working and alarm limits set.

Gas supplies
- Check the pipeline is attached to the wall and the back of the anaesthetic machine.
- Check the pipeline pressures on the anaesthetic machine indicate 400-500kPa
- Ensure that there is an oxygen cylinder (and if you need nitrous oxide) at the back of the machine and check that there is a sufficient amount in each should the main pipeline fail.
- Remember that nitrous oxide will always read 50kPa until it is quarter full because it is measuring the vapour pressure.

Check the operation of the flow meters
- Look to see if any cracks in the flow meters, that each value operates smoothly and that the bobbin rotates freely.
- Check the anti- hypoxia devices
- Check the oxygen flush (this is your emergency oxygen bypass control)

Check the vaporizer(s)
- Check filled to adequate marking
- Check correctly seated on back bar
- Check for leaks. Occlude common gas outlet when vaporiser and flow meter turned on and check to see if the bobbin drops from the back pressure. Check this each time vaporizer changed.
- Remember to turn off vaporiser after checking.

Check the breathing system
- Ensure a new filter and angle piece/catheter mount used for each patient
- Packaging should not be removed until point of use (this ensures nothing can fall in and cause an obstruction)
- Ensure all connections are secure.
- Check for leak by occluding the patient end, turning the APL valve to full and pressure oxygen flush and watch bag inflate and then see the pressure rise on the gauge.
- The Bains inner tubing is checked by occluding it and watch the bobbin fall.
- Check the valves in the circle by occluding patient end and ‘bagging’ - the valves should move indicating there is no sticking.

Check the ventilator
- Place the reservoir bag on the patient end, turn the ventilator on and set the volumes, respiratory rate and watch to see the bellows move sufficiently, there is no sticking as they move and look at the monitor to see the volumes achieved to ensure no leak.

Check the scavenging system is connected and working

Check that the soda lime is not exhausted (know the colours of the soda lime prior to use and when exhausted)

Check your ancillary equipment
- Is the light on your laryngoscope working? Have a spare
- Check the cuff on your tube.
- Check the suction
- Are all your adjuncts e.g. airway, boogie, LMA are present should you require them.
- Do you have a tilting trolley?

Check that an alternative means to ventilate the patient is available e.g. Ambu bag

Record
- Sign and date the logbook kept with the anaesthetic machine to confirm the machine has been checked.
- Record the machine check on the anaesthetic chart

Prepare your drugs and send for your patient when the team is ready
WHAT IS A RAPID SEQUENCE INDUCTION (RSI)?

A RSI is a technique that involves a rapid IV induction, muscle relaxation to secure and protect the airway in a patient at risk of aspiration.

To reduce this risk further pressure of 40N is applied to the cricoid membrane until confirmation that the airway is secure.

Which patients require a RSI?

- Patient with a full stomach who require emergency surgery.
- Patients with conditions that will decrease gastric emptying:
  - Acute abdomen secondary to appendicitis, bowel obstruction, peritonitis or a suspected ectopic pregnancy.
  - Diabetics
  - Pregnancy
- Patients with decreased respiratory reserve (or FRC)
  - Obese
  - Pregnant
- Most A&E patients because:
  - You may not have starvation history
  - They may have limit physiological reserve
  - No time to waste. Need rapid airway control
- Patients with severe reflux. Are their symptoms present on:
  - Coughing
  - Bending over
  - Lying flat
  - Very frequent metallic taste in mouth.

Who is needed for a RSI?

- A competent anaesthetist
- An experienced ODA
- An adequately pre-assessed patient who has been explained about induction, use of cricoid and that suxamethonium causes myalgia.

What needs to be done to prepare the anaesthetic room?

- Check the machine, circuit and suction
- Check all your airway equipment.
  - 2 laryngoscopes and bulbs working
  - 2 tubes with cuffs checked
  - Bougies
  - LMA ready should you face a can’t intubate scenario
  - Guedel and nasopharyngeal airway, should you need it in an emergency

Drugs

- Emergency drugs all drawn up
  - Metaraminol (10mg in 20mls- 0.5mg/ml)
  - Ephedrine (30mg in 10mls- 3mg/ml)
  - Atropine (600mcg/ml)
- For induction
  - Thiopentone diluted in WATER (500mg in 20mls – 25mg/ml)
  - Suxamethonium (100mg in 2mls- 50mg/ml). Always draw up 2 syringes should you spill some on injecting.
  - 10mls of NaCl flush
- Once airway secure
  - Fentanyl- (100mcg in 2mls- 50mcg/ml)
  - Muscle relaxant of choice

When not to use suxamethonium?

- In patients with ↑ K+
- In burn patients can be used only up to 2hrs after insult because of potassium release from cells thereafter for a period of time.
- With caution in renal patients because of K+

Before proceeding be familiar with what to do if:

- You can’t intubate and can’t ventilate
- How to recognise and manage malignant hyperpyrexia
- How to avoid, recognise and manage suxamethonium apnoea.
- What to do if patient vomits- release cricoid pressure. (Look at flowchart for management of aspiration)
When patient arrives
  o Check tilting trolley. If not change.
  o Monitoring and record baseline observations.
  o Large bore IV access if possible and start running IV fluids as required.
  o Place suction under pillow at reachable distance along with boogie.
  o If patient has NG in situ suction prior to starting.
  o Pre-oxygenate for 3 minutes with 100% O₂ – this increases the oxygen reserve and removes nitrogen allowing more time for intubation before saturations drop.
  o After 3 minutes start to slowly administer Thiopentone and ask the ODA to start to apply cricoid. The end point you are looking for is the loss of the eyelash reflex.
  o Flush line with NaCl 0.9% and follow this with suxamethonium followed by another flush. Suxamethonium can cause bradycardia especially in children, always have atropine on hand.
  o After 30-45 seconds attempt intubation.
  o If you are lucky and you visualise the cords and insert the tube, inflate the cuff and then:
    • Auscultate the bases and apices of the chest bilaterally and insure it is equal and listen over epigastrium.
    • If AE R>L pull tube back and auscultate again.
    • Look for a capnograph tracing (don’t panic it takes 5-10secs to show up)
  o Once all these features have been checked and you are happy the airway is secure and protected ask the ODA to release cricoid. Fentanyl can be given at this point.
  o Once patient starts breathing then administer longer acting muscle relaxant as you have now excluded suxamethonium apnoea.
  o On extubation the patient must be awake and able to protect their airway before you pull the tube. This means eyes open, able to follow command or able to lift head off pillow for approximately 10 seconds.

PREPARING THE ANAESTHETIC ROOM FOR REGIONAL PROCEDURES

Prior to entering an anaesthetic room you should have:
  o Pre-assessed patient
  o Explained the procedure- risks and benefits
  o Consented and documented discussion.

In the anaesthetic room:
  o Full monitoring
  o Check machine, suction, tilting trolley
  o Prepare airway adjuncts and emergency drugs should you need to intubate or resuscitate from intravascular injection.
  o Establish IV access and run in fluids to keep line patent.
  o Baseline observation recorded.
  o Always explain every step to the patient.
  o Position them correctly.
  o Clean and drape area
  o Scrub and adequately gown and prepare equipment and drawn up the local to the correct quantities according to patient weight.
  o Proceed and explain to the patient what you are doing and what they may feel.
  o Once you feel you are in the correct locality prior to injecting always draw back on the syringe to insure not intravascular. Do this after every 5mls.
  o Always ask the patient to inform you if they are experiencing any dizziness, palpitations or abnormal sensations.
  o If blood drawn back at any stage stop and remove needle. If need be start again.
  o Repeat observations post procedure and continue to monitor the patient during their procedure.

It is good practice to review your patient at the end of your session. Look for complications. Advise them to use that limb with care until full sensation returns as they may injure themselves without realising.
SHO 'BREAD AND BUTTER' CASES

As an SHO once you have completed your 3 month competency you will enter the world of on-call anaesthesia and you will be commonly performing the following procedures

- Appendicectomy
- Sick laparotomy
- I+D abscess
- ERPC
- Ruptured ectopic- either laparoscopically or laparotomy
- Fracture neck of femur

Just as a guide these are the things you need to be aware of:

- Emergency procedures need to be performed by an experienced surgeon.
- Laparoscopic procedures should not be performed out of hours in emergency situations unless done so by an experienced operator.
- Always assess the patient as thoroughly as possible.
- Always ensure blood is easily available.
- Always inform your senior colleagues once you have seen the patient, discuss problems and how you will proceed with your anaesthetic.
- If a very sick patient or a child your consultant should be informed and involved. Look at your hospital protocols for informing consultants out of hours.
- In all cases blood must be at least G+S and if any evidence of bleeding or haemodynamic instability X-match must be requested and blood available ASAP.
- Never anaesthetise your patient until you have seen the surgeon in theatre and he/she is ready to start.

APPENDICECTOMY/ECTOPIC

- Large bore access
- Monitoring and baseline observation
- RSI
- Antibiotics
- Analgesia
- Anti-emetic
- LA post-op to skin
- PCA post-op, regular paracetamol, NSAIDs if not CI.
- Monitor blood loss and replace as necessary.

I+D ABSCESS

These patients are very anxious. Despite large amounts of volatile agents they can still go into laryngospasm on insertion of LMA or on incision of abscess depending on where it is. To reduce the risk of this happening:

- IV induction:
  - 2mg midazolam
  - 500mcg alfentanil- this works quicker than fentanyl and reduces the laryngeal reflex
  - Propofol
  - Insert the LMA about 20sec after propofol given as long as mouth easy to open.
  - Start maintenance
  - Wait 2 mins before transfer to theatre to allow sufficient MAC to prevent patient waking up on transfer. Alternatively prior to transfer give 250mcg of alfentanil and 30mg propofol.

- Once patient on the table:
  - Try achieve 1 MAC prior to surgeon starting
  - Before surgical incision, give 250mcg alfentanil and increase the volatile slightly as this part is very stimulating.
  - If the patient coughs ask the surgeon to stop and deepen anaesthesia before proceeding.
- Voltarol PR if no CI
- Paracetamol and ondansetron to be given either in theatre or in recovery.
SICK LAPAROTOMY

- Regardless of their age these patients can become very unstable.
- Always remember very young and very old patients have a lot of less physiological reserve while young fits patients may look well but they may just be compensating.
- 2 large bore peripheral access
- Consider A-line/ CVP
- Catheterise
- RSI- if NG tube already insitu suction first.
- NG tube
- Always remember if septic they will be warm and vasodilated so titrate induction agent carefully to prevent ↓BP.
- Always have vasopressors at hand.
- Fluids- young patients can tolerate a lot fluid so don’t be shy!
- Analgesia, antibiotics, anti-emetic
- May need Noradrenaline intra-operatively (4mg in 50mls) titrate dose according to response
- PCA- post-op
- Extubate awake after suctioning NG and oropharynx

ERPC

These patients are very anxious. Despite large amounts of volatile agents they can still go into laryngospasm on insertion of LMA. To reduce the risk of this happening:

- IV induction:
  - 2mg midazolam
  - 500mcg alfentanil- this works quicker than fentanyl and reduces the laryngeal reflex
  - Propofol
  - Insert the LMA about 20sec after propofol given as long as mouth easy to open.
  - Start maintenance
  - Wait 2 mins before transfer to theatre to allow sufficient MAC to prevent patient waking up on transfer. Alternatively prior to transfer give 250mcg of alfentanil and 30mg propofol.

- Once patient on the table:
  - Try achieve 1 MAC prior to surgeon starting
  - Before the cervix is dilated given 250mcg alfentanil and increase the volatile slightly as this part is very stimulating.
  - If the patient coughs ask the surgeon to stop and deepen anaesthesia before proceeding.

- Ask the surgeon if they want syntocinon given and advice when to administer.
- Voltarol PR if no CI
- Paracetamol and ondansetron to be given either in theatre or in recovery.

THE FRACTURE NECK OF FEMUR

Most of these patients are:

- Elderly- more often then not with dementia and unable to give a history.
- Have multiple co-morbidities
- Cardiac and respiratory problems which pose a risk in both general and regional procedures.
- Have been found on the floor so may have renal impairment worsened by rhabdomyolysis. K’ likely ↑
- These patients need to be optimised pre-operatively.
- Hb>10, U &Es noted, clotting and INR normal, X-match.
- Know your surgeon. There is no point in doing a spinal if the surgeon takes >2hrs for the procedure.
- Discuss case with senior if ASA III and above or if you not happy about any aspect of the case.
- If GA- titrate induction agents carefully as will ↓BP easily.
- Careful intra-operative fluid to prevent pulmonary oedema. Catheterization and close input/ output monitoring may be required.
- Careful use of analgesia so not to cause prolonged respiratory depression.
- Antibiotics
- Monitor blood loss and replace as necessary.
- If surgeons using cement mix ask them to tell you before using as a ↓BP or ↓ETCO2 suggests fat emboli.
- Post-op analgesia.
- Ensure surgeons have written up LMWH.
**LAPAROSCOPIC SURGERY**

It involves blind insertion of 2 trocars into a cavity, one to insufflate gas under pressure and the second to introduce the laparoscope.

**Considerations that must be taken when anaesthetising a patient for a laparoscopic procedure.**

**On induction**
Do not over ventilate using the bag and mask as you will insufflate the stomach and bowel, increasing the risk of bowel perforation on introduction of the laparoscope.

**Intra-operative**

**Positioning:**
- Laparoscopic cholecystectomy requires head up causing ↓BP, ↓cerebral perfusion
- Gynaecological and surgical procedures require head down causing cerebral oedema and retinal detachment.

**Risk of:**
- Vascular trauma
- Gas embolism associated with increased insufflation pressure will cause circulatory collapse
- Impaired cardiac function
- Insufflation pressures > 15mmHg ↓preload + cardiac output and may even cause compression of vena cava.
- Vagal mediated bradycardia from peritoneal distension
- CO$_2$ absorption ↑ETCO$_2$
- Pneumoperitoneum will cause diaphragmatic splinting – therefore use IPPV
- Surgical emphysema +pneumothorax

**Post-operatively**
- Pain from residual gas within the peritoneal cavity.
- Sudden haemodynamic instability should raise suspicion of bleeding.
Unanticipated difficult tracheal intubation - during rapid sequence induction of anaesthesia in non-obstetric adult patient

Plan A: Initial tracheal intubation plan

Direct laryngoscopy → Any problems → Call for help

Pre-oxygenate
Cricoid force: 10N awake → 20N anaesthetised
Direct laryngoscopy - check:
- Neck flexion and head extension
- Laryngoscopy technique and vector
- External laryngeal manipulation - by laryngoscopist
- Vocal cords open and immobile
- If poor view:
  - Reduce cricoid force
  - introducer (bougie) - seek clicks or hold-up and/or Alternative laryngoscope

Succeed → Tracheal intubation

Verify tracheal intubation
- Visual, if possible
- Cuff pressure
- Occlusal seal

Not more than 3 attempts, maintaining:
- Oxygenation with face mask
- Cricoid pressure and anaesthesia
- "If in doubt, take it out"

Plan B not appropriate for this scenario

Plan C: Maintenance of oxygenation, ventilation, postponement of surgery and awakening

Use face mask, oxygenate and ventilate
- 1 or 2 person mask technique (with oral ± nasal airway)
- Consider reducing cricoid force if ventilation difficult

Failed oxygenation
- e.g. SpO₂ < 90% with FiO₂ 1.0 via face mask

Plan D: Rescue techniques for "can't intubate, can't ventilate" situation

LMA
- Reduce cricoid force during insertion
- Oxygenate and ventilate

Failed ventilation and oxygenation

Succeed → Postpone surgery and awaken patient if possible or continue anaesthesia with LMA or ProSeal LMA if condition immediately life-threatening
Failed intubation, increasing hypoxaemia and difficult ventilation in the paralysed anaesthetised patient: Rescue techniques for the “can’t intubate, can’t ventilate” situation

failed intubation and difficult ventilation (other than laryngoscopy)

Face mask
Oxygenate and Ventilate patient
Maximum head extension
Maximum jaw thrust
Assistance with mask seal
Ora 6mm nasal airway
Reduce cricoid force - if necessary

failed oxygenation with face mask (e.g. SpO₂ < 90% with FiO₂ 1.0)
call for help

LMA™ Oxygenate and ventilate patient
Maximum 2 attempts at insertion
Reduce any cricoid force during insertion

Oxygenation satisfactory and stable: Maintain oxygenation and awaken patient

“can’t intubate, can’t ventilate” situation with increasing hypoxaemia

Plan D: Rescue techniques for “can’t intubate, can’t ventilate” situation

or

Cannula cricothyroidotomy
Equipment: Kink-resistant cannula, e.g. Patil (Cook) or Ravissin (VBM)
High-pressure ventilation system, e.g. Mansjet III (VBM)
Technique:
1. Insert cannula through cricothyroid membrane
2. Maintain position of cannula - assistant’s hand
3. Confirm tracheal position by air aspiration - 20ml syringe
4. Attach ventilation system to cannula
5. Commerce cautious ventilation
6. Confirm ventilation of lungs, and exhalation through upper airway
7. If ventilation fails, or surgical emphysema or any other complication develops - convert immediately to surgical cricothyroidotomy

Surgical cricothyroidotomy
Equipment: Scalpel - short and rounded (no. 20 or Mintrach scalpel)
Small (e.g. 8 or 7 mm) cuffed tracheal or tracheostomy tube
4-step Technique:
1. Identify cricothyroid membrane
2. Slit incision through skin and membrane
3. Enlarge incision with blunt dissection (e.g. scalpel handle, forceps or dilator)
4. Insert tube and inflate cuff
Ventilate with low-pressure source
Verify tube position and pulmonary ventilation

Notes:
1. These techniques can have serious complications - use only in life-threatening situations
2. Convert to definitive airway as soon as possible
3. Postoperative management - see other difficult airway guidelines and flow-charts
4. 4mm cannula with low-pressure ventilation may be successful in patient breathing spontaneously
Unanticipated difficult tracheal intubation—during routine induction of anaesthesia in an adult patient

Direct laryngoscopy → Any problems → Call for help

Plan A: Initial tracheal intubation plan

- Direct laryngoscopy - check:
  - Neck flexion and head extension
  - Laryngoscope technique and vector
  - External laryngeal manipulation - by laryngoscopist
  - Vocal cords open and immobile
  - If poor view: Introducer (bougie) - seek slips or hold-up and/or Alternative laryngoscope

Direct laryngoscopy - check:
- Not more than 5 attempts, maintaining:
  - 1) oxygenation with face mask and
  - 2) anaesthesia

Succeed → Tracheal Intubation

Verify tracheal intubation
- (1) Visual, if possible
- (2) Capnograph
- (3) Oesophageal detector
  - "If in doubt, take it out"

Plan B: Secondary tracheal intubation plan

ILMA™ or LMA™
- Not more than 2 insertions
- Oxygenate and ventilate

Failed oxygenation
- (e.g. \( \text{SpO}_2 = 90\% \text{ with FiO}_2 1.0 \))
- via ILMA™ or LMA™

Plan C: Maintenance of oxygenation, ventilation, postponement of surgery and awakening

- Revert to face mask
- Oxygenate and ventilate
- Reverse non depleting relaxant
- 1 or 2 person mask technique
  - (with oral or nasal airway)

Succeed → Postpone surgery
- Awaken patient

Failed ventilation and oxygenation

Plan D: Rescue techniques for "can’t intubate, can’t ventilate" situation

Confirm: ventilation, oxygenation, anaesthesia, C/S stability and muscle relaxation - then fiberoptic tracheal intubation through ILMA™ or LMA™ - 1 attempt
- If LMA™, consider long flexometallic, nasal RAE or microtracheal tube
- Verify intubation and proceed with surgery

Failed intubation via ILMA™ or LMA™

Difficult Airway Society Guidelines Flow-chart 2004 (Use with DAS guidelines paper)

Please note typo: IMLA™ should read ILMA™
WHY IS MY PATIENT NOT BREATHING AT THE END OF THE CASE?

Always keep the patient asleep till they are breathing spontaneously. They do not need 1.0 MAC as there is no surgical stimulus but at the same time you don’t want to wake them up when they are not breathing.

Considerations
- Neuromuscular blockade (NMB)
  - If patient had suxamethonium consider suxamethonium apnoea.
  - For other NMB drugs look at anaesthetic chart and see when the last dose was given. Apply nerve stimulator look for train of four or double burst stimulus. Ensure the patient has been adequately reversed and there is no prolonged NMB.
  - Have any drugs been given to prolong NMB - e.g. gentamicin
- Opioid
  - Look at pupils - if pinpoint suggests a lot of opioid still present that may be causing respiratory depression. Reverse with naloxone (400mcg in 4mls and give 100mcg increments).
- Normocapnia
  - Hypocapnia will ↓ respiratory drive.
  - Once corrected if still not breathing consider doxapram to restore respiration up to 100mg.
- Have they too much volatile on board? Reduce it and observe.
- Ensure normothermia, U&Es, ABGs ok
- If still not breathing spontaneously or waking up consider transfer to ITU

Inadequate breathing
This usually happens in patients in recovery. The patient is awake and before anything give 100% Oxygen, reassure the patient and then ascertain the cause. If the situation does not improve rapidly re-intubation may need to be considered.

AIM MAINTAIN O₂ AND CO₂ ELIMINATION
HYPOXIA

Definition
- SpaO₂ <90%
- PaO₂ <8kPa

Assess and manage simultaneously - Be systematic in your approach to the situation.
- 100% O₂ and call for HELP.
- Consider (DOPE)
  - Disconnection
  - Obstruction- patient/equipment
  - Patient- aspiration, PE, pneumothorax
  - Equipment problems.

If a patient becomes hypoxic, look at the patient.
- Is the chest moving?
- Is the bellow moving?
- Are the other parameters ok?
- ETCO₂ dropped?

All may suggest a disconnection or a more serious problem. You can ask the surgeon to stop till you have established cause and managed the problem.
- Switch to manual ventilation – Is it easy to bag?
- Listen to the chest- is AE equal and bilateral?
- If no is it more on the right side? Is tube too far down? If so pull back on tube and see if improvement.
- Suction ETT
- Is the airway device connected properly?
- If suspect circuit or machine ventilate with water’s circuit and TIVA and check circuit and machine.
**BRADYCARDIA**

Management is treating the cause and the following need to be considered.

**Anaesthetic factors**
- **Hypoxia**
  - Drug induced
    - Is patient on a β blocker or digoxin
    - Opioid- Remifentanyl
    - Suxamethonium especially in children
- **High spinal block affecting T1-T4**

**Surgical factors**
- **Vagal stimulus**
  - anal dilatation
  - peritoneal dilatation
  - cervical dilatation
  - Stretch of the extra-ocular muscles.

**Patient factors**
- **Cardiac disease**
- **Athletes**
- **Endocrine**
  - Hypothyroid
- **Metabolic**
  - Hyperkalaemia
- **Neurological**
  - ↑ICP causing the Cushing’s reflex

---

**TACHYCARDIA**

Management is treating the cause and the following need to be considered.

**Anaesthetic factors**
- **Inadequate anaesthesia +/- inadequate muscle relaxation, inadequate analgesia**
  - ↑BP
  - Reactive pupils
  - Sweating
  - Movement
  - Lacrimation
  - Fighting ventilator
- **Hypercarbia**
  - ↑MH
  - Check CO₂ absorber
  - ↓MV
- **Hypoxia** - initial response tachycardia
- **Drugs**
  - Anticholinergic
  - Catecholamines
  - Oxytocinon

**Surgical factors**
- **Hypovolaemia** - compensation for vasodilatation
- **Sepsis**

**Patient factors**
- **Cardiac arrhythmia** - SVT/VT
UNINTENTIONAL HYPOTENSION

Hypotension detected by non-invasive or invasive BP monitoring (? Loose cuff) - Check cuff/A-line positioning first

| Warm peripheries | Suggest vasodilatation secondary to volatile anaesthetic, sepsis, LA (high block associated with ↓HR), histamine release |
| Cold peripheries | Suggest hypovolaemia or pump failure, usually associated with ↑HR |

100% Oxygen

Airway and Breathing
Consider intubating if necessary

Circulation
Give fluid bolus (10ml/kg stat) and assess response
Check for blood loss and that surgeon not reducing venous return
Elevate legs if excluded high spinal
Reduce the inhalational agent/epidural infusion
Monitor ECG (looking for arrhythmias that may suggest LA toxicity)
Consider inserting an arterial line if not already in place

Inotropes- if poor response to fluids/ or if SBP<80mmHg
Metaraminol 0.5-1mg boluses
OR
Low CO states ephedrine 3-6mg boluses

Infusion: dobutamine 5-10mcg/kg/min or adrenaline 0.1-0.2mcg/kg/min

Treat the cause

| Decreased venous return | Reduce surgical pressure on great veins 200-300ml fluid quickly IV, repeat if: BP improved BP unchanged CVP unchanged Look for blood loss |
| Pump failure | Treat dysrhythmia Decreased contractility- inotropes If pulmonary oedema- frusemide 40mg IV*2 |
| Obstruction | Tension pneumothorax- treat Cardiac tamponade- raised CVP, muffled heart sounds. Insert 14G cannulae under xiphisternum towards nipple |
| Other considerations | PE Air embolus Septicaemia |
**HYPERTENSION**
*(Intra-operative/Post-operative)*

<table>
<thead>
<tr>
<th>Confirm reading</th>
<th>Check cuff size/flush A-line and check transducer level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check other parameters</td>
<td>Check SpO2, ETCO2, MAC, look at pupils (Cushing’s reflex)</td>
</tr>
<tr>
<td>Other checks/exclusions</td>
<td>Check if vasopressor administered accidentally</td>
</tr>
<tr>
<td></td>
<td>Be aware of surgical cause e.g. cross clamping of aorta</td>
</tr>
<tr>
<td>Correct reversible physiological causes</td>
<td>Consider catheterisation as pain maybe from full bladder.</td>
</tr>
<tr>
<td>↑FiO₂</td>
<td></td>
</tr>
<tr>
<td>Hyperventilate</td>
<td></td>
</tr>
<tr>
<td>Increase depth of anaesthesia</td>
<td></td>
</tr>
<tr>
<td>Give analgesia- 25-50mcg of Alfentanil? +ve affect</td>
<td></td>
</tr>
<tr>
<td>Vasodilators</td>
<td>Sodium nitroprusside for resistant hypertension (0.5-1.5mcg/kg/min)</td>
</tr>
<tr>
<td>Hydralazine 5mg slow IV every 15 mins</td>
<td></td>
</tr>
<tr>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>GTN (1mg/ml) start at 3ml/h and titrate according to effect</td>
<td></td>
</tr>
<tr>
<td>If HR&gt;90bpm consider B blockade if no CI</td>
<td>Esmolol 0.5mg/kg loading dose followed by an infusion of 50-200mcg/kg/min</td>
</tr>
<tr>
<td>Metoprolol 1-2 mg increments</td>
<td></td>
</tr>
<tr>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>Labetalol 5mg increments</td>
<td></td>
</tr>
<tr>
<td>Treat the cause</td>
<td></td>
</tr>
<tr>
<td>o Measurement error</td>
<td></td>
</tr>
<tr>
<td>o Inadequate depth of anaesthesia/analgesia</td>
<td></td>
</tr>
<tr>
<td>o Essential hypertension</td>
<td></td>
</tr>
<tr>
<td>o Hypercapnia</td>
<td></td>
</tr>
<tr>
<td>o Hypoxia</td>
<td></td>
</tr>
<tr>
<td>o Tracheal intubation/extubation</td>
<td></td>
</tr>
<tr>
<td>o Drugs</td>
<td></td>
</tr>
<tr>
<td>o Aortic clamping</td>
<td></td>
</tr>
<tr>
<td>o MH</td>
<td></td>
</tr>
<tr>
<td>o PIH (Pregnancy induced hypertension)</td>
<td></td>
</tr>
<tr>
<td>o HCP</td>
<td></td>
</tr>
<tr>
<td>o Endocrine causes: thyroid storm and phaeochromocytoma</td>
<td></td>
</tr>
</tbody>
</table>
**ASPIRATION**

**Definition**
Entry of gastric contents into the bronchial tree causing a chemical pneumonitis, foreign body obstruction or atelectasis

**Risk Factors**
- Full stomach
- Delayed gastric emptying causes include:
  - Trauma
  - Pregnancy
  - Obstruction
  - Diabetes
  - Opioids preoperatively
- Known reflux
- Raised intragastric pressure (intestinal obstruction, pregnancy, laparoscopic surgery)

<table>
<thead>
<tr>
<th>Clinical features</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>During intubation</strong></td>
</tr>
<tr>
<td>- visualisation of foreign material on laryngoscopy</td>
</tr>
<tr>
<td><strong>Intra-operatively</strong></td>
</tr>
<tr>
<td>- coughing, laryngospasm, ↓SpaO₂, ↑RR, ↑HR, ↓lung compliance- causing high airway pressures,</td>
</tr>
<tr>
<td><strong>Post-operatively</strong></td>
</tr>
<tr>
<td>- Gastric contents visible on suctioning ETT, unexpected ↓SpaO₂, ↑RR/ dyspnoea, bronchospasm, intercostal recession, wheeze, crackles or ↓AE bases. If chest signs absent not definite that aspiration has not happened.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Precautions and Management</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>100% Oxygen and apply cricoid pressure</strong></td>
</tr>
<tr>
<td><strong>Head down +/- lateral position</strong></td>
</tr>
<tr>
<td><strong>Suction oral cavity</strong></td>
</tr>
</tbody>
</table>
| **Intubate and suction trachea** | If aspiration occurs on induction consider:
  - Cancelling elective surgery
  - Commencing emergency surgery
  - Inserting a large bore NG tube to decompress stomach prior to extubation |
| **Assess air entry** | CXR (diffuse infiltrative pattern especially right lower lobe but may not be evident acutely) |
| **If bronchospasm treat with nebulisers** | |
| **Assess gas exchange** | Pulse oximetry initially then ABG |
| **Decide whether to extubate or transfer to ITU for further period of intubation and ventilation.** | Extubate depending on shunt:
  - Insert NG tube and suction all the gastric contents prior to extubating
  - Chest physiotherapy
  - CPAP to maintain adequate oxygenation |
| **Consider antibiotics** | |
| **Consider steroids to reduce inflammatory response** | If transfer to ITU:
  - If slow improvement consider bronchoscopy to visualise any foreign materials and attempt to remove them. |
**LIFE THREATENING AIRWAY OBSTRUCTION**

<table>
<thead>
<tr>
<th>Clinical features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stridor</td>
</tr>
<tr>
<td>Drooling</td>
</tr>
<tr>
<td>Laryngospasm</td>
</tr>
<tr>
<td>Soft tissue obstruction</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Call for senior help</th>
</tr>
</thead>
<tbody>
<tr>
<td>(anaesthetic and surgical)</td>
</tr>
<tr>
<td>100% Oxygen or Heliox</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Considerations at this point:</th>
</tr>
</thead>
<tbody>
<tr>
<td>o Anatomical level of the lesion</td>
</tr>
<tr>
<td>o Degree of obstruction</td>
</tr>
<tr>
<td>o Ability to oxygenate</td>
</tr>
<tr>
<td>o Risk of airway soiling from bleeding/aspiration</td>
</tr>
<tr>
<td>o Likely degree of difficulty of surgical access to the trachea</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Consider techniques of securing and protecting the airway that will allow adequate oxygenation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhalational induction- lesion below the vocal cords or inhalational foreign body</td>
</tr>
<tr>
<td>Awake fiberoptic- lesion above the vocal cords</td>
</tr>
<tr>
<td>Rigid bronchoscopy&amp; jet ventilation- tracheal compression</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cricothyroidotomy if immediate airway needed or other manoeuvres have failed</th>
</tr>
</thead>
<tbody>
<tr>
<td>What you need:</td>
</tr>
<tr>
<td>o Surgical prep</td>
</tr>
<tr>
<td>o Dressing pack</td>
</tr>
<tr>
<td>o 10-14G cannulae attached to 10ml syringe</td>
</tr>
<tr>
<td>o Oxygen tubing with a hole along its length</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Place patient supine and prep the skin</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Locate the cricothyroid membrane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stabilize trachea</td>
</tr>
<tr>
<td>Anterior between the thyroid cartilage and cricoid cartilage</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Insert the cannula directly over the membrane and direct the needle 45% posteriorly until air aspirated</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Advance catheter downwards while withdrawing needle.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Care not to perforate the posterior wall of the trachea</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attach O2 tubing and hub and ventilate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermittent ventilate by occluding the open hole in the oxygen tubing with thumb for 1 second and releasing for 4 seconds.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prepare for surgical cricothyroidotomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate oxygenation can only be maintained for 30 - 45 mins.</td>
</tr>
</tbody>
</table>
### HIGH AIRWAY PRESSURES

**Definition**
Abnormally high positive pressure in the breathing system or peak inspiratory pressure >30 cmH2O.

<table>
<thead>
<tr>
<th>Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ventilator alarms:</strong></td>
</tr>
<tr>
<td>High airway pressure</td>
</tr>
<tr>
<td>Low tidal volume</td>
</tr>
<tr>
<td>Low minute volume</td>
</tr>
<tr>
<td><strong>Monitor alarms</strong></td>
</tr>
<tr>
<td>Diminished cardiac output (↑HR, ↓BP)</td>
</tr>
<tr>
<td><strong>Visual</strong></td>
</tr>
<tr>
<td>Poor chest expansion</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Look to see if surgical cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>In ENT procedures this can be caused by insertion of the Boyle’s Davis Gag</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Deepen anaesthesia if evidence patient ‘light’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coughing, straining, biting airway</td>
</tr>
<tr>
<td>Inadequate muscle relaxation- if so supplement.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Switch to manual ventilation &amp;100% Oxygen and turn off Nitrous</th>
</tr>
</thead>
<tbody>
<tr>
<td>If chest not moving at all consider</td>
</tr>
<tr>
<td><strong>Obstruction</strong></td>
</tr>
<tr>
<td>Tube kinked</td>
</tr>
<tr>
<td>Mucus plugging</td>
</tr>
<tr>
<td>Obstructed circuit</td>
</tr>
<tr>
<td><strong>Chest wall rigidity</strong> secondary to opioid use- stop drug</td>
</tr>
<tr>
<td>If chest moving unilateral consider</td>
</tr>
<tr>
<td>One lung ventilation – tube too far down right main bronchus</td>
</tr>
<tr>
<td>Pneumothorax/ Haemothorax</td>
</tr>
<tr>
<td>Tension pneumothorax</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Is it difficult to ventilate because of resistance?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Look at the chest to see if ventilating bilaterally</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Listen to the chest to ensure AE normal and bilateral</th>
</tr>
</thead>
<tbody>
<tr>
<td>If wheeze present consider</td>
</tr>
<tr>
<td>Anaphylaxis</td>
</tr>
<tr>
<td>Asthma</td>
</tr>
<tr>
<td>If coarse crackles consider pulmonary oedema.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Manage the problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remember ALWAYS think EPO (Equipment/Obstruction/Patient) as causes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Equipment/Obstruction Patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tube kinked/ patient biting on tube/ FB in tubing</td>
</tr>
<tr>
<td>Pneumothorax/ Tension pneumothorax</td>
</tr>
<tr>
<td>Erect CXR – absent lung markings lateral to lung edge</td>
</tr>
<tr>
<td>Anaphylaxis- bronchospasm</td>
</tr>
<tr>
<td>Pulmonary oedema</td>
</tr>
<tr>
<td>Opioid induced chest wall rigidity</td>
</tr>
<tr>
<td>Airway pressures will rise in patients who are obese, have severe restrictive lung and chest wall disease and are also position dependent.</td>
</tr>
<tr>
<td>Raised intra-abdominal pressure</td>
</tr>
<tr>
<td>Inadequate muscle relaxation causing patient to breathe against the ventilator</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventilate using a Water’s circuit and see if improvement</td>
</tr>
<tr>
<td>Check position of ETT- pull back if necessary.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Obstruction- suction down ETT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumothorax (Asymmetrical chest expansion ↓ AE and hyper resonance on percussion)</td>
</tr>
<tr>
<td>If present treat by insertion of chest drain if symptoms or signs suggest patient unstable or according to size</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tension pneumothorax</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓RR, ↓SpO2, tracheal deviation and jugular venous distension late signs and often absent)</td>
</tr>
<tr>
<td>Needle decompression 2nd intercostals space mid clavicular line followed by chest drain insertion</td>
</tr>
</tbody>
</table>
**MALIGNANT HYPERPYREXIA (MH)**
- Incidence 1:30,000 of all GA.
- **Triggering agents:** Suxamethonium, Halothane, Enflurane, Isoflurane, Desflurane and Sevoflurane

### Clinical Features
- ↓ \( \text{SpO}_2 \) despite ↑ \( \text{FiO}_2 \)
- Unexplained tachycardia with an unexpected ↑ \( \text{ETCO}_2 \) and ↑ \( \text{MV} \).
- **Metabolic acidosis**, ↑ \( K^+ \)
- Cardiovascular instability- unstable BP, arrhythmias
- A rise in body temperature which increases by more than 2° C/h
- Muscle rigidity (especially trismus) - either following suxamethonium or during GA.
- Surgeons may complain of increased oozing is usually a sign of DIC

*A diagnosis of MH should be assumed if suspicions are aroused.*

*Other causes: re-breathing, sepsis, awareness, thyroid storm, neuroleptic malignant syndrome*

### Call for Help
- **Stop GA/ turn off volatile**
- Terminate surgery or continue with TIVA/regional agents that precipitate MH are suxamethonium and volatile agents
- Use a new circuit +/- ‘vapour’ free machine

- **100% Oxygen**
- Hyperventilate 2-3 * MV
- Monitor: Sats, \( \text{ETCO}_2 \) (achieve normocapnia), ECG, BP, Temp, Hb, U&E, CK, Clotting screen, fluid balance.

- **Dantrolene 2-3mg/kg IV**
- Repeat if necessary 1mg/kg PRN
- Vials of dantrolene contain 20mgs Dantrolene sodium, 3g mannitol and require 60mls of water to reconstitute.

- **COOLING**
- 1 - 2L iced IV 0.9% NaCl.
- Surface cooling using ice over the major vessels
- Consider pleural and peritoneal lavage
- Consider cardiopulmonary bypass via femoro-femoral circulation
- Temperature maybe unstable for 24-48hrs

### Treat myoglobinuria by maintaining diuresis of at least > 3ml/hr.

- **Correct metabolic acidosis with 8.4% sodium bicarbonate 1ml/kg** if \( \text{PaCO}_2 \) within normal limits.
- Monitor blood gases and pH and correct hyperkalaemia

- **Treat arrhythmias with Amiodarone 150mg loading dose followed by an infusion**
- Manage DIC

- **Admit to ITU**
- Continue to monitor and manage organ dysfunction and investigate family.
### SEVERE LARYNGOSPASM

<table>
<thead>
<tr>
<th>Clinical features</th>
<th>Some causes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stridor or ‘Crowing’ – partial obstruction</td>
<td>o Light anaesthesia (induction or emergence)</td>
</tr>
<tr>
<td>Silence/ breath holding- complete obstruction</td>
<td>o Soiling of larynx</td>
</tr>
<tr>
<td>Tracheal tug</td>
<td>o Strong stimuli- anal stretch, cervical dilatation</td>
</tr>
<tr>
<td>Respiratory distress</td>
<td>o Tracheal extubation; particularly in smokers</td>
</tr>
<tr>
<td>Suprasternal and infrasternal recession</td>
<td></td>
</tr>
<tr>
<td>Loss of capnograph</td>
<td></td>
</tr>
<tr>
<td>Difficulty ventilation</td>
<td></td>
</tr>
<tr>
<td>↓SaO₂</td>
<td></td>
</tr>
</tbody>
</table>

#### Stop precipitating stimulus, if any.
If surgical ask surgeon to stop- reassess

- Open and clear airway
  - Forceful chin lift/jaw thrust

- CPAP with 100% Oxygen via bag and mask
  - If improves continue with procedure/ recovery of patient

- Patient ↓SaO₂ dropping
  - CALL FOR HELP!
  - Use 20-30mg increments of propofol or increase volatile flow to deepen anaesthetic.
  - Continue CPAP and oxygen

- ↓SaO₂ critical (<75%)
  - Induction with propofol 50-100mg
  - Muscle relaxant
    - Suxamethonium 0.25-0.5 mg/kg IV
  - Note the dose of suxamethonium is under half normal dose so should wear off pretty quickly.

- Bag mask ventilate
  - Consider LMA
  - If any risk of aspiration intubate.

- Life threatening hypoxia
  - Needle/surgical cricothyroidectomy

- Monitor patient for negative pressure pulmonary oedema post episode
- Consider inserting NG post- CPAP therapy to decompress the stomach
- If intubate plan for extubation in monitored area with resus facilities. Consider deep extubation if no risk of aspiration.

Needle/surgical cricothyroidectomy
## LOCAL ANAESTHETIC TOXICITY

**Clinical features**

If awake:
- Tinnitus
- Light Headedness
- Visual Disturbances
- Circumoral numbness
- Metallic taste
- Slurred speech
- Drowsiness, Convulsions, Apnoea, Hypotension

**ECG changes:**
- ↑P-R interval, A-V dissociation, ↑QRS
- Sinus bradycardia leading to asystole
- VT/VF can also occur

<table>
<thead>
<tr>
<th>Stop injecting drug</th>
<th>Maintain airway</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100% Oxygen via non rebreather bag/anaesthetic circuit</td>
</tr>
<tr>
<td></td>
<td>Attach monitoring</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treat Convulsions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Titrate IV:</td>
</tr>
<tr>
<td>Diazepam 5-15mg</td>
</tr>
<tr>
<td>OR</td>
</tr>
<tr>
<td>Midazolam 3-10mg</td>
</tr>
<tr>
<td>OR</td>
</tr>
<tr>
<td>Thiopentone 50-150mg and plan to intubate</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treat hypotension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevate legs</td>
</tr>
<tr>
<td>IV fluids 5-10mls/kg stat</td>
</tr>
<tr>
<td>ephedrine 3mg IV in increments</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treat arrhythmias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amiodarone 150mg IV bolus over 5 mins</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CARDIAC ARREST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commence ALS</td>
</tr>
<tr>
<td>Intralipid 1V</td>
</tr>
<tr>
<td>Intralipid 20% 1.5ml/kg (100mls) over 1 min</td>
</tr>
<tr>
<td>Start continuous infusion of 0.25ml/kg/min over 15mins (400mls)</td>
</tr>
<tr>
<td>Continue CPR</td>
</tr>
<tr>
<td>Repeat bolus once or twice more at 5 mins if circulation not restored</td>
</tr>
<tr>
<td>Continue infusion until patient stable.</td>
</tr>
<tr>
<td>If no improvement increase infusion to 0.5ml/kg/min</td>
</tr>
</tbody>
</table>
## SAFE DOSE OF LOCAL ANAESTHETIC

<table>
<thead>
<tr>
<th>Drug</th>
<th>Maximum recommended dose mg/kg/4hr</th>
<th>Maximum dose with vasopressor mg/kg/4hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lidocaine</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Bupivicaine (binds more to the myocardium)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Levobupivicaine</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Prilocaine</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Cocaine</td>
<td>1.5-3</td>
<td></td>
</tr>
</tbody>
</table>

Adapted from Allman K, Wilson I. Oxford Handbook of Anaesthesia
**TOTAL SPINAL**

<table>
<thead>
<tr>
<th>Clinical features</th>
<th>Cause:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sudden ↓ BP, sometimes with HR &lt;60</td>
<td>□ Inadvertent subarachnoid injection of an epidural anaesthetic</td>
</tr>
<tr>
<td>N&amp;V</td>
<td>□ Unexpected spread of a standard spinal anaesthetic</td>
</tr>
<tr>
<td>Weakness and paraesthesia in upper limbs</td>
<td></td>
</tr>
<tr>
<td>Weak voice</td>
<td></td>
</tr>
<tr>
<td>Respiratory failure</td>
<td></td>
</tr>
<tr>
<td>Loss of consciousness (LOC)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reassure patient and explain what is happening as they will be aware</th>
<th>100% Oxygen via anaesthetic circuit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airway and Breathing</td>
<td>If patient conscious when losing ventilatory drive, small dose of induction agent and suxamethonium if paralysis not complete. Titratre carefully as spinal will have caused a degree of cardiovascular instability.</td>
</tr>
<tr>
<td>Secure airway and ventilate if patient unconsciousness or respiratory arrest.</td>
<td>Ventilate until spontaneous respiration returns. If risk of aspiration is high intubate otherwise LMA can be used.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Circulation</th>
<th>Monitor SaO₂, ECG and BP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treat ↓ BP</td>
<td>Raise legs to increase venous return but ensure that plenty of pillows under patient shoulder to prevent further LA spread cephalad.</td>
</tr>
<tr>
<td>Ephedrine 6-9mg boluses OR Metaraminol 1-2mg boluses</td>
<td></td>
</tr>
<tr>
<td>Rapid IV infusion 10-20mls/kg of colloid or crystalloid stat and then continue to titrate according to response.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treat HR&lt; 60</th>
<th>Patient may need to be transferred to ITU till the block has worn off.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atropine 0.6-1mg IV</td>
<td></td>
</tr>
</tbody>
</table>

| Peri-arrest | |
|-------------||
| Adrenaline 100mcg increments IV or vasopressors as an infusion | |
## ACUTE TRANSFUSION REACTION

### Clinical features
- Cyanosis
- Wheeze
- Dyspnoea
- Urticarial rash
- Fever
- Anaphylaxis

<table>
<thead>
<tr>
<th>Action</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stop transfusion and start IV fluids 100%</strong></td>
<td>Continue to infuse 0.9% NaCl through line to keep patent</td>
</tr>
<tr>
<td></td>
<td>Re-check blood with patient ID, DOB and name on wrist band.</td>
</tr>
<tr>
<td><strong>Assess vital signs including temperature</strong></td>
<td>If mild treat pyrexia with paracetamol</td>
</tr>
<tr>
<td></td>
<td>Antihistamine for urticaria</td>
</tr>
<tr>
<td></td>
<td>recommence transfusion at slower rate</td>
</tr>
<tr>
<td><strong>Look for signs of respiratory distress</strong></td>
<td>Dyspnoea, tachypnoea, wheeze, cyanosis</td>
</tr>
<tr>
<td><strong>If severe maintain airway, 100% oxygen</strong></td>
<td></td>
</tr>
<tr>
<td><strong>If hypotensive suspect anaphylaxis and treat</strong></td>
<td></td>
</tr>
<tr>
<td><strong>If evidence of multiorgan failure intubate and transfer to ITU</strong></td>
<td><strong>THE FOLLOWING MUST BE NOTIFIED:</strong></td>
</tr>
<tr>
<td><strong>Treat:</strong></td>
<td>- Blood bank</td>
</tr>
<tr>
<td></td>
<td>- The consultant haematologist</td>
</tr>
<tr>
<td></td>
<td>- Hospital transfusion committee</td>
</tr>
<tr>
<td></td>
<td>- Any serious hazards must be report to the serious</td>
</tr>
<tr>
<td></td>
<td>hazards transfusion scheme (SHOT)</td>
</tr>
<tr>
<td>- Renal failure</td>
<td></td>
</tr>
<tr>
<td>- Respiratory failure</td>
<td></td>
</tr>
<tr>
<td>- DIC</td>
<td></td>
</tr>
</tbody>
</table>
Part 3
Presentation and management of A&E cases

ALS algorithms
ATLS for anaesthetists
Anaphylaxis
Status epilepticus
The Burns Patient
The acute asthmatic/COPD patient
The unconscious patient and prevention of secondary head injury
Adult Advanced Life Support Algorithm

Unresponsive?
- Open airway
- Look for signs of life

Call Resuscitation Team

CPR 30:2
Until defibrillator / monitor attached

Assess rhythm

Shockable (VF / pulseless VT)
- 1 Shock
  - 160-360 J biphasic or 300 J monophasic
- Immediately resume CPR 30:2 for 2 min

Non-Shockable (PEA / Asystole)
- Immediately resume CPR 30:2 for 2 min

During CPR:
- Check reversible causes* e.g.:
  - Correct reversible causes
  - Check electrode position
  - Attempt / verify:
    - IV access
    - Airway and oxygen
  - Give uninterrupted compressions when airway secure
  - Give adrenaline every 3-5 min
  - Consider: amiodarone, atropine, magnesium

* Reversible Causes
- Hypoxia
- Hypoglycaemia
- Hypo/hyperkalaemia/metabolic
- Hypothermia
- Tension pneumothorax
- Tamponade, cardiac
- Toxins
- Thrombosis (coronary or pulmonary)

With permission from the Resuscitation Council Guidelines 2005
Paediatric Advanced Life Support

With permission from the Resuscitation Council Guidelines 2005
Newborn Life Support

With permission from the Resuscitation Council Guidelines 2005
Bradycardia Algorithm
(includes rates inappropriately slow for haemodynamic state)

If appropriate, give oxygen, cannulate a vein, and record a 12-lead ECG

**Adverse signs?**
- Systolic BP < 90 mmHg
- Heart rate < 40 beats min⁻¹
- Ventricular arrhythmias compromising BP
- Heart failure

**YES**

- Atropine 500 mcg IV

**Satisfactory response?**

**YES**

- **Risk of asystole?**
  - Recent asystole
  - Mobitz II AV block
  - Complete heart block with broad QRS
  - Ventricular pause > 3s

**NO**

- **Interim measures:**
  - Atropine 500 mcg IV repeat to maximum of 3 mg
  - Adrenaline 2-10 mcg min⁻¹
  - Alternative drugs * OR
  - Transcutaneous pacing

**NO**

**Seek expert help**

Arrange transvenous pacing

* Alternatives include:
  - Aminophylline
  - Isoprenaline
  - Doxamine
  - Glucagon (if beta-blocker or calcium-channel blocker overdose)
  - Glycopyrrolate can be used instead of atropine

With permission from the Resuscitation Council Guidelines 2005
Resuscitation Council (UK)

Tachycardia Algorithm
(with pulse)

- Support ABCs: give oxygen; cannulate a vein
- Monitor ECG, BP, SpO₂
- Record 12-lead ECG if possible; if not, record rhythm strip
- Identify and treat reversible causes (e.g., electrolyte abnormalities)

Synchronised DC Shock*
Up to 3 attempts

Unstable

- Amiodarone 300 mg IV over 10-20 min and repeat shock, followed by:
  - Amiodarone 900 mg over 24 h

Is patient stable?

- Signs of instability include:
  1. Reduced conscious level
  2. Chest pain
  3. Systolic BP < 90 mmHg
  4. Heart failure

(Rate-related symptoms uncommon at less than 160 beats min⁻¹)

Stable

Broad QRS

Is QRS regular?

- Broad QRS Irregular
  - Seek expert help

Possibilities include:
  - AF with bundle branch block
  - Pre-excited AF
  - Consider amiodarone
  - Polymorphic VT (e.g., torsade de pointes - give magnesium 2 g over 10 min)

- Broad QRS Regular
  - If ventricular tachycardia (or uncertain rhythm):
    - Amiodarone 300 mg IV over 20-60 min; then 900 mg over 24 h
  - If previously confirmed SVT with bundle branch block:
    - Give adenosine as for regular narrow complex tachycardia

Narrow QRS

Is rhythm regular?

- Narrow QRS Regular
  - Use vagal manoeuvres
  - Adenosine 6 mg rapid IV bolus; if unsuccessful give 12 mg; if unsuccessful give further 12 mg
  - Monitor ECG continuously

- Narrow QRS Irregular
  - Irregular narrow complex tachycardia
  - Probable atrial fibrillation
  - Control rate with:
    - β-Blocker IV or digoxin IV
    - Amiodarone 300 mg IV 20-60 min; then 900 mg over 24 h

Normal sinus rhythm restored?

- Yes
  - Seek expert help

Possible re-entry PSVT:
  - Record 12-lead ECG in sinus rhythm
  - If recurrent, give adenosine again & consider choice of anti-arrhythmic prophylaxis

- No
  - Seek expert help

Irregular Narrow Complex Tachycardia

Possible atrial flutter
  - Control rate (e.g., β-Blocker)

* Attempted electrical cardioversion is always undertaken under sedation or general anaesthesia.
ATLS

<table>
<thead>
<tr>
<th>Airway and C-spine stabilisation</th>
<th>Protect and Secure if compromise exists</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% oxygen</td>
<td>If conscious use nasopharyngeal if no suspicion of basal skull fracture</td>
</tr>
<tr>
<td></td>
<td>If unconscious, no gag reflex present use oropharyngeal airway and plan to intubate using manual stabilisation of the C-spine</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Breathing</th>
<th>Intubate early if problems with ventilation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exclude and treat</td>
<td></td>
</tr>
<tr>
<td>Pneumothorax/ Tension</td>
<td></td>
</tr>
<tr>
<td>Haemothorax</td>
<td></td>
</tr>
<tr>
<td>Chest wall injury</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Circulation</th>
<th>Assess skin colour, pulse rate and strength, BP, capillary refill time, look for bleeding, pelvic spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 * 14 G cannulae</td>
<td>Bloods for FBC, U&amp;E, COAG, X-MATCH and BHCG in females.</td>
</tr>
<tr>
<td>Bloods including X-match</td>
<td>Treat haemorrhagic shock aggressively.</td>
</tr>
<tr>
<td>1L warmed Hartmann’s stat</td>
<td>-----------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Disability</th>
<th>Eye Opening</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCS and pupil size</td>
<td>Spontaneous 4</td>
</tr>
<tr>
<td>Rapid neurological assessment</td>
<td>To Speech 3</td>
</tr>
<tr>
<td>If GCS &lt;8 consider intubation</td>
<td>To pain 2</td>
</tr>
<tr>
<td></td>
<td>None 1</td>
</tr>
<tr>
<td></td>
<td>Best Motor Response</td>
</tr>
<tr>
<td></td>
<td>Obey’s Commands 6</td>
</tr>
<tr>
<td></td>
<td>Localizes pain 5</td>
</tr>
<tr>
<td></td>
<td>Normal flexion (withdrawal) 4</td>
</tr>
<tr>
<td></td>
<td>Abnormal flexion (decorticate) 3</td>
</tr>
<tr>
<td></td>
<td>Extension (decerebrate) 2</td>
</tr>
<tr>
<td></td>
<td>None (flaccid) 1</td>
</tr>
<tr>
<td></td>
<td>Verbal Response</td>
</tr>
<tr>
<td></td>
<td>Orientated 5</td>
</tr>
<tr>
<td></td>
<td>Confused 4</td>
</tr>
<tr>
<td></td>
<td>Inappropriate words 3</td>
</tr>
<tr>
<td></td>
<td>Incomprehensible sounds 2</td>
</tr>
<tr>
<td></td>
<td>None 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Further examination of abdomen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undress and make a thorough examination</td>
<td>Log roll and examine spine</td>
</tr>
<tr>
<td></td>
<td>Look at other injuries and obtain a full neurological assessment.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Secondary survey</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**ANAPHYLAXIS**

**Actual clinical features:**
- Cardiovascular collapse
- Bronchospasm - Transient/Asthmatic
- Cutaneous - rash / erythema / urticaria
- Angioedema
- Generalised oedema
- Pulmonary oedema

<table>
<thead>
<tr>
<th>Stop agent</th>
<th>Call for help</th>
</tr>
</thead>
</table>
| **Maintain airway, give 100% oxygen and lie patient flat with legs elevated** | 1-2L of crystalloid  
All adult patients may require 2-4 L |
| **IV Fluids** | |
| Adrenaline 50-100 mcg IV (0.5-1ml of 1 in 10000) over 1 min with titration of further doses. | If unable to gain access 1 in 1000 adrenaline 0.5mls-1ml (500mcg- 1mg ) IM every 10mins |
| **For cardiovascular collapse**  
Adrenaline 0.5-1mg (5-10mls of 1 in 10000) maybe required in titrated doses. | Give at a rate of 0.1mg/min stopping when a response has been obtained. |

| **Paediatric doses of adrenaline 1 in 1000 IM** |
|---|---|---|
| >12yrs | 500mcg (0.5ml) | |
| 6-12 yrs | 250mcg (0.25ml) | |
| >6mths- 6yrs | 120mcg (0.12ml) | |
| <6mths | 50mcg (0.05ml) | |

<table>
<thead>
<tr>
<th><strong>Secondary therapy</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrocortisone 100-300mg IM/IV</td>
</tr>
<tr>
<td>Chlorphenamine 10mg-20mg IM/IV</td>
</tr>
<tr>
<td>Salbutamol nebuliser</td>
</tr>
</tbody>
</table>

| **Paediatric doses** |
|---|---|
| Hydrocortisone | Chlorphenamine |
| 1-6yrs | 50mg IM | 2.5-5mg IM |
| 6-12yrs | 100mg IM | 5-10mg IM |
| >12 yrs | 100-500mg IM | 10-20mg IM |

Adapted from AAGBI Anaphylaxis Guidelines 2003
### STATUS EPILEPTICUS

Continuous seizure activity lasting > 30mins
Intermittent seizure activity lasting >30mins during which consciousness is not regained

| 100% oxygen and insertion of an oropharyngeal or nasopharyngeal airway | Acute Causes: 
Electrolyte imbalance 
Stroke 
Cerebral anoxia/ hypoxic damage 
CNS infection 
Encephalitis 
Toxicity 
Sepsis 
ARF 
Eclampsia |
|--------------------------|---------------------|
| **Monitor ECG, SaO₂** 
Check BM and treat hypoglycaemia | **Chronic causes:** 
Pre-existing epilepsy 
Alcoholic 
Space occupying lesion (SOL) |
| **IV Lorazepan (0.1mg/kg)** 
**or** 
**IV Diazepam (0.1mg/kg)** | **Send bloods for** 
FBC, U+E, Ca²⁺, Mg²⁺, PO₄³⁻, toxicology |
| If continues >10 mins 
**Phenytoin 15-17mg/kg** bolus by slow IV infusion 
Post loading dose 100mg 6-8hrly | **ABG** |
| Consider RSI and intubation if hypoxic, hypercarbic or seizures not terminating 
CT scan if required and then admit to ITU | If patient is pregnant and seizure activity may be associated with pre-eclampsia or eclampsia 4g Mg over 15mins Infusion 1g/h over 24hrs minimum |
| | (Dilute in 50- 100ml 0.9% NaCl not exceeding a concentration of 10mg/min and run at a rate of <50mg/min). ECG monitoring is required. |
| | Once the patient is stable continue to investigate and manage complications: 
• Hyperthermia 
• Rhabdomyolysis 
• Cardiac arrhythmias 
• Pulmonary aspiration 
• Neurological pulmonary oedema |
| | Correct reversible causes. |
THE BURNS PATIENT
Requires simultaneous management and assessment.

AIRWAY
- 100% O₂ (besides oxygenation will help with CO poisoning)
- Look for evidence of inhalational injury
  - Burnt eyebrows + nasal hair + face
  - Soot in sputum
  - Stridor
  - Respiratory distress
- If any of the above present consider early intubation because of worsening oedema. RSI and only use Suxamethonium in first 24hrs after which there is an increase of K⁺ release.
- Do not cut the tube as will get ‘swallowed’ by facial oedema later

BREATHING
- Look at RR rate and pattern of breathing
- ABG - remember the PaO₂ may be normal in CO poisoning because it accounts for the O₂ in dissolved blood.
- Bronchoscopy can be considered when patient stable

CIRCULATION
- Attempt 2 large bore IV cannulae
- Bloods – FBC, U+E, CLOTTING, COHb, X-MATCH
- Consider A-Line
- Urinary catheter and aim for output of 50ml/hr
- Fluid replacement: Parkland Formula
  - Hartmann’s 4ml × kg × %Total Burn Surface Area (TBSA) in 24hours.
  - Half total over 8 hrs, remainder over 16hrs.

DISABILITY
- Rule of nine’s- see diagram, or palm area = 1% burn
- Assess severity of burns:
  - Age × % TBSA
- Major burn is
  - Full thickness >10% TBSA
  - Partial thickness > 15% TBSA
  - Burns to hands, feet, perineum, inhalational, chemical, and electrical.
  - Burns in patient’s with serious pre-existing medical condition.
- Severe burn > 40% TBSA

EVALUATION
- During your assessment it is important to evaluate the history of the injury:
  - Explosion
  - Fire in an enclosed space
  - Inhalational of toxic fumes
- Where was patient in relation to the insult, exposure time? All these things will give to an estimation of how long before a sequela is seen.
THE ACUTE ASTHMA/COPD PATIENT

HISTORY

History of disease
- Diagnosis
- Treatment
- Control:
  - How often they use inhalers?
  - How often have attacks?
  - Steroid use?
  - Hospital admissions/ITU admission

Onset of current attack
- Prodome- coryzal symptoms, allergen, cold
- How often inhalers used today
- Sputum

EXAMINATION

- GCS and look at patient general state and cyanosis
- HR, BP, Capillary refill time
- RR, use of accessory muscles, listen to the chest

INVESTIGATIONS

- Bloods/ blood cultures
- ECG- ensure no ischaemic event or PE
- ABG- worry if Normal/ ↑PaCO₂ and PaO₂ < 8kPa- pt tiring
- Attempt PEFR

<table>
<thead>
<tr>
<th>SEVERE ASTHMA</th>
<th>LIFE THREATENING ASTHMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pt unable to complete sentence</td>
<td>Silent chest</td>
</tr>
<tr>
<td>HR&gt; 110 BPM</td>
<td>Cyanosis</td>
</tr>
<tr>
<td>RR&gt;25</td>
<td>Bradycardia</td>
</tr>
<tr>
<td>PEFR&lt;50% predicted</td>
<td>Confusion</td>
</tr>
<tr>
<td></td>
<td>Exhaustion</td>
</tr>
<tr>
<td></td>
<td>PEFR &lt;33%</td>
</tr>
</tbody>
</table>

MANAGEMENT

- Sit the patient up
- 100% oxygen
- Salbutamol nebs- 2.5-5mg back to back initially. If no response consider an infusion.
  - SE-↑ HR, arrhythmias, tremor, ↑BM, ↓K+
- Atrovent 500mcg 6 hourly
- Steroids- 200mg IV- peak response 6-12 hrs
- Magnesium- 8mmol in 100 ml NaCl 0.9% over 30 mins
- Aminophylline- loading 3mg/kg followed by an infusion of 0.5mg/kg/hr.
  - Omit loading dose if patient on theophylline
  - SE- arrhythmias, convulsion, N+V, headaches, restlessness
- Fluids
- Assess every 30-60mins

When to intubate
- Respiratory arrest
- Low GCS
- Exhaustion- ↑PaCO₂, ↓PaO₂, ↓pH

When ventilated
- Remember patient already has intrinsic PEEP from bronchoconstriction so aim for prolonged expiration.
- Limit peak pressures
- On the ventilator: ↓RR, ↓TV, I<E, avoid PEEP
- Permissive hypercapnaemia maybe permitted to allow adequate ventilation.
THE UNCONSCIOUS PATIENT AND PREVENTION OF SECONDARY HEAD INJURY

As an anaesthetist you will be required to provide airway support and transfer to scan for most of these patients. How do decide who to tube and who not to?

Ascertain a history of event, history of trauma, past medical and drugs history.

Think of the causes:
- Trauma
- Tumour
- Infection
- Metabolic- DKA, Hyponatraemia/encephalopathy/ post-ictal
- Drugs
- Vascular- ?bleed

Ask yourself 2 questions
- Has the patient got a patent airways and able to self ventilate?
- Can they protect their airway?
  - GCS>8
  - Gag present – try inserting a gueduel and see if tolerate it.
  - If no to either- intubate – this will provide adequate oxygenation to minimise the risk of secondary brain injury secondary to hypoxia.

O/E look particularly at:
- Neuro- GCS, pupils, tone, reflex plantars, neck stiffness, photophobia
- CVS- look particularly for ↓HR ↑BP
- RESP- look for abnormal breathing patterns
- SKIN- rash

Investigations
- Standard bloods/septic screen (Blood cultures, urine, sputum)
- Urine toxicology
- Blood sugars
- ABG
- CT scan – if normal consider LP

If suspecting intracranial pathology the sooner you initiate neuroprotection the less likely you are to cause secondary brain injury.

NEUROPROTECTION

Cerebral perfusion pressure (CPP) = MAP-ICP
CPP should be maintained between 70-80mmHg

To do so:
- Maintain MAP of 80mmHg as the ability to auto regulate has gone. In patients with known hypertensive disease a higher MAP should be sought.
- PaO₂ >6kPa
- Ventilate to normocarbia, PaCO₂ 4.5kPa as above this value there is cerebral vasodilatation and ↑ICP.
- Secure ETT with tape and not tie as it prevents decrease in venous return from cerebral circulation and hence does not increase ICP.
- Keep patient head up 30-40 degrees to reduce ICP.
- Central access through femoral vessels.
- Do not tape the eyes as you will need to assess the pupil size regularly.

Dilatation of one pupil is suggestive of raised ICP and a poor prognosis. If this starts to happen the following can help improve the condition by decreasing cerebral metabolic rate and reducing cerebral perfusion and oxygen demand.
- 100 mg propofol
- Titrate thiopentone
- 100mls 10% mannitol
Part 4
Miscellaneous

Analgesia

Jehovah’s Witness

Sickle cell disease

Smoking

Blood and blood products

Acid- Base balance- the basics

Metabolic abnormalities

Transfer of the critically ill patient
ANALGESIA

Look at the protocols in your hospital and talk to the pain nurses about what drugs they use and ask them to explain how the epidural and PCA pumps work. Ask to go on a pain round to learn how to assess pain.

The easiest way to assess a patient’s pain is to ask them!
- Where is the pain?
- The nature of the pain?
- Intermittent or constant?
- Has analgesia helped it?
- On a scale of 0-10, 0 being no pain and 10 being the worst pain they have ever had how would they rate their pain?

Common analgesics in anaesthesia
- Paracetamol 1g IV/O/PR qds regularly
- NSAIDS
  - Ibuprofen 200mg-400mg O tds
  - Diclofenac- 50mg O/IV/PR tds
  - Note the CI are asthmatics, patients with PUD and renal impairment
- Codeine phosphate 30-60mg O tds
- Tramadol 50-100mg O/IV qds
- Oromorph 10-20mg 4hrly
- Morphine 5-10mg IM 4 hrly
- Buscopan 20mg IV/IM tds for spasmodic pain

PCA (check each hospitals bags maybe different)
- Morphine (2mg/ml) 1 mg bolus 5 min lockout
- Fentanyl (10mcg/ml) 10mcg bolus 5 min lockout
- Backgrounds can be prescribed according to circumstances

Epidurals (each hospital has different mixtures)
- Mostly Bupivicaine 0.1% with 2mcg/ml Fentanyl
- Plain bupivicaine

The use of these should be with advice from a senior
- Clonidine- 150mcg titrated slowly IV. It releases endogenous opioids
- Ketamine- 2.5-7.5mg orally (not to be used without discussion with consultant)

How can I test the patients epidural block is working?
- Check the site of the catheter and level of insertion
- Note if been used. If not you need to administer a test dose of 2mls of 0.25% first, after aspiration of the catheter to ensure not in a blood vessel, and look to see if sudden profound block or ↓BP, difficulty in breathing suggesting intra dural catheter. Manage as such and call for help.
- If epidural infusion already running feel feet, if they are warm bilaterally suggesting good working epidural if placed in lumbar region.
- Check motor block- ask patient to ‘wiggle’ toes or bend knees? Post-op you don’t want a motor block. If present reduce rate.
- Check sensory block with ethyl chloride spray. As patient to tell you when feels the temperature of spray on body as cold as on their hand. Also test the level above that cold sensation to check not getting colder.
- If requires bolusing always ask the nurse to check pre bolus obs and then needs obs done every 5-10mins for 45mins.
- Bolus through pump of draw up 10mls 0.25%. Bupivicaine and give 3mls every 10mins till symptoms improve or block ascends.
- If epidural not working consider stopping and starting patient on PCA.
- Epidural catheter can only come out 12hrs post clexane or when clotting normal.
- Clexane can be give 12hrs post insertion or removal or catheter. Once again look at the policy in your hospital as this may vary.
- If catheter falls out in patient who is at risk of haematoma ask nurses to do Neuro obs half an hourly for 4 hrs and then 1-2hrly for another 4hrs.
JEHOVAH’S WITNESS

These individuals read the scriptures in a literal way, which mean that they extrapolate to blood transfusion the biblical prohibition about eating blood.

They vary it the extremity to which they abide by this and hence it is important to clearly identify and document what they will and will not accept should they require blood products.

The very strict will NOT accept:
- Blood
- Blood products
- Platelets
- Albumin
- Immunoglobulin or clotting factors
- Autologous transfusions for the reason that blood has left the body.

You must establish precisely what is acceptable to patients and treat accordingly.

Pre-operatively
Check Hb and optimise:
- Haematinics
- Stop NSAIDs
- Consider erythropoietin (↑ PVC by 2% daily)

Operative management
- Minimise blood loss while monitoring tissue oxygenation
- Consider regional techniques where appropriate
- Carefully position the patient to reduce venous pressure
- Consider hypotensive anaesthesia
- Experienced surgeon to ensure minimal blood loss
- Hypothermic anaesthesia (↓ O2 consumption)
- Haemodilution so that the net volume of blood loss is reduced.
- Drugs e.g. Tranexamic acid which will inhibit fibrinolysis.

Post-operatively
- Maximize O2 delivery
- Minimize O2 consumption
- Minimize blood loss
- Consider ITU
SICKLE CELL DISEASE

Autosomal dominant haemoglobinopathy with an increased prevalence in black, Mediterranean and Indian population. β chain of HbA has valine substituted for glutamic acid in position 6

FACTS

Sickle cell trait individuals
- have a normal life expectancy
- Hb>11
- Sickling if SaO₂ < 40%
- ↑ risk of pulmonary infarction

Sickling in diseased individuals occurs with
- Hypoxia
- Acidosis
- ↓ temp
- Cellular dehydration from hypovolaemia
- Initially sickling is a reversible process
- Sickle cell results in decreased microvascular blood flow (or occlusion) causing further local hypoxia, acidosis and thus further sickling.
- Local infarction causes the symptoms and signs of sickle cell crisis

SIGNS OF CRISIS

- Acute chest syndrome
  - Pleuritic pain
  - Cough
  - Fever
- Other complaints
  - Bone pain
  - Muscle tenderness
  - Erythema
  - Abdominal pain
  - Splenic sequestration
  - Haematuria
  - Priapism
  - CVA/TIAs

ANAESTHETIC CONCERNS

- Ensure all patients from the region of prevalence know their status. If not a Sickledex must be performed. If it is positive blood must be sent for electrophoresis to ascertain whether patient is a homozygote (disease state) or heterozygote (Trait).
- Transfusion: exchange (to achieve HbS<40%) or top up (Hb 10-12g/dl) is contentious and depends on surgical procedure. To discuss with haematologist.
- Ensure oxygenation and humidified oxygen throughout and into post-operative period.
- Avoid hypothermia by using warmed fluids and warming blanket.
- Avoid low flow or stasis in circulation
  - Adequate hydration (warm fluids) throughout and into the post-operative period.
  - Avoid arterial tourniquets
  - Adequate position.
- Avoid acidosis by remembering that hypercarbia may contribute to this.
- Adequate analgesia- pain causes increase oxygen consumption and catecholamine release.
- Anaesthetic technique can be either GA or regional as long as the above are adhered to. The latter has the advantage of good post operative pain relief but remember you may need to supplement this as the block wears off.
- Antibiotics as hyposplenism is associated with an increased infection risk.
SMOKING

FACTS

- The margin of safety of anaesthesia is reduced in smokers.
- Smokers also tend to have co-existing diseases such as obesity, alcoholism, COPD and cardiovascular disease.
- Ciliary activity takes 6-52 to recover
- Abstinence may precipitate anxiety, irritability, nausea and insomnia

WHAT HAPPENS IN A SMOKER’S BODY?

In the airway
- Mucus hyper secretion and impaired clearance.
- Small airway narrowing and sputum retention
- ↑ airway reflexes causes laryngospasm and bronchospasm

In the blood
- Level of Carboxyhaemaglobin (COHb) can rise to > 15% which decreases O₂ delivery to the tissues as well as shifting the oxyhaemoglobin curve to the left.
- Thromboembolic events are more common due to ↑ platelet aggregation and haematocrit.
- ↑ catecholamine levels as an affect of nicotine

Cardiovascular changes caused by nicotine
- ↑HR, ↑SVR and ↑BP because of an increased adrenergic response.
- ↑ myocardial oxygen demand whereas coronary blood flow ↓

ANAESTHESIA

Pre-operatively
- Advise the patients not to smoke prior to surgery. It can help improve oxygenation intra-operatively by reducing COHb levels.
- Premeds may be required to minimise anxiety.

Induction
- Pre-oxygenate
- Intubation may produce an exaggerated pressor response.
- Consider neuromuscular blockade to prevent coughing.
- Avoid histamine release i.e. use Vecuronium/ Rocuronium not Atracurium

Intra-operatively
- Avoid Desflurane as it is believed to ↑HR, ↑BP in smokers.
- Response to opiate maybe affected by liver enzyme induction.

Post-operatively
- Thromboprophylaxis
- 24hrs humidified oxygen and chest physio.
- Respiratory complications are 6-8 times more common than in non-smokers.
- Surgical complications are more common due to tissue hypoxia and impaired wound healing.
## BLOOD AND BLOOD PRODUCTS

All donated blood is tested for HIV, hepatitis B and C and syphilis.

<table>
<thead>
<tr>
<th>Preparation</th>
<th>Red cells</th>
<th>Platelets</th>
<th>FFP</th>
<th>CRYO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plasma removed and packed red cells are suspended in an additive solution</td>
<td>From pooled buffy coats of whole blood donated</td>
<td>Centrifugation of whole blood from previous</td>
<td>Thawing a single donation of FFP at 4 degree</td>
<td></td>
</tr>
<tr>
<td>- saline, adenine, glucose and mannitol (SAG-M) or citrate, phosphate</td>
<td>suspended in male plasma)</td>
<td>donor and frozen to achieve F VIII</td>
<td>Celsius.</td>
<td></td>
</tr>
<tr>
<td>- dextrose and adenine(CPDA)</td>
<td>Individual donor apheresis- whole blood is</td>
<td>concentration &gt;0.7iu/ml</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>sampled from donor, mixed with anticoagulant</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>and centrifuged.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage</td>
<td>2-6 deg C</td>
<td>20-24 deg C on agitator rack</td>
<td>-30 deg C</td>
<td>-30 deg C</td>
</tr>
<tr>
<td>Shelf life</td>
<td>35 days</td>
<td>5 days</td>
<td>1 yr (frozen)</td>
<td>1 yr (frozen)</td>
</tr>
<tr>
<td></td>
<td>Transfuse within 30mins of removal from fridge</td>
<td>Start transfusion immediately over 30mins</td>
<td>Once thawed transfuse within 4 hrs</td>
<td>Use within 4 hrs</td>
</tr>
<tr>
<td></td>
<td>and complete by 4 hrs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compatibility testing</td>
<td>Must be ABO and RhD compatible with recipient</td>
<td>Preferably ABO identical with patient. Rh</td>
<td>Ideally it should be ABO compatible to avoid</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>negative females &lt;45yrs should be given</td>
<td>risk of haemolysis with anti- A or anti-B. If</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rh D negative platelets</td>
<td>unavailable different grouped FFP can be</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>given, except in Blood group O in which</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>only O can be given.</td>
<td></td>
</tr>
<tr>
<td>Indications for transfusion</td>
<td>If blood required for haemorrhage or in order</td>
<td>In stable patients, a platelet count &gt; 10</td>
<td>Acquired coagulopathy related to haemorrhage,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>to improve oxygen carriage.</td>
<td>* 10^7 in absence of active bleeding does not</td>
<td>trauma, sepsis, cryoprecipitate used if</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>warrant platelet transfusion.</td>
<td>fibrinogen &lt;1g/dl.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Invasive intervention in a patient with a</td>
<td>VWB disease Patients with haemophilia if F.VII</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>platelet count &lt; 50*10^9/l e.g. surgery,</td>
<td>not available</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>insertion of a chest drain, CVP (&gt;50*10^9/l</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>required)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Active bleeding &gt;50*10^9/l</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dose</td>
<td>10-15ml/kg can raise platelet count by</td>
<td>12-15ml/kg. In 70kg man this is equivalent</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>approximately 20*10^9/l</td>
<td>to 3-4*300ml pack of FFP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Volume: 250-350mls with a platelet count &gt;2.4</td>
<td>Acute reversal of warfarin 5-10ml/kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>*10^11 per adult dose.</td>
<td></td>
<td>10UNITS- 300MLS</td>
<td></td>
</tr>
<tr>
<td>Other facts</td>
<td>Slightly acidic</td>
<td>The haemostatic affect of FFP declines</td>
<td>Rich in factor VIII, V WB factor, factor XIII,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Do not administer via a giving set used to give</td>
<td>progressively after thawing within 24 hrs.</td>
<td>fibronecin and fibrinogen.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>blood.</td>
<td>VWB factor, Anti-fibrinbin III, Factors</td>
<td>Packs contain at least 150-300mg of fibrinogen</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>XIII, XII, XI, X, IX all i.e Factors V, VIII, VII, II and fibrinogen remain stable.</td>
<td>and 70iu of factor VII</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>FFP contains more fibrinogen.</td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td>£120</td>
<td>£200 per adult dose</td>
<td>£30 per 300ml</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>£300 for 1units</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
What is a group and save?
Patients blood is tested to determine ABO and Rh D type and to detect red cell antibodies that could haemolyse transfused red cells. The sample is held in the lab for 7 days.

What is a X-match?
The patient’s blood is tested to confirm compatibility with each unit or red cell to be transfused. If group and saved this takes 20 mins to do.

Checking blood
- Confirm patient’s ID by ID bracelet and case notes.
- Check blood compatibility label to ensure the blood is correct for patient
- Check expiry date and unit number
- Inspect bag to ensure integrity of plastic casing.
- Details of blood transfused including volume. Should be recorded on the anaesthetic chart or clinical notes.

Signs of transfusion reaction
- Anaphylaxis
- TRALI (Transfusion related acute lung injury) - acute dyspnoea, hypoxia, bilateral pulmonary infiltrates after 24hrs after transfusion.

Table to show abnormalities in clotting with different disorders.

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Platelet count</th>
<th>INR</th>
<th>APTT</th>
<th>Fibrinogen</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liver disease</td>
<td>N/↓</td>
<td>↑</td>
<td>↑</td>
<td>N/↓</td>
<td>N/↓</td>
</tr>
<tr>
<td>DIC</td>
<td>N/↓</td>
<td>↑</td>
<td>↑</td>
<td>N/↓</td>
<td>↑ FDPs (fibrinogen degradation products) D-dimer (II,V, VIII)</td>
</tr>
<tr>
<td>Massive transfusion</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>N/↓</td>
<td>Normal FDPs</td>
</tr>
<tr>
<td>Warfarin</td>
<td>N</td>
<td>↑↑</td>
<td>↑</td>
<td>N</td>
<td>↑ II, VII, IX, X</td>
</tr>
<tr>
<td>LMW Heparin</td>
<td>N (rarely ↓)</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>↑ anti-Xa</td>
</tr>
</tbody>
</table>

All this information has been taken from the booklet Blood Transfusion and the Anaesthetist - Blood Component Therapy (2005) Guidelines published by the AAGBI
ACID BASE BALANCE- THE BASICS

This is a very large area that needs to be addressed by reading the fundamental text.

TERMINOLOGY

Acidity is normally expressed in hydrogen ion concentration \([H^+]\) in units of nanomoles per litre (nmol/L) or the negative logarithm of hydrogen ion concentration in mol/l (pH) or a proton donator.

Bases
A base is a substance that can accept hydrogen ions and by doing so reduce \([H^+]\) and thus the acidity of solutions or a proton acceptor.

Base deficit is a situation where there is a deficit of base in a system leading to a degree of acidosis.

Buffers are substances that, by their presence in solution, increase the amount of acid or base that has to be added to cause a unit change in \([H^+]\). They bring about this change by having the ability to absorb or release H\(^+\) as an acid or base is added.

Major Acid-Bases disorders + compensatory mechanisms

<table>
<thead>
<tr>
<th>Primary disorder</th>
<th>Primary disturbance</th>
<th>Primary compensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory acidosis</td>
<td>↑PaCO(_2)</td>
<td>↑HCO(_3^-)</td>
</tr>
<tr>
<td>Respiratory alkalosis</td>
<td>↓PaCO(_2)</td>
<td>↓HCO(_3^-)</td>
</tr>
<tr>
<td>Metabolic acidosis</td>
<td>↓HCO(_3^-)</td>
<td>Hyperventilation (↓PaCO(_2))</td>
</tr>
<tr>
<td>Metabolic alkalosis</td>
<td>↑HCO(_3^-)</td>
<td>Hypoventilation (↑PaCO(_2))</td>
</tr>
</tbody>
</table>

Lactic Acidosis
Is described as a metabolic acidosis accompanied by a raised plasma lactate level of > 2mmol/L. There is a simultaneous increase in lactate and \([H^+]\) in this condition and they reflect an imbalance between oxygen requirement and oxygen delivery to allow for cellular respiration. Lactate is a by product of the citrate cycle.

<table>
<thead>
<tr>
<th>Type A lactic acidosis- relates to tissue hypoxia</th>
<th>Type B lactic acidosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise</td>
<td>Drugs</td>
</tr>
<tr>
<td>Shock</td>
<td>Diabetes</td>
</tr>
<tr>
<td>Hypoxia</td>
<td>Renal failure</td>
</tr>
<tr>
<td>Anaemia</td>
<td>Sepsis</td>
</tr>
<tr>
<td></td>
<td>Liver disease</td>
</tr>
</tbody>
</table>

Anion Gap
In order for the body to maintain electrical neutrality the number of anions must equal the number of cations. Most of the cations can easily be measured and in plasma the major contribution to cation charge is Na\(^+\) ion. It is not easy to count the anion charge because a significant contribution made by proteins which cannot be easily measured, so chloride and bicarbonate are used to measure this component.

\[
\text{Anion gap} = (\text{Na}^+ + \text{K}^+) - (\text{Cl}^- + \text{HCO}_3^-)
\]

Difference is normally between 8-12 mmol. In disease states this gap can widen.

<table>
<thead>
<tr>
<th>Increase in anion gap</th>
<th>Decrease in anion gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uraemic acidosis</td>
<td>Hypoalbuminaemia</td>
</tr>
<tr>
<td>Ketoacidosis</td>
<td>Hypernatraemia</td>
</tr>
<tr>
<td>Salicylate poisoning</td>
<td>Hypomagnesaemia</td>
</tr>
<tr>
<td>Lactic acidosis</td>
<td>Hypercalcaemia</td>
</tr>
<tr>
<td>Dehydration</td>
<td>Lactic acidosis</td>
</tr>
<tr>
<td>Toxicity: methanol, paraaldehyde</td>
<td></td>
</tr>
</tbody>
</table>

63
<table>
<thead>
<tr>
<th><strong>METABOLIC DISTURBANCES</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HYPOKALAEMIA</strong></td>
</tr>
<tr>
<td><strong>Definition</strong></td>
</tr>
<tr>
<td><strong>Cause</strong></td>
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<tr>
<td><strong>Clinical changes</strong></td>
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<td></td>
</tr>
<tr>
<td><strong>Management</strong></td>
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<td></td>
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<tr>
<td><strong>Anaesthetic considerations</strong></td>
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</tr>
</tbody>
</table>
controlling ventilation will prevent respiratory alkalosis.

Adapted from Allman K, Wilson I. Oxford Handbook of Anaesthesia

TRANSFER OF THE CRITICALLY ILL PATIENT

The following must be done prior to transferring a patient

- Communication
  - Between you and the team member accepting the patient at another hospital and this should be clearly documented.
- Detailed assessment of your patient
  - Ascertain the risk/benefit of transfer
- All patients must be stabilised prior to transfer
  - Intubate if needed
  - Fluid resuscitate
  - If on inotropes ensure patient is not requiring high amounts as they are not safe to transfer.
- Likely problems anticipated and plans made on how they will be managed.
  - A competent doctor and nurse to accompany patient.
- Pre transfer intervention
  - E.g. if you suspect your patient made need to be intubated en route intubate early and ensure transfer is to an ITU.
- Equipment check
  - If this is not your patient and you are just transferring them ensure you have had a comprehensive handover.

What do to check and double check prior to transfer?

- Patient safe to transfer
- Adequate access- at least one large bore peripheral access even if central line present.
- Check the CXR to ensure the ETT and CVP are in place and no complications from their insertion.
- Adequate monitoring (iBP, NIBP, Sats, ECG, temperature (especially in children)) and battery life on monitor full.
- Appropriate sedation and inotropes and sufficient supply.
- Extra infusion pump
- Transfer form
- Mechanical ventilator
- Enough Oxygen
- What is the estimated length of your journey?
- Quantity in litres of oxygen in your cylinder/ patient’s MV= duration that cylinder will last.
- Transfer bag containing airway equipment, drugs, extra IV access etc. check present
- Ambu bag- if you run out of oxygen at least you can manually ventilate patient.
- Suction
- Consider taking a defibrillator, extra syringe pump or battery, extra battery for the monitor.

Drugs

- Emergency drugs- metaraminol, ephedrine, atropine, adrenaline, propofol (to bolus)
- Inotropes
- Sedation and muscle relaxant
- Analgesia
- Fluids

On transfer if patient deteriorates in the ambulance, stop and resuscitate.
Always remember there is limited space and poor access in the back of an ambulance so ensure prior to departing everything is laid out so you can reach it if you need to.
Recommended Reading

1. How to Survive in Anaesthesia: A Guide for Trainees
   Neville Robinson, George Hall

   Keith Allman, Iain Wilson

3. Anaesthesia and Intensive Care A to Z: An Encyclopaedia of Principles and Practice
   Steven M. Yentis, Nicholas P. Hirsch, Gary B. Smith

4. Basic Physics & Measurement in Anaesthesia
   Paul D. Davis, Gavin N. C. Kenny

5. Essentials of Anaesthetic Equipment
   Baha Al-Shaikh, Simon Stacey

6. Respiratory Physiology: The Essentials
   John B. West

7. Pharmacology for Anaesthesia and Intensive Care
   Tom Peck, S. Hill, M. Williams

8. Fundamentals of Anaesthesia
   Colin Pinnock, Ted Lin, Tim Smith, Robert Jones