# ICU + ANAESTHESTICS

| ICU principle | Indications for ICU | ICU Additions | ICU complications → solutions |
|---|---|---|---|
| • Respiratory support<br>• Cardiovascular support<br>• Renal support<br>• Nutritional support<br>• Neurological support<br>• Dermatological support<br>• Liver support | Cannot be managed by ward !!<br>• **Threatened airway or hard to intubate**<br>• **Post-CPR**<br>• **Severe Sepsis**<br>• **Major trauma** (closely monitor vitals + neuro obs)<br>• **Post-op major surgery** (e.g. AAA repair)<br>• **Any Organ failure** →Ventilatory/ circulatory/renal support → dialysis? Ionotropes?<br>• **Bleeding/massive transfusion**<br>• **High analgesia/sedation** req. – risk of resp. depression<br>• **Complex co-morbidity w/ hi**gh likelihood of early post-op complication (e.g. poorly controlled OSA, PPH patient) | *Analgesia support:*<br><br>*Nutritional support:*<br>• **Mouth**<br>• **NGT**<br>• **(PEG) –** percutaneous endoscopic gastrostomy (tube from surface of abdomen to stomach)<br>• **TPN** via CVC→ thrombophlebitis risk so given via central line (NOT peripheral cannula) | **Acute**<br>• **Ventilator assoc. lung injury** (barotrauma, volutrauma) → short-term APO, hypoxia → long-term: fibrosis, recurrent infection, cor-pulmonale<br>• **Ventilator assoc. pneumonia** (25% complication) → position semi-fowler and head elevation<br>• **Catheter related blood infections** (e.g. from CVC) – 25% mortality →Rx with ABx or Ag impregnated catheters<br>• **Delirium** → AT4 assessment (to identify delirium) → Dexmedetomidine (sedate agitated pts) + Rx cause<br>**Chronic**<br>• **Catheter assoc. UTI**<br>• **Stress related mucosal ulcers** (e.g. erosion of upper GIT) → Rx: PPI and H2 antagonist<br>• **VTE** → calf compression +SC clexane<br>• **Critical illness myopathy** (due to corticosteroids or muscle relaxants) → difficult to wean off mech. Ventilation<br>• **Critical illness neuropathy** → optimize BSL control<br>• **Transfusion related reactions (**TRALI, sepsis, overload, coagulopathy) |

*Why is it difficult to mobilise after being ventilated?*

- Patient may have decompensated from the initial event and thus, organs and muscles need to take time to adapt to the new conditions
- Critical illness will also cause both myopathy and neuropathy particularly after paralysing agents have been used
- The **long-term immobility** = muscle atrophy as deconditioned when ill ➔ MOBILISE Early w/ PT ➔ reactivate muscles to restore power and endurance.
- If patient has a **tracheostomy tube** still in place, the reduced air intake means there is reduced ventilation due to reduced tidal volume. This will cause a low V/Q mismatch, thus causing organ hypoperfusion.

*What is the prognosis of patients who have gone through ICU?*

- **POOR** despite successful resuscitation and rehabilitation. Often there is some damage to organs during the entire process.
- +++ morbidity and mortality ➔ longer rehabilitation period ➔ lose their independence earlier relative to healthy age-matched controls.
- +++ f/u with different specialists and allied health professional to manage their condition and progress ➔ costs, logistics, time
- +++ new meds, which can lead to further financial burden and increase the risk of drug-drug interactions, non-compliance due to polypharmacy.

*Why is it important to ask about antibiotic usage during a sepsis crisis?*

- Antibiotics may confound the blood culture results, particularly if there is bacterial infective source
- Antibiotics may actually be asking the severity of the condition patient is in (false sense of security when managing patient)
- Be aware of possible anaphylactic allergic reactions to certain antibiotics

*What can be done when locating the source?*

- Strip patient from head to toe
- 2ND survey to determine key ports of entry (e.g. IDC, wound site, central lines, cannula sites) as well as areas of excoriations, lacerations, puncture wound

## ICU MORTALITY RISK CALCULATORS (APACHE-II and MPM)

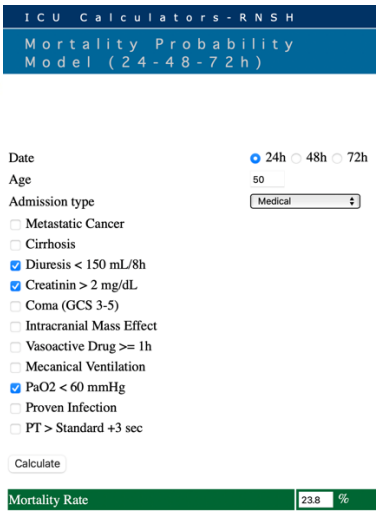
*What are the **2 main factors** consider during admission?*

1) **the potential to reverse the acute condition**
2) **the baseline physiological reserve (their baseline health).**
   *e.g.* patients with a 90% probability of dying w/ underlying terminal condition should be given palliative care approach rather than have invasive interventions

| Acute Physiology And Chronic Health Evaluation II (APACHE-II) | |
|---|---|
| | **Measurements** |
| Within 24 hours of admission to the ICU<br>*(The point score is calculated from a patient's age and these 12 routine physiological measurements)* | 1. AaDO2 or PaO2 (depending on FiO2)<br>2. Temperature (rectal)<br>3. Mean arterial pressure<br>4. pH arterial<br>5. Heart rate<br>6. Respiratory rate<br>7. Sodium (serum)<br>8. Potassium (serum)<br>9. Creatinine<br>10. Hematocrit<br>11. White blood cell count<br>12. Glasgow Coma Scale |
| **Interpretation:**<br>• Measurements are utilised in addition to information about previous health status (recent surgery, history of severe organ insufficiency, immunocompromised state).<br>• This generates a score between 0-71, higher scores correspond to higher severity of disease and higher likelihood of mortality. | |

Knaus WA, Draper EA, Wagner DP, Zimmerman JE (1985). "APACHE II: a severity of disease classification system". *Critical Care Medicine*. **13** (10): 818–29. doi: 10.1097/00003246-198510000-00009. PMID 3928249. (This is the first published description of the APACHE II scoring system)

Knaus WA, Zimmerman JE, Wagner DP, Draper EA, Lawrence DE (1981). "APACHE-acute physiology and chronic health evaluation: a physiologically based classification system". *Critical Care Medicine*. **9** (8): 591–7.



# FLUID Management; FLUID + ELECTROLYTES

***Assessing volume levels:***

Hypervolaemic
- XS fluid intake
- XS salt intake
- IVF

Euvolaemic

Hypovolaemic (Dehydrated)
- Vomit / diarrhoea
- Internal bleeding
- Burns
- DI

***Examination***

1. **Aids** = finished meal? Cups of water? IDC/drain output?

*Dehydration signs::*

1. **VITALS = hypoTN, Tachycardia, CRT >2s, tachypnoea**
2. Dry MM – stick tongue out
3. Sunken eyeballs
4. Cold peripheries
5. Low urine output
6. Low weight

*Fluid overload signs:*

1. Elevated JVP
2. Displaced apex beat (most sensitive for HF)
3. Pulm. Oedema (bibasal crackles, low sats)
4. Peripheral oedema, ascites
5. Weight gain

***Bedside Investigations***:
- Wt, BMI
- **BLADDER SCAN → ?IDC**
- Urine - ↑SG, urine osmolarity
- ECG – arrythmias?

***Blood Investigations***:
- FBC (↓Hb – anaemia)
- EUC / CMP
- Serum osmolarity
- LFT – check albumin
- BNP - HF

***Imaging Investigations***
- ECHO
- CXR

***Mx (conservative):***

| | ***Overload (WET)*** | ***Dry*** |
|---|---|---|
| ***Non-pharm*** | *1L fluid restrict*<br>*Na restricted diet* | *Hydrate* |
| ***Pharm*** | *20mg IV furosemide* | *IVF resus – crystalloid (0.9% NS or Hartman's)* |

**Practice note:**

**What is the best fluid? -amount/type always depends on patient's weight**

***What is 3rd spacing?*** *Low level of fluid in intravascular space but XS fluid in interstitial space → appear hypovolemic or fluid overloaded at same time*

**When to refer?**
- Cannot maintain adequate fluid balance
- Cannot maintain electrolytes

## Colloid

| | |
|---|---|
| **Vol. needed** | Vol for vol |
| **MoA** | • Molecules too large to cross capillary walls – fluid remain in intravascular space<br>• Long half-life (hrs-days) |

- **Greater increased effect on intravascular vol. (1.5:1)**
  - For sepsis (NOT for TBI)

| | **Natural** | **Synthetic** |
|---|---|---|
| **Example** | • Whole blood<br>• FFP<br>• pRBC<br>• Albumin | • Geleatins<br>• Dextrans<br>• Hydroxyethyl starch |
| **ECF** | **Increased (esp. intravascular vol.)** | |
| **ICF** | **NONE** | |
| **Use** | • Cirrhosis<br>• Critically ill – ARDS, burns, sepsis<br>• Bleed → blood | • Fluid resus<br>• Maintenance fluid<br>• Hypovolaemic hypoNa<br>• IV drug solvent |
| **A/E** | • Fluid overload → cardiac failure<br>• Allergic<br>• Expensive + may not be vegan | |

## Crystalloid

| | |
|---|---|
| **Vol. needed** | 3x vol needed |
| **MoA** | • Molecules small enough to cross capillary walls → less fluid in intravascular space<br>• Short half life (30-60 mins) |

| | **Hypotonic** | **Isotonic** | **Hypertonic** |
|---|---|---|---|
| **Example** | • 5% dextrose and 0.18% NS<br>• Hypotonic saline | • Normal saline (0.9%)<br>• Lactated ringer's soln (aka Hartmann's)<br>• plasmolyte | • 3% NaCl<br>• 5% NaCl |
| **ECF** | Increased | Increased | Increased |
| **ICF** | Increased | none | Decreased |
| **Ind. Use** | • Correct hyperNa<br>• Maintenance fluid<br>• IV drug solvent<br>• Children<br>• Hypoglyceamia or with insulin IV | • Fluid resus<br>• Maintenance fluid<br>• Hypovolaemic hypoNa<br>• IV drug solvent | hypoNa (severe) cerebral oedema |
| **A/E** | **FLUID OVERLOAD – cerebral, peripheral, pulmonary oedema**<br>• hypoNa, hypoK<br>• hyperglyceamia<br>• cerebral oedema<br><br>NO dextrose in:<br>• brain haemorrhage<br>• re-feeding syndrome | • **0.9% NS** = HYPERchloraemia acidosis<br>• **Ringer's/ Hartman** = ++ lactate in liver failure, hyper K<br>• **Plasmalyte → high HCO3** | Osmotic demyelination syndrome → cerebral oedema |

| | **Resus** | **Maintenance** | **Replacement fluids** |
|---|---|---|---|
| **Fluid** | 0.9% NS | Crystalloids (NS, dextrose) or colloids | Crystalloids → selected with similar electrolyte content to fluids that are lost |
| **Scenario** | Sepsis, hypoTN | PERI-OP & POST-OP<br>**NBM due to bowel obstruction** | POST-OP + VOMITING + DIARRHOEA |
| **Method** | **Rapid fluid bolus (within 10-30mins)**<br>• Adults NS or LR 500-1000mL IV bolus<br>• Children: NS or LR 10-20mL/kg IV bolus | NBM patients but do not have volume depletion, hypotension, or ongoing losses<br>• **Adults → 1-2mL/kg/hr**<br>• **Children (> 28 days) → 4:2:1 rule**<br>  ○ *4mL/kg/hr (1st 10 kg)*<br>  ○ *+2mL/kg/hr (2nd 10 kg)*<br>  ○ *+1mL/kg/hr (remaining)*<br>**Maintenance fluid requirement per kg of wt higher in children due to increased SA* | ***Replace lost body fluids and electrolytes***<br>**Hypovol. shock (N + D, burns, sepsis, fistula)** → • **Hartmann's BEST** as less $Cl^-$ to minimise risk of hyperchloremic acid (check lactate)<br>**Dehydration** (poor intake) → • **Dextrose-saline** (normal maintenance fluid)<br>• **If hypoTN** → bolus Hartman/saline<br>**Haemorrhage** → • **Colloid Transfusion** (4x pRBC + 2x FFP)<br>• **FFP/ platelets** (stop bleed)<br>• BUT need to find source |
| **Consider** | • **vasopressors** (e.g. metaraminol) → maintain BP and reduce peripheral fluid loss<br>• **Ionotropes** (e.g. dobutamine, levoseminardin)<br>• **Blood products** (FFP, packed RBC – group + X-match) | • **Patient's weight**<br>• Check EUC before prescribing<br>• **Give oral/NG-tube fluids whenever possible** → minimizes fluid overload | • **Pre-existing fluid loss** (STAT bolus – 500mL 0.9% saline/Hartmann's soln)<br>• **Measure Ongoing losses** (replace future losses – measure vomits, diarrhoea vs intake)<br>• **DO NOT** Give K at a rate > 10mM/hr or use maintenance protocols |

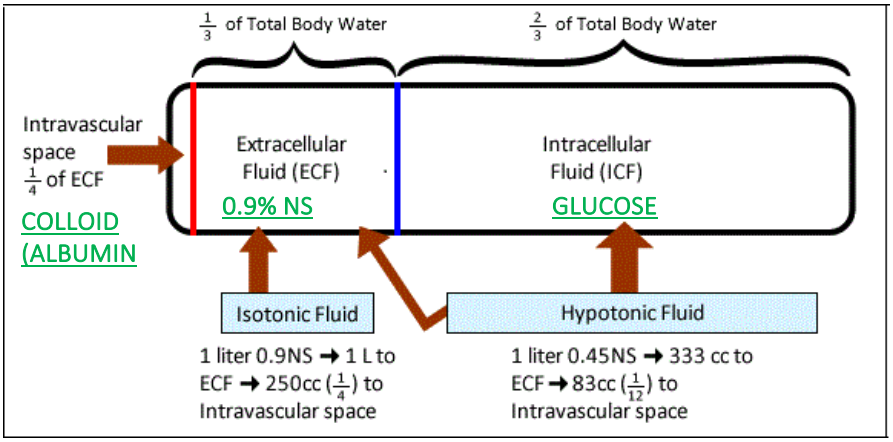
## *Special cases:*

| | | | |
|---|---|---|---|
| **Post-op** | **Cell lysis during surgery** → elevated K, | **AKI** | **No K**<br>**Low protein diet** (0.6g/kg/day) = ↓ hyperfiltration |
| **Sepsis** | **Hartman or 0.9% saline** → vasopressors + monitor? | **CKD** | **Avoid fluid overload** → monitor K → ?ECG |
| **HF** | Nb: **may normally be hypotensive** → low Na diet, furosemide, fluid restriction and record daily weights | **Alcoholic** | **Pabrinex BEFORE dextrose** (avoid Korsakoff)<br>➢ Replaced B1 (100mg thiamine) |
| **Liver failure** | **5% dextrose** – excess Na causes ascites | **Brain haemorrhage** | **Saline** (dextrose destroys brain) |

# Crystalloid Fluids

| Fluid | $Na^+$ mEq/L | $Cl^-$ mEq/L | $K^+$ mEq/L | $Ca^{2+}$ mEq/L | Glucose g/L | Buffer | Osmolarity mOsm/L | Tonicity | Typical Indication |
|---|---|---|---|---|---|---|---|---|---|
| Normal plasma | ~ 140 | ~ 100 | ~ 4 | ~ 2.4 | ~ 0.85 | $HCO_3^-$ ~ 24 mEq/L | ~ 290 | N/A | N/A |
| 0.9% saline (a.k.a. "normal saline" or NS) | 154 | 154 | 0 | 0 | 0 | 0 | 308 | "Isotonic" | Resuscitation |
| 0.45% saline (a.k.a. ½ NS) | 77 | 77 | 0 | 0 | 0 | 0 | 154 | Hypotonic | Maintenance |
| 3% saline | 513 | 513 | 0 | 0 | 0 | 0 | 1026 | Hypertonic | Severe Hyponatremia |
| D5 ½NS + 20 meq KCL | 77 | 97 | 20 | 0 | 50 | 0 | 446 | Hypertonic → Hypotonic | Maintenance |
| D5W | 0 | 0 | 0 | 0 | 50 | 0 | 252 | Hypotonic | Hypernatremia Hypoglycemia |
| Lactated Ringer's (LR) / Hartmann's solution* | 130 | 109 | 4 | 3 | 0 | Lactate 28 mEq/L | 273 | Isotonic | Resuscitation |

## 60% TOTAL BODY WT = TOTAL WATER




DOES NOT ENTER ICF

Table 2 Daily Electrolyte Requirements

| | DAILY REQUIREMENT | FOR 70-KG ADULT | FOR 10-KG CHILD |
|---|---|---|---|
| Sodium | 1-2 meq/kg | 70-140 meq/day | 10-20 meq/day |
| Potassium | 0.5-1.0 meq/kg | 35-70 meq/day | 5-10 meq/day |
| Calcium | 0.2-0.3 meq/kg | 1.4-2.1 meq/day | 2.0-3.0 meq/day |
| Magnesium | 0.35-0.45 meq/kg | 24.5-31.5 meq/day | 3.5-4.5 meq/day |
| Chloride | equal to sodium | equal to sodium | equal to sodium |
| Bicarbonate/Acetate | use with chloride to balance cations and help pH | use with chloride to balance cations and help pH | use with chloride to balance cations and help pH |

## Classification of Shock

| | Class I | Class II | Class III | Class IV |
|---|---|---|---|---|
| **Blood loss (mL)** | < 750 | 750-1500 | 1500-2000 | > 2000 |
| **Blood loss (%body vol)** | < 15% | 15-30% | 30-40% | > 40% |
| **HR** | < 100 | **> 100** | > 120 | > 140 |
| **BP** | Normal | Normal | **Decreased** | **Decreased** |
| **Pulse pressure** | **Normal/ Increased** | Decreased | Decreased | Decreased |
| **RR** | 14-20 | 20-30 | 30-40 | > 35 |
| **Urine output (mL/ hr)** | > 30 | 20-30 | 5-15 | Negligible |
| **CNS** | Slightly anxious | Mildly anxious | Anxious and confused | **Confused and lethargic** |
| **Fluid replacement** | Crystalloid | Crystalloid | **Crystalloid and Blood** | **Crystalloid and Blood** |
| **Base Excess** | 0 to -2 | -2 to -6 | -6 to -10 | < -10 |

## Calculating fluids:

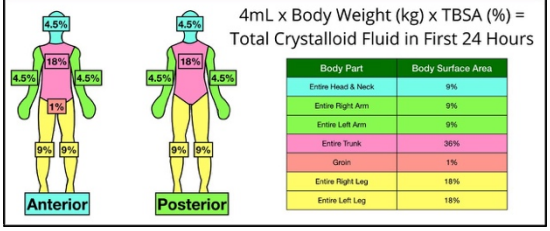
- 60% of total body weight is water
- 4:2:1 rule in children
- CHECK HcT (for haemodilution) due to XS fluid resuscitation

## PARKLAND FORMULA for burns

The volume required over 24 hours will be:

- **4 ml x % burn SA x body weight in kg**
- half this volume is given in **the first 8 hours**
- **Resus w/ NS or Hartmann's but consider colloids (albumin) if deep burns**

## Parkland Formula for Burns




## Daily Requirements: (for 70kg man)

- **Water** = 25-30 mL/kg/day (2L)
- **Glucose** ≈ 50/100g.day (50-100g)
- **Na, K and Cl = 1mM/kg/day** (70mM)

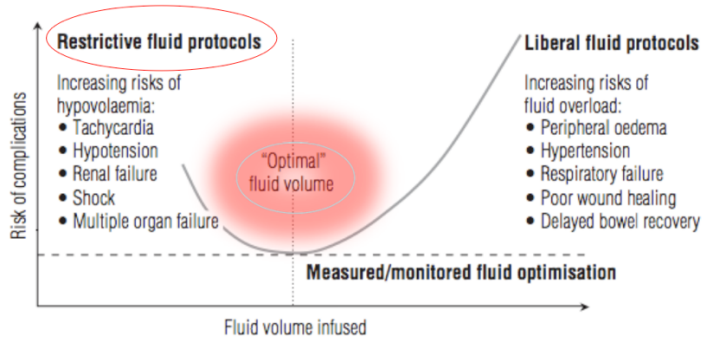
## Input vs Output:

- Daily weighing
- UO ≈ 0.5mL/kg/hr
- Oral intake / IVF / NGT
- Drains/ stoma / IDC

## High risk patients (need senior input)

- Elderly or frail patients
- Significant oedema
- Sodium imbalance (low or high Na)
- **Heart** failure
- **Renal** failure
- **Liver** failure

# FLUID Management (5 R's)




**Osmolarity**
- mOsm/L of a solution
- measures ALL of the particles per volume in the solution
- Normal serum = 280 – 300 mOsm/L
- **Sodium** is the biggest contributor **(Na x 2 + urea + glucose)**

**Tonicity**
- The particles in a solution that CANNOT cross a plasma membrane
- Depends on membrane properties
- **Effective osmotic pressure**

**Oncotic pressure**
- Osmotic pressure exerted by **proteins/colloids**

## Resuscitation

**What do I give?**

| | |
|---|---|
| **Crystalloids** | Saline vs Hartmann's (balanced) |
| **Colloids** | Starches ➔ AKI, coagulopathy, CHEST<br>Albumin ➔ SAFE except for TBI |

**How do I give?**

1. Have a repeatable outcome measure
   a. E.g. vitals
   b. Check ➔ Warm, Wet, With it or Wactate
2. Decide on safety stopping point
   a. Failure to response
   b. Insipient cough OR increasing O2 requirements
   c. PiCCO values
3. Give **500mL over < 15mins**
4. Evaluate response and repeat

**What could go wrong?**
- ➢ All sick patients have risk of APO
- ➢ Rapid infusion of crystalloids may damage glyocalyx

**Considerations**

**Increased fluids bolus**
- ➢ Increased atrial stretch → cause reduce HR and CO
- ➢ Increased CVP → counterintuitively reduces perfusion (despite Increased preload)
- ➢ Increased UO → may be due to ↑ANP and NOT eGFR

## Routine maintenance

- **1L of blood = 3L of non- blood fluids**
- **25 mls/kg/day ≈ 1 mL/kg/hr**
  - **Na/Cl/K ≈ 1mM/kg/day**
  - **Glucose 50-100g/day**
- Less is more elderly/CCF/CKD/malnourished
- Take into account OTHER sources of fluid and electrolytes
  - Oral intake
  - ABx
  - Sedation / vasopressors
  - Nutrition and TPN
  - Check Cl daily (if using NS) and watch for acidemia

## Replacement

**What has been lost**

Replace Like with like
- Insensible loss = water + small amounts of NaCl
- Gastric = low Na + Chloride rich (acid)
- Pancreatic = Na + $HCO_3$ rich
- Upper GI = similar to serum (Na, Cl, $HCO_3$ rich)
- Lower GI = K rich and Cl free

**How much is lost?**
- **Easy** = NGT, IDC, Ileostomy
- **Hard** = 3rd spacing (burns, ileus, peritonitis)

| | |
|---|---|
| **Mild (<5%)** | C/O thirst |
| **Mod (5-15%)** | Dry MM, skin turgor, mild tachycardia, reduced UO |
| **Severe (>15%)** | Altered mental state, hypoTN, |

**How much will continue to be lost?**

Clinical parameters
- ➢ 5, 10 and 15% assessments
- ➢ Daily weight
- ➢ Fluid balance charts

## Redistribution

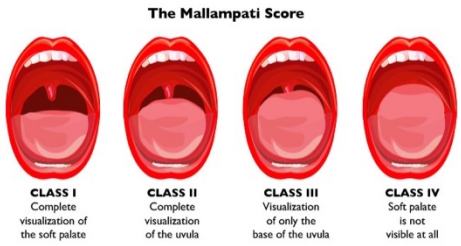
| | |
|---|---|
| **1ST spacing** | • Normal distribution within ECF and ICF |
| **2nd spacing (fluid we see)** | • Accumulation in interstitial compartment<br>• Available for xchange between compartments |
| **3rd spacing** | • **NOT** available for xchange between compartments<br>• e.g. ascites, oedema from burns/surgery |

## Reassessment

- Most important thing

# Pre/Intra-operative Assessment

**INITIAL AIRWAY ASSESSMENT**
1) Ability open mouth
2) Subluxation of jaw
3) Thyro-mental distance
4) Cervical motion and stability




| ASA class | Definition | Pooled mortality (%) |
|---|---|---|
| I | Healthy | 0–0.3 |
| II | Mild systemic disease with no functional limitation | 0.3–1.4 |
| III | Severe systemic disease with functional limitation | 1.8–5.4 |
| IV | Severe systemic disease – constant threat to life | 7.8–25.0 |
| V | Moribund patient – unlikely to survive 24 h with or without operation | 9.4–57.8 |
| E | Suffix added to denote emergency operation | |

## Key tips to consider before Hx and exam?

Do YOU HAVE THE *CORRECT PATIENT & Hx?*
1. *Who* is the pt? → age, wt
2. *What* surgery? *Why*? Done by reg or consultant?
3. *When* is surgery?
4. *Where* is surgery? (radiology, OR etc.)
5. ***How to reduce cost***?
6. ***Plan beyond skin incision*** *(are they going home/wards/ICU?)* → *need ionotropes*

| Risk | Surgery | Action |
|---|---|---|
| **Low (<1%)** | Breast + dental | No Ix |
| **High (1-5%)** | Vascular + thoracic (lung) | Ix to lower risk (reduce long-term health complications) |
| **ED (>5%)** | AAA, recent MI, decomp. HF, High grade arrythmia, valvular issue (AS, peritonitis, appendicitis) | ED surgery regardless of CVS risk |

## PMHx + PSHx + meds
and response to anaesthesia

1) **Post-Op comp** (sepsis, pain, anaesthetics)
2) **Cardiac Hx**
3) **Resp Hx**

| | Concern | Pre-Op Investigations | Solution |
|---|---|---|---|
| **Resp (airway + breathing)** | ➢ **Beards, jaw protrusion**<br>➢ **Acute** (E.g. PE, pneumothorax, pneumonia, infection)<br>➢ **Chronic** (OSA, ILD, COPD) | ➢ **Auscultate + O2 sats**<br>➢ **CXR** → check for HF, PPM<br>➢ **Spirometry + ABG**<br>➢ **OSA** checklist | ➢ **Cease smoking > 4 weeks**<br>➢ Post-op monitor→ beware breathless pt<br>➢ Immunosuppressed (steroids – COPD) |
| **CVS (IHD)** | AHA revised cardiac risk index<br>4) High risk surgery<br>5) Hx of ***IHD*** (ACS-MI, UA, decomp. HF)<br>6) Hx of ***HF + surgical*** Hx (stents, CABG)<br>7) Hx of ***CVD***<br>**8) IDDM**<br>9) **Renal impairment** (eGFR – CKD → fluid caution) | 1. **Bloods + products** ➔ Group + save (pRBC, FFP, cryoppt, plts)<br>a. FBC, EUC, - **anaemia (↑↑↑ post-op complication)**<br>b. COAG, B-HCG<br>**2. CXR, CTA/CTPA or V/Q scan**<br>3. ***ECG*** **(pre & post)** – ? AF, ischaemic damage (inverse T waves, path Q waves, BBB)<br>a. ***PERFORMED IN ALL > 65 TO pre-operatively***<br>4. ***TOE/TTE, stress tests*** → ONLY if Hx of valvular disease (MR) or heart failure (LVEF)<br>5. **Cardiopulmonary exercise testing** to check for reserve– CPET, stress ECHO | |
| **CVS (HTN)** | ++ peri-op morbidity | ➢ 24hr holter-monitor | ➢ Target MAP > 65,<br>➢ SBP > 80 (higher if older w/ PVD) |
| **Diabetes** | ➢ ++ infection risk<br>➢ Micro + macrovascular comp. | ➢ BSL, HbA1C,<br>➢ OGTT (new T2DM | ➢ Optimise BSL control (target 5-10mM)<br>➢ Avoid fasting + BSL fluctuations<br>➢ Make sure 1st on list |
| **Older age + Obesity** | ➢ High risk of desaturation rapidly | ➢ STOP BANG score for OSA cause– *snore, tried, observed, BP, BMI, age > 50, neck cir. > 40cm, gender - male* | ➢ Minimise post-op comp<br>➢ Lose weight |

## Capacity and function

1) **Previous surgeries** and response to anaesthesia
2) **Memory to take meds**
3) **SOCIAL support**
4) **Logistics** (getting to hospital)

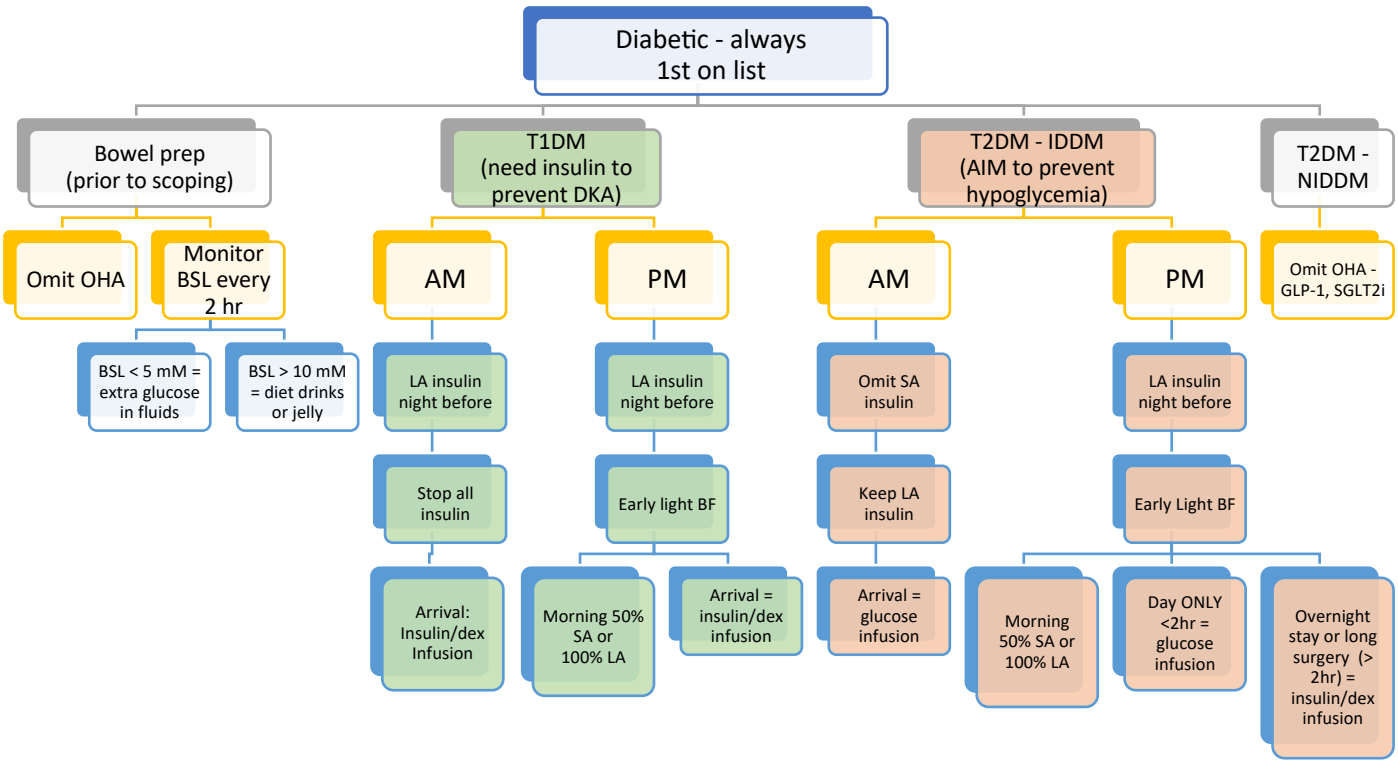
| | | | |
|---|---|---|---|
| **PMHx** | **Response to anaesthetics** | ➢ **Previous response**<br>➢ **Allergies to** ➔ propafol (soy, egg), Opioids,<br>➢ **Check FHx** – malignant hyperthermia | ***Previous surgeries***<br>➢ Difficult airways<br>➢ Stents ,<br>➢ CABG<br>➢ Jt replacements<br>➢ Abdo surgery |
| | **Medication allergies** | ➢ ***Antibiotics***: penicillin, vancomycin,<br>➢ ***Heparin/Protamine***: HIT<br>➢ ***Iodine & chlorhexidine*** | |
| **Exercise tolerance** | *MET – Metabolic equivalent – what can they do?*<br>➢ 1 MET – *eating, sitting, bath, shower and dress*<br>➢ 4 METs – *walk up flight of stairs*<br>➢ 10 METs – *strenuous exercise* | | **Improve METs – condition/train**<br>➢ Walk unaided?<br>➢ 6-metre walk |
| **Function / mood** | ➢ Frailty score: Rockwood or Fried scale<br>➢ **NSQIP risk index** (surgical risk calc → age, organ fn, chronic illness, poor nutrition, cognitive dyfn, male)<br>➢ **Nottingham hip # score →** quicker to theatre = ↓mortality<br>➢ **Depression = longer hospital stay** | | **Functional aids**<br>➢ Sensory/hearing aids (glasses , hearing aid)<br>➢ Dentures<br>➢ Walking stick, wheelchair |
| **Alcohol** | Organ damage → hepatic encephalopathy, pancreatitis | | Avoid withdrawal + delirium |
| **Smoking** | +++ risk of IHD, PVD, HTN →<br>➢ Atherosclerosis, ↓ tissue perfusion<br>➢ ↓wound healing<br>➢ Carcinogenic<br>➢ Lung disease (Bronchiectasis, COPD) → ↓ciliary motion & sputum clearance | | **Cease smoking > 4 weeks**<br>1) Improve tissue perfusion (days)<br>2) ↑ wound healing<br>3) ↑ pulm. Function<br>4) ↑ immune system |

## Meds

*Allowable meds:*
- **Anti-depress** (watch for uncontrol HTN)
- **Analgesics**
- **PD drugs** (levodopa)
- **Anti-anxiety** (watch for ↑SNS activity or O2 demand)
- **BB, CaB**
- **Insulin**

| | Drug | Stopped? | Reason? |
|---|---|---|---|
| **Antiplatelets** (Stents) | Aspirin (COX 1/2 inhibitor) | 5-7 days (only if high risk) | **Stratify stroke risk (CHADS-VASC)**<br>➢ **Low risk** (<5%) = no bridging needed<br>➢ **Mod risk (5-10%)** = stop warfarin 5 days before + start clexane (Stop day before surgery)<br>➢ **DOAC –** no bridging needed |
| | Clopidogrel -Plavix (P2Y12 inhibitor) | 5-7 days | |
| | Ticagrelor (P2Y12 inhibitor) | 5-7 days | |
| **Anti-coagulants** (AF, tissue valve, DVT) | **Warfarin** → **Beware INR > 3.5 + warfarin = spinal haematoma** | ≈ 5 days [**Vit K, prothrombinex**] → restart 12-24 hours after surgery | |
| | **Dagabitran (anti-thrombin - IIa )** | 1 day [**idaraucuzimab**] | |
| | **Clexane (LMWH)** | 3 days before + post-op LMWH for 3 days | |
| | **DOACS = -xabans (Xa inhibitor)** | ≥3 days [**Praxibind**] + post-op LMWH for 3 days -- may not need if low risk surgery (e.g. cataracts) | |
| **Anti-hypertensives** | **ACEi/ARB** | 1 day | HypoTN |
| | **Diuretics** | 1 day | HypoK + ↓BP |
| **Oral Hypoglycaemics** | **Metformin** | 1 day | Lactic acidosis + AKI |
| | **GLP-1** | 1 day (only if bowel prep) | GI disturbance |
| | **SGLT2i** | 3-4 days (1 day if day-only procedure with no bowel prep) | Euglycaemic Ketoacidosis (monitor ketones pre and post-op) |
| **Natural therapies** | **Ginger, gingko, garlic, ginseng + fish oil** | Few days | ++ bleeding risk |
| **NSAID** | **Ibuprofen** | Days before | PUD |
| **Other** | **OCP** | 4 weeks before major surgery | |

# Peri-operative Mx of the Diabetic Patient




***Make plan with endocrinology and anaesthetics**

***Check ketones before and after (is it starvation ketosis, DKA or euglycemic ketoacidosis)**

## Key learning points

- BSL < 3mM ➔ IV 50% dex bolus
- BSL < 6mM ➔ IV insulin + 5% dex
- BSL 18-20mM (after intermediate insulin) ➔ WAIT before giving actrapid to avoid hypoglycaemia
- Check ABG + ketones >1.5mM for SGLT2i (pre and post-op)
    - Can omit SGLT2i for one day (if day ONLY procedure + no bowel prep)
- Sliding scale insulin
    - BSL check qid
    - ½ U per BSL → titrate accordingly
- Steroid usage  used may need to give insulin after 4-5 hrs later
- Pre=operatively
    - CHO loading and increase cardiorespiratory fitness

## Intern should Plan for ERAS

- Shortened fast (2hr prior to surgery OK)
- EARLY mobility (PT)
- Fluid Mx
- ABx follow-up
- Early removal of lines
- Wean analgesia
- Nutrition step-down (**NBM → TPN → clear fluid → low residue → light diet → full**)
    - TPN (via CVC) -> given if high catabolic state (e.g. sepsis) with no gut function
- Early Transfer home, aged care, rehab?

### Diabetic patients in ICU issues:

- Poor glycaemic control (hyper/hypoglycaemia)
- **Use IV insulin-dextrose keep patients 6-10mM:**
    - *minimise tight BSL control*
    - *Avoid intermittent SC insulin bolus or oral hypoglycaemics*
- Increased sepsis risk
- Poor wound healing
- High risk of AKI (esp. if existing renal impairment)
- Lactic acidosis
- DKA (esp. T1DM)
- Hyperosmotic -non-ketotic state (T2DM)

# Principles of Surgery

## *Ambroise Pare's principle of surgery*

"eliminate the superfluous, restore the dislocated, separate things that have united and join what has been divided and repair defects in nature"

## *Natural process of healing and inflammation:*

| ***Skin*** | ***Ulcer*** | ***Sinus*** | ***Fistula*** | ***Abscess / cyst*** | ***Cyst and abscess drainage Hypergranulation (proud flesh)*** | ***Keloid scar*** |
|---|---|---|---|---|---|---|
|  |  |  |  |  |   | *Along langer's lines (XS healing)* *Repairs in 2 years* |
| ***Incision*** | ***Join / fistula*** | ***Overhealing stenosis*** | ➢ ***False aneurysm*** ➢ ***Perforation/ leak*** ➢ ***Heamorrhage*** | | *Types of healing:* 1. *Healing by primary intention = primitive intension closed by sutures* 2. *Healing by secondary intention = wound left open to heal by granulation contraction* | |
|  |  |  |  | | | |

| Stage | Process | Duration | Can it be repaired? |
|---|---|---|---|
| **Haemostasis** | ➢ Prevent / stop bleed → plt + cytokines → vasoconstrict<br>1) Primary haem = during surgery<br>2) Secondary haem = post-surgery | 1-3 hours/day | ➢ Within "2 weeks" of surgery, anything can be repaired<br>➢ Once > 2 weeks – proliferation phase begins (highly fragile state) and anatomy changes |
| **Inflammation** | ➢ Activated immune system to remove pathogen and necrotic tissue | 3-20 days | |
| **Proliferation** | ➢ Healthy tissue regrows (ECM + collagen = granulation)<br>➢ Angiogenesis | 1-6 weeks | |
| **Remodelling** | ➢ Granulation tissue matures into scar tissue (improved tensile strength) | 6 weeks to 2 years | |

## *What factors affect surgery success – Dimension of surgery?*

- **Time** → *HIPR*
- **Age** → older age = more fragile, longer wound healing and cut eailiy
- **Nutrition**→ when was last proper meal, concern for surgery if BMI < 18 (ANOREXIA)
- **Chemo**
- **Redo** → within 2 weeks
- **RT** → esp. pelvic surgery → cervicitis, proctitis
- **Tissue handling** → gentle vs rough

| Wound Classification | Definition | Examples | Surgical Site Infection Risk |
|---|---|---|---|
| Clean | Sterile procedure with no entrance into the GI tract, GU tract, or respiratory tract | Hernia repair, mastectomy, thyroidectomy, AAA repair | 1%-3% |
| Clean-contaminated | Procedure with only minor breaks in sterility with controlled entry into the GI tract, GU tract, or respiratory tract with no significant contamination | Cholecystectomy, appendectomy, small bowel resection, colon resection | 5%-8% |
| Contaminated | Procedure with poor sterility secondary to gross spillage from GI tract, GU tract, or respiratory tract or presence of foreign debris | Cholecystectomy with bile spillage, appendectomy for perforated appendicitis, small bowel or colon resection in setting of perforation | 20%-25% |
| Dirty/Infected | Procedure involving contamination by established infectious processes | Abscess drainage, debridement of necrotizing soft tissue infections | 30%-40% |

## *What are the surgical "rules of thumb"*

- Mishap
- Attend
- Causation
- Next operation

## *What are some important surgical considerations?*

- **Langer's lines = lines of skin tension** (topological lines) to minimise skin tension across wounds + more aesthetically pleasing
  1) *"discovered when Langer punctured numerous circular holes and noticed there were actually ellipsoid in shape"*
- ***Enhanced recovery after surgery (ERAS) Program***
  1) *Early mobilisation to reduce muscle breakdown, and improve muscle function*
  2) *Early oral feeding POST-OP – avoid long periods of fasting*
  3) *Minimise time on paralytic or ventilation*

## *How can we categorise the types of surgeries*

| Emergency | Elective | Semi-elective |
|---|---|---|
| ➢ **E1 – (1 hr)** – LSCS ED – cord prolapse, severe burn, ACS, shock | ➢ **CAT 1 (urgent – within 30 days**) – heart valve replacement, limb amputation | ➢ Breast augmentation |
| ➢ **E4 – (4 hr)** – testicular torsion, threatened limb | ➢ **CAT 2 (semi-urgent – within 3 months)** – hip replacement, prostate removal, nerve decompression | ➢ Removal of benign tumour |
| ➢ **E8 – (8 hrs**) – appendicitis | ➢ **CAT 3 (Non-urgent – within 1 year)** – carpal tunnel release, grommets, varicose vein removal, tonsillectomy, endometriosis | |
| ➢ **E24 – (24 hrs)** – abscess | | |

# COMMON ANAESTHESIA PROCEDURES

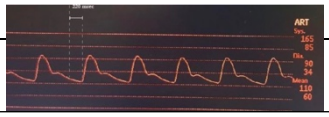
**ECG - Check for arrhythmias**
- ***Rhythm*** *– AF (most common), SVT*
- **Tachycardia –** *pain, drugs, inadequate anaesthesia*

**Pulse oximeter = O2 SATS AND pulse detected!!**
- Early warning of atelectasis, low perfusion

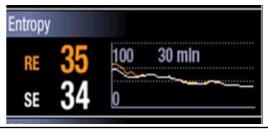
**Capnography** = *FROM GAS SAMPLER LINE*
- **gold standard to determine patent airway**
- **Check for bronchospasm**

**NIBP ➔ Check for hypoTN causes**
- **Hypovol?, - fasting, blood loss**
- **XS anaesthesia,**
- **Rx: fluid bolus, vasoconstrictors**

**Oyxgen analyser -** *FROM GAS SAMPLER LINE*
- Detects failure to supply O2



**Arterial line "Art-line"**
- Continuous monitoring – manage unstable patient
- Easy intra-op blood sampling




**Entropy (processed EEG + EMG)**
- **RE-** response entropy (EMG)
- **SE –** state entropy (EEG)
- Awareness monitoring
- **Depth of anaesthesia**


**Cerebral Oximetry**
- Maintain pt 10-20% of baseline or flat
- **Improve cerebral blood flow** by → raise BP, raise CO2, reduce head-up

## *AIRWAY MANAGEMENT:*

| | Procedure | Indications |
|---|---|---|
| ***Endotracheal tube (ETT)*** | • flexible plastic tube with an inflatable cuff (balloon) at one end and a connector at the other<br>• different sizes (diameter in mm)<br>• syringe inflate the cuff via the ***pilot line***<br>• ***Murphy's eye*** provides an extra hole on the side of the tip that gas can flow through in the event that the main opening at the tip of the ETT becomes occluded (blocked) | Assistive devices:<br>• ***McGrath laryngoscope*** (camera +screen attached – live feed to visualise vocal cords)<br>• ***bougie*** used (when vocal cords cannot be visualised) - ETT slides along the bougie into the correct position in the airway and remains there when bougie removed<br>• ***stylet*** - stiff metal wire (with a plastic coating) to bend tip of ETT ***anteriorly*** towards the ***trachea*** (to avoid going posteriorly into oesophagus |
| ***Awake fibre-optic intubation*** | • ETT inserted while patient conscious under guidance of endsocpe | • **restricted mouth opening or difficult anatomy** (e.g., after RT to the neck (since Putting patient to sleep prior to inserting ETT has +++ risk of hypoxia)<br>• ***Trismus*** – makes intubation more difficult |
| **Supraglottic Airway Devices** | • tip of the SAD located at the top of oesophagus<br>• SADs with inflatable cuffs are called ***laryngeal mask airways*** (***LMA***).<br>• ***I-gel*** is a type of non-inflatable SAD that uses a gel-like cuff that moulds to the larynx | • alternative to endotracheal intubation for ventilation<br>• first option if intubation fails in a difficult airway scenario |
| ***Nasopharyngeal* airways** | • measured from the edge of the ***nostril*** to the ***tragus*** of the ear. | emergency scenarios, for example, in A&E or at cardiac arrests<br>CI: ***base of skull fracture*** |
| ***Oropharyngeal (Guedel)*** | • centre of the mouth to the angle of the jaw | ventilating the patient via a face mask and bag prior to inserting an SAD or ETT |
| **Tracheostomy** | • Performed under GA or in an emergency<br>• **hole is made in the front of the neck with direct access to the trachea.**<br>• Tube attached via "**trach-tie"**<br>• Tube may be temporary or permanent<br>  ○ often inserted at the end of head and neck operations, for example, after a ***laryngectomy*** procedure (where a permanent tracheostomy will be required | • **Respiratory failure where long-term ventilation may be required** (e.g., after an acquired brain injury)<br>• **Prolonged weaning from mechanical ventilation** (e.g., ICU patients that are weak after critical illness)<br>• **Upper airway obstruction** (e.g., by a tumour or head and neck surgery)<br>• **Management of respiratory secretions** (e.g., in patients with paralysis)<br>• **Reducing the risk of aspiration** (e.g., in patients with an unsafe swallow or absent cough reflex) |

## Difficult airway categorisation

1. **Plan A** – ***laryngoscopy*** with ***tracheal intubation***
2. **Plan B** – ***supraglottic airway device***
3. **Plan C** – ***face mask ventilation*** and wake the patient up
4. **Plan D** – ***cricothyroidotomy***

## ANZCA PS18 – Equipment MUSTS

1. **O2 analyser**
2. **Pulse oximeter**
3. **Ventilator alarm**
4. **Co2 monitor**
5. **Inhalational anaesthetic agent monitor**

## *CIRCULATORY MANAGEMENT:*

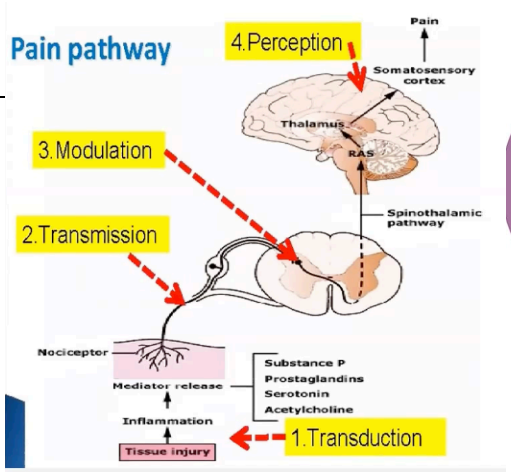
| | Procedure | Indications |
|---|---|---|
| **Arterial Line** | • Cannula inserted into an ***artery*** (e.g., the ***radial artery***).<br>• **Cannot give medications** | • MONITOR BP in real-time<br>• Easy ABG |
| **Central Line** (CVC) | • long thin tube inserted into large vein (e.g. IJV, Subclavian or femoral) with tip in SVC<br>*beware of **coagulase negative staphylococci (epidermis)** | • Give meds - ***inotropes***, ***amiodarone*** or fluids with a ***high K+ concentration (all usually quite irritating if given via PIVC)***<br>• Take bloods |
| **Vas Cath** (CVC) | • Temporary long thin tube inserted into large vein (e.g. IJV or femoral) with tip in SVC | • short-term ***haemodialysis*** (in renal failure). |
| **PICC Line** (CVC) | • long, thin tube is inserted into a ***peripheral vein up to SVC or RA*** | • useful as medium-term IV access – lower infection risk |
| **Tunnelled Central Venous Catheter** (Hickman) | • long, thin catheter that enters the skin on the chest, travels through the ***subcutaneous tissue*** ("***tunnelled***"), then enters into the ***subclavian*** or ***jugular vein***, with a tip that sits in the ***superior vena cava***. | • ***cuff*** (sleeve) that surrounds the catheter near the skin insertion → promote adhesion to tissue = MORE PERMANENT<br>• regular IV treatment (e.g., chemotherapy or haemodialysis). |
| **Portacath** (CVC) | • small chamber (***port***) under the skin at the top of the chest that is used to access the device<br>• ***subclavian vein***, with a tip that sits in **SVC or RA** | • fully internalised under the skin, reducing the chance of infection<br>• long-term for regular IV treatment (e.g., chemotherapy). |
| **Pulmonary Artery Catheter** (***Swan-Ganz catheters***) | • catheter is inserted into the internal jugular vein and ending at pulmonary artery | • ***Measure pulmonary artery wedge pressure (Indication of LA pressures)*** |

*Nb: **coagulase negative staphylococci** (such as Staphyloccus epidermidis) = **most common blood** isolates that cause central line infections

# POST-OP PAIN MANAGEMENT

**Statements to remember:**

1) *"Pain is subjective sensory and emotional experience assoc. w/ actual or potential skin damage"* **IASP 2020**
2) **Poorly treated post-op pain** is assoc. w/ increased hospital stay, delayed amputation and long-term functional impairment (**Pain leads to disabilit**y)
3) It is **NOT** the individual drug or therapeutic modality alone, but the combination and application that makes them effective (**NO panacea**)
4) Pain is **ALWAYS an OUTPUT** of the brain (even if nociceptors are not firing)
5) Rising use of opioids due to over-prescription and substance abuse

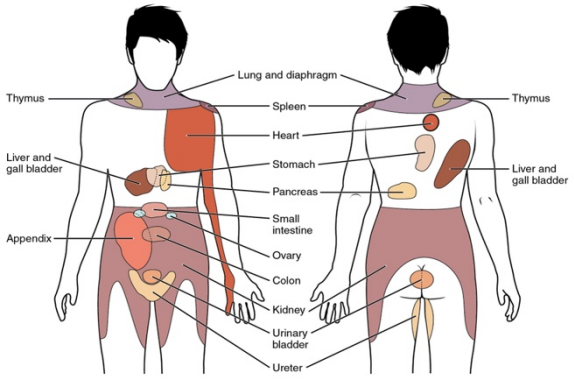


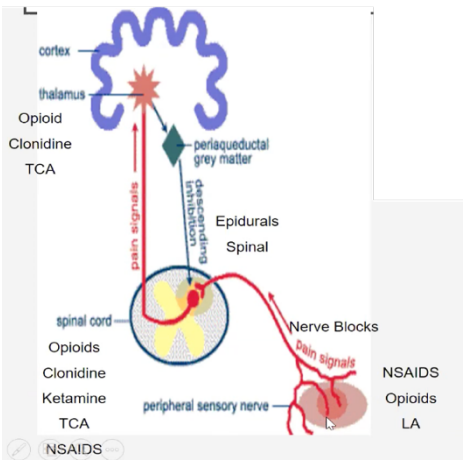


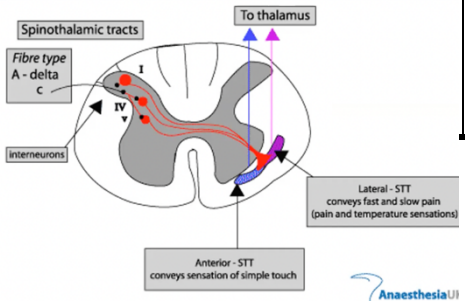
| Process | Level | MoA | Pathology |
|---|---|---|---|
| **1) Transduction** | **Peripheral** | • Nociceptors (free nerve endings) → when damaged → release of PG, serotonin → inflammation | • Allodynia = pain from non-noxious stimuli<br>• 1° Hyperalgesia = increased pain sensitivity in directly **damaged** tissue |
| **2) Transmission** | **Peripheral** | • Transmitted by fast a-delta fibres (large), slow c-fibres (thin)<br>• Peripheral signal amplified | |
| **3) Modulation (Gate theory)** | **Central** (*spinal cord*) | • Descending pathways (impulses from brain to SC via CST) to inhibit ascending neuron<br>○ **Rostral ventral medulla** →PAG<br>○ **PAG** – release encephalins<br>○ **Nucleus raphe Magnus** – release serotonin | • 2° Hyperalgesia = increased pain sensitivity in surrounding **undamaged** tissues<br>**Open** / **Close**: Physical: Injury extent / Medication, counter-stimulation; Emotional: Anxiety, worry, tension / Relax, + rest; Mental: Pain focus, boredom / Working, distracted |
| **4) Perception** | **Central** (*brain*) | *Regulated by 2 main pathways + 1 intergative site:*<br>○ **Discriminatory pathway** (thalamus + parietal lobe)<br>○ **Mesolimbic (Affective pathway)** = AMYGDALA<br>○ **Sensory integration** – prefrontal lobe (motivates behavioural change) | ○ Neural plasticity + rewiring → changes perception of pain<br>○ Damaged inhibitory pathways → new neurons become excitatory (amplify pain) ➔ allodynia, hyperalgesia |

| | Acute pain | Chronic pain = complex regional pain syndrome (CRPS) |
|---|---|---|
| **Cause** | New onset pain (within 3 weeks)<br>• Injury<br>• Infection<br>• surgery/trauma | • Pain persisting beyond expected time of healing (**usu > 3 mths or 12 weeks**)<br>○ Chronic **primary pain** = no underlying condition can explain pain<br>▪ IBS, fibromyalgia,<br>○ Chronic **secondary pain** = underlying condition to explain pain<br>▪ Cancer, neuropathi, migraine, endometriosis, chronic pancreatitis, post-surgical, RA |
| **Assoc.** | • **Withdrawal reflex** (mainly nociceptive)<br>• NOT pathophysiological | • **Neuropathic + Pathophysiological**<br>• **Assoc. w/:**<br>○ **Limbic issues** (*depression, anxiety, PTSD, borderline personality, developmental issues*)<br>○ **Advanced age , females, low SES, poor lifestyle**<br>○ *Post-op* |
| **H+E** | ○ ***SOCRATES*** = *Duration + **time of day** (?↑ICP) + location*<br>○ ***Allodynia*** = *pain from sensory inputs not typically causing pain*<br>○ ***Pain scale***<br>○ (***visual analogue*** *0-10 or faces pain scale*<br>○ *Numerical rating scale (0-10))*<br>○ ***Abbey Pain scale*** = *non-verbal/dementia pts*<br>○ ***McGill Pain Questionnaire*** = *Pain clinic*<br>○ ***Mental health screen*** - *?suicidal*<br>○ ***Red flags***<br>○ *Recent traumatic injury (crush fracture_*<br>○ *cancer (active vs Rx) - UWL, NS, fever, chills*<br>○ *immunocompromised (steroid, transplant IVDU)*<br>○ *nocturnal pain/sweats*<br>○ *urinary/faecal incontinence (?cauda equina)*<br>○ *new onset weakness* | ***Check current meds (what's worked, what hasn't)***<br>• *Any tolerance + A/E*<br>• *Prescription habits – non-compliance, multiple Docs, private doctor scripts*<br>• *Shx: work stress, home environ, financial situation*<br><br>***Exams (look, feel, move) - any inconsistencies between hx and clinical features?***<br>1. *Well-dressed? Eccentric? Sad? Happy?*<br>2. *Antalgic gait →Muscle wasting (disuse)*<br>3. *Rash / Bruises / inflammation*<br>4. *Pain on movement →ROM – reductions*<br>5. *Sensation = brush or deep allodynia, numbness, altered cold/heat*<br>6. *Psychosocial (beliefs, coping strategies) →DASS 21* |

| | Nociceptive Pain | | Neuropathic Pain |
|---|---|---|---|
| | **Somatic** | **Visceral** | |
| **Location** | Localised | Generalised | Radiating or specific |
| **Character** | Pinprick, stabbing, sharp | Ache, pressure, dull | Burning, prickling, electric shock like |
| **MoA** | **A-delta + periphery** (myelinated large diameter) | **C-fibre + deep innervation** (unmyelinated small diameter) | ➢ **Dermatomal** (periphery)<br>➢ **Non-dermatomal** (central) |
| **Onset** | **Fast** | **Slow** | **Fast** |
| **E.g.** | • Periosteum, joints<br>• Sickle cell<br>• Superficial laceration, burns, trauma<br>• Otitis media<br>• Stomatitis | • **Colic spasm pain** (nausea + sweating)<br>• **Appendicitis** (anorexia)<br>• **Renal colic** (extreme)<br>• **Chronic pancreatitis**<br>• **IBS**<br>• **Angina**<br>• **Periods**<br>• **Burning** (sciatica, nerve compression) | • ***Crushing / compressing*** (Trigeminal, avulsion, post-traumatic neuralgia)<br>• ***Toxins***: Peripheral neuropathy (HIV, diabetes, alcohol, chemo)<br>• ***Limb amputation*** – phantom limb pain – cortical remodelling<br>• ***Infection***: Herpetic Neuralgia |
| **Rx** | • Panadol<br>• NSAID<br>• Opioids | • Panadol<br>• NSAID<br>• Opioids | Try each one by itself:<br>• ***Amitriptyline*** (TCA)<br>• ***Duloxetine*** – an SNRI<br>• ***Gabapentin*** ( anticonvulsant)<br>• ***Pregabalin*** – ( anticonvulsant)<br>***Alternative:***<br>➢ *Physiotherapy to maintain strength*<br>➢ *Tramadol (rescue therapy)*<br>➢ *Capsaicin = localised pain* |



# COMMON PAIN MEDS (WHO LADDER)

| | MoA | Indication | Contraindications | Adverse Effect |
|---|---|---|---|---|
| **Paracetamol** (*acetaminophen*) | • Unknown<br>• Analgesic & anti-pyretic<br>• Given PO or IV ( 5% glucose + 0.9% NS) | • **Mild-mod acute pain**<br>• *Reduce dose in elderly or pts < 60kg* | **Reduce dose in elderly, small or hepatic involvement** | **+++BSL** (esp. if IV)<br>**OD = Hepatotoxicity** (15mg/kg/dose qid) |
| **NSAIDs** | • **COX1/2 inhibition = inhibit PG production=** Analgesic & anti-pyretic & anti-inflammatory<br>• **COX1/2 inhibition** = *Ibuprofen, Diclofenac (Voltaren)*<br>• ***COX-2 inhibitor*** = *Parecoxib, celecoxib (minimise Gi ulcer but greater VTE risks)* | • **Mild-mod acute pain**<br>• **Migraine**<br>• Parecoxib = rental stones/ fractures<br>**Mg as co-analgesia** | ➢ **Asthma**<br>➢ **Renal impairment** (eGFR < 30)<br>➢ **Deranged LFT**<br>➢ Anuria<br>➢ Uncontrolled HTN<br>➢ **PUD/ GIB** | ➢ **Gastritis** → PPI w/ meals<br>➢ **Stomach ulcers**<br>➢ **Asthma exacerbation**<br>➢ **Renal impairment**<br>➢ **HTN, CAD** |
| **Opiates vs Opioids**<br>➢ **Opiates** = natural (morphine)<br>➢ **Opioids** = synthetic (fentanyl, oxycodone)<br>➢ **PO** (SA vs LA)<br>➢ **IV** (*Bolus in PACU* **OR** PCA in ward) | **Activate μ-opioid receptor**<br>***Short-acting*** / ***Intermediate acting*** / ***Long- Acting (start 1st)***<br>***Tramadol*** *(Opioid + SNRI) PO or IV* / ***Oxycodone*** *(endone)* / ***Targin*** *(Opioid + naloxone)*<br>***Hydromorphine*** *"Jurnista" 1/6TH of total 24 hr bg dose (RESCUE DOSE)* / ***Morphine*** *(ordine = soln)* / ***MS contin***<br>***Palexia*** *(stronger than tramadol)* / ***Tapentadol*** *(opioid + SSRI) (Palexia SR)*<br>***Buprenorphine*** *(partial opioid)* / *Sl or patch*<br>**Potency levels:**<br>Fentanyl > oxycod > morphine > codeine > tramadol<br>*NB: naloxone can cause pain exacerbation and agitation* | | | |

| | Dose | Indications | CI |
|---|---|---|---|
| **Codeine PO** | Panamax co<br>Panadiene Forte 500/30 (30-60mg every 4-6 hrs)<br>**Add prophylactic anti-emetics for nausea** | Pregnancy | **Constipation = SBO/LBO** (10% poor metabolisers)<br>**Hepatic failure** (prodrug)<br>**Drowsy, confused, miosis, myoclonus, dry mouth**<br>**Sedation, resp. depression** |
| **Oxycod.** | 2.5-15mg PO Q4h PRN | Breakthrough | ➢ Calculate Cr clearance<br>➢ CrCl < 1 (use ½ estimated dose)<br>Beware in:<br>➢ Elderly<br>➢ Deranged LFT<br>➢ MAOi |
| **Ordine (morph soln)** | 5-20mg PO q4h | Cannot swallow, SOB or mucositis | |
| **Targin** | PO 5/2.5 – 80/40mg BD | Regular pain | |
| **Tapentadol IR (palexia)** | PO 5-100mg 4-6h (max 600mg) | Unable to tolerate endone | |
| **Morphine** | 2.5/5/10mg QID – q1h<br>Peak at 1-2hrs | Palliative or NBM<br>Severe pain | Senior advice |
| **Buprenoph** | Patch 5-40mcg/hr every 7 days | Moderate pain ONLY | Ensure patch removed |
| **Fentanyl** | Intranasal | CKD + palliative | |

| | | | | |
|---|---|---|---|---|
| **Triptan** | • Serotonin (5-HT) receptor agonists<br>• *Sumatriptan (oral 30%, 60% injectable)* | Migraine ONLY | MOH | MOH |
| **TCAs & SNRI** | • Inhibit NA and 5-HT re-uptake → inhibits nociception<br>• **TCA**: *amitriptyline, notryptyline*<br>• **SNRI:** *duloxetine, venlafaxine* | • Used mainly for mood disorders<br>• **Neuropathic pain**<br>• **Chronic primary pain** | *SSRI are ineffective*<br>***Serotonin syndrome*** | • **TCA**: anti-SLUDGE<br>• **SNRI**: fatigue, constipation, insomnia, anorexia |
| **Gabapentin & Pregabalin** | *Neuropathic agents*<br>• **Inhibit voltage gated Ca channel** → reduce neurotransmitter release | • Post-herpetic neuralgia<br>• Diabetic neuropathy<br>• **Neuropathic pain**<br>• **MSK fracture pain** | NOT for central neuropathic pain or HIV associated neuropathy | • **Sedation**<br>• **Ataxia** |
| **Carbamazepine** | • **Inhibit voltage gated Na channel** → reduce neuronal excitability | • **Mostly for trigeminal neuralgia** (unproven) | pregnancy, bone marrow failure | |
| **Ketamine** | • NMDA receptors antagonist<br>• Anaesthesia without resp. depression | • ED – trauma pt and sedation<br>• Peri-op to reduce post-op pain (e.g. **MSK fracture pain)** | | • Dissociation<br>• Polyuria, freq, urgency (cystitis mimic) |
| **Lidocaine** | • Na channel blocker | • Renal colic<br>• Local, epidurals | | |

**NB: good pain management involves lifestyle changes and MDT** (*pain specialists, physios, GPs, social workers psychologists*)**!! NOT just meds**

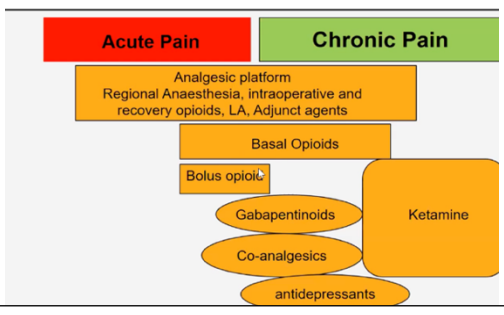
- **CONTACT APS and PALL Care if unsure about baseline and breakthrough doses (ALSO time limit endone whene giving script)**
- **Give Mg as co-analgesia to NSAID and PCT to reduce opioid usage + Laxatives**
- **Avoid NSAID, paracetamol, opiates and anti-convulsant for chronic PRIMARY pain ➔ use TCA and SNRI**

**Common exam questions:**

- ***"This patient is on 30mg of modified-release morphine every 12 hours; what would be the correct breakthrough dose?"*** *In this scenario, 10mg is the correct answer, as the patient is getting 60mg background morphine every 24 hours (30mg twice a day).*
- ***"Patient A takes the same amount of morphine as patient B but claims there is no change in their pain level? Explain****? Patient A may be a poor acetylator, hence cannot breakdown codeine (prodrug) to get active component. Otherwise, is Patient A taking it as prescribed or is their an underlying cause*

| Opioid | Route | Equivalent Dose |
|---|---|---|
| **Morphine (Mod. Release)** | Oral | 10mg |
| **Morphine** | IV / IM / SC | 5mg (20-30mg / daily + 5mg breakthrough) |
| **Codeine** | Oral | 100mg |
| **Tramadol** | Oral | 100mg |
| **Oxycodone** | Oral | 6.6mg |
| **Diamorphine** | IV / IM / SC | 3mg |
| *Buprenorphine* | patch | 5mcg/hr = 12mg /24 hr oral morphine |
| *Fentanyl (for CKD)* | Patch<br>Intranasal | 12mcg/hr = 30mg / 24 hr oral morphine<br>For children |

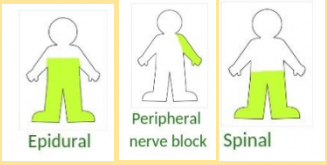
ANALGESIA PROTOCOL (PERIOPERATIVE)

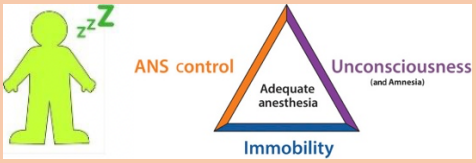



**AIM = MULTIMODAL ANALEGSIA**
*to maintain steady state for good analgesia (early weaning)*

# Types of Anaesthesia

"*reversible* loss of all sensation and LOC"




| | Local | Regional | General |
|---|---|---|---|
| **Define** | Numb single area | Blocking sensation to particular site | Making patient unconscious |
| **Pre-op** | ➢ **NO fasting needed**<br>➢ **Check allergies**<br><br>**Half-life (mins) / Toxic Dose (mg/kg)**<br>Lignocaine: 100 / 2-7<br>Ropivacaine: 120 / 3-4<br>Bupivacaine: 160 / 2 | ➢ **NO fasting needed**<br>➢ **Check allergies** | **Fasting prior to operation:**<br>➢ 6 hours of no food or feed before operation<br>➢ 2 hours of no clear fluids (i.e. fully "nil by mouth"<br>**Why do you need empty stomach (NBM)?**<br>➢ Risk of aspiration pneumonia + pneumonitis<br>➢ Inc. ED patients, non-fasting, full stomach |
| **Types** | • **Topical**<br>• **Infiltration**<br><br>**Indications**:<br>➢ Skin **sutures**<br>➢ Skin **biopsies**<br>➢ **Dental** procedures<br>➢ **Minor surgery** (carpal tunnel)<br>➢ Insertion **central line**<br>➢ **Percutaneous procedures** (e.g. PCI)<br>➢ **LP** | 1) **Peripheral nerve block** (under USS guidance)<br>a. **Brachial plexus**<br>b. **Femoral nerve** (neck of femur #, TKR)<br>**2) Neuraxial block**<br>a. **Epidural** → C/S, severe lung disease, lower limb surgery, child delivery<br>b. **Spinal** – no catheter → lower limb and pelvic surgeries, LSCS<br>c. **A/E** = haematoma, infection, hypoTN, local anaesthetic toxicity<br>3) **IV regional/peripheral ➔ Bier's block** (19th century – Bohr war → IV local anaesthetic given with tourniquet to prevent systemic spread → only distal areas anaesthetized (Best for forearm injuries)<br><br>**Monitored anaesthetics care (MACS):**<br>➢ Conscious BUT calm/sedated state (e.g. benzos) | 1) **Pre-medication = to make intubation easier**:<br>a. ***Benzodiazepines*** (e.g., midazolam) = relax muscles and reduce anxiety (also causes amnesia)<br>b. ***Opiates*** (e.g., fentanyl or alfentanyl) = reduce pain and hypertensive response to the laryngoscope<br>c. ***Alpha-2-adrenergic agonists*** (e.g., clonidine), = for sedation and pain<br>**2) Total IV or parenteral anaesthesia (TIVA) – analgo-sedation**<br>a. **Propofol ➔** *allosteric agonist of GABAa receptor*<br>b. **Etomidate ➔** *if haem unstable (less impact on CVS)*<br>c. **Barbiturates** (thiopental) ➔ *brain surgery*<br>d. **Benzodiazepines** (*midazolam*)<br>e. ***Opioids*** *(fentanyl)*<br>**3) Total inhalation anaesthesia – ether analgesia**<br>**a. Gas (NO given w/ Oxygen) -** Euphoric effect, analgesia<br>i. ***Indications*** = pregnancy, child, casualty !<br>b. **Volatile anaesthesia** (*sevoflurane, isoflurane)* |
| **A/E** | **A/E of Local and Regional Anaesthetics:**<br>**Systemic toxicity** (anaesthetic leak into blood NOT nerve)<br>➢ **Prodrome** = metallic taste, facial numbness<br>➢ **CNS (Crosses BBB)** → confused, seizures, resp. depression → resp. acidosis + hypoventilation<br>➢ **CVS toxicity** → (1) initially HTN, tachycardia → (2) gradual slow rate of fast conducting pathways (purkinje) → (3) hypoTN, bradycardia, unopposed ventricular contraction → VF/VT → cardiac arrest | | **Commonly**,<br>➢ IV meds are induction agents (i.e. induce unconsciousness),<br>➢ ***inhaled*** medications for ***maintaining*** GA during operation (since they take time to reach effective concentration since they need to diffuse across the lung tissue and into the blood)<br>➢ ***Total intravenous anaesthesia*** (***TIVA***) uses IV meds for BOTH induction and maintenance of GA (Propofol) → nicer recovery (as they wake up) compared with inhaled options.<br><br>**Emergence**:<br>➢ Wean off muscle relaxant – to avoid "awareness under anaesthesia"<br>➢ Nerve stimulator on either ulnar nerve (thumb twitch) or facial nerve (orbicularis oculi twitch) → if response gets weaker with more stimulation → indicates that muscle relaxant not worn off<br>➢ Consider reversal agent e.g. **sugammedex**<br><br>**A/E of GA:**<br>➢ Post-op sore throat, nausea and vomiting<br>➢ Aspiration<br>➢ Dental injury<br>➢ Anaphylaxis<br>➢ Cardiovascular eventsc (e.g. MI, stroke, arrythmia)<br>➢ Death<br>➢ Malignant hyperthermia (**rare BUT fatal)**<br>o Assoc. w/ suxamethonium and volatile anaesthetics<br>o Hypermetabolic response to anaesthesia → febrile, tachycardia, acidosis, hyperK, rigidity, XS CO2 production<br>o **Rx: dantrolene** (interrupts muscle rigidity by disrupting Ca ion movement in SKM) |

| Block | Effect | Complication |
|---|---|---|
| **Spinal/epidural** | Motor | Limb damage/weakness |
| | SNS blockade | HypoTN, bradycadria, incontinence |
| | Infection | Infection (meningitiis/enceph) |
| **High spinal/ thoacic /epidural** | motor | Resp. failure<br>Infection (meningitiis/enceph) |
| **All CNS/PNS blocks** | Sensory | Thermal/pressure injury<br>Neuropathic pain |
| **Upper /lower limb block** | Proprioception | Impaired balance |
| **Brachial plexus** | Phrenic nerve | Resp. failure |
| **Brachial plexus** | RLN | Hoarsness, aspiration |
| **Brachial plexus** | PSNS block | Horner's syndrome (enophthalmos, miosis, ptosis, anhydrosis) |
| **Femoral nerve (within iliopsoas m.)** | | Inability to flex hip |

**Rx**

## Treatment for systemic toxicity

1) Stop injection
2) BOLUS interlipid therapy (stop protein binding)
3) Ventilate – FiO2
4) Stop cerebral excitation → benzo, propofol, barbiturate
5) Correct HypoTN + arrythmia → IVF, ionotrope, vasopressor, anati-arrythmic
6) Monitor for hypoxia + acidosis

# EPIDURAL VS SPINAL ANAESTHESIA

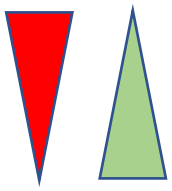
**Desired dermatome level of neuraxial block**

| Type of surgery | Upper dermatomal block level | Anatomical landmark | Optimal insertion point |
|---|---|---|---|
| Oesophagus, lung | T1 | Below clavicle | T6–7 |
| Upper abdomen | T1 | Below clavicle | T9–10 |
| Lower abdomen | T6 | Distal sternum | T9–10 |
| Caesarean delivery | T4 | Nipples | L4–5 |
| Lower limb | L1-2 | Inguinal crease | L4–5 |

**WHAT SENSATIONS LOST FIRST? [ORDER OF BLOCKADE]**

Thin nerve fibres blocked 1st before thick fibres (i.e. sensory BEFORE motor)

1) ANS
2) Pain
3) Temp
4) Touch
5) Deep pressure
6) Motor

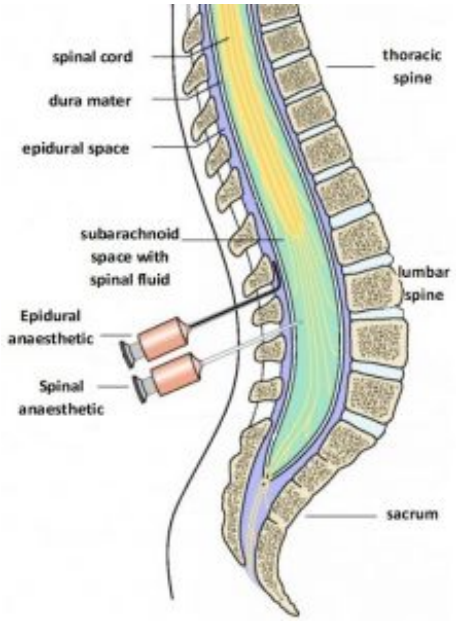


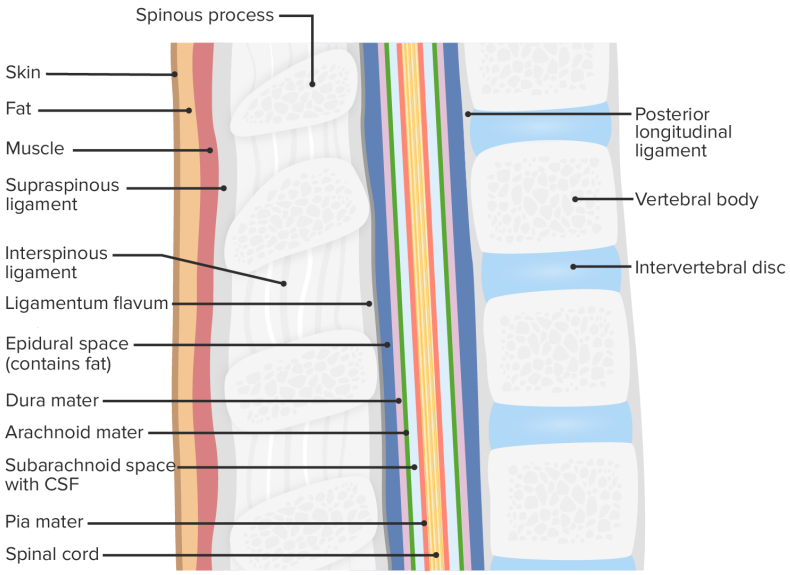
Recovery in REVERSE ORDER

**MAIN CONTRAINDICATIONS**

5) ANTI-COAG usage (warfarin, coagulopathy)
6) Anaphylaxis
7) Thrombocytopenia
8) Active bleed/ infection
9) Raised ICP

| | Central Neuraxial Anaesthesia (spinal block) | Epidural Anaesthesia |
|---|---|---|
| **Type** | ***regional anaesthesia***. | ***regional anaesthesia***. |
| **Indication** | • Caesarean sections – cannot feel legs<br>• Transurethral resection of the prostate (TURP)<br>• Hip fracture repairs | • pregnant women in labour<br>  ○ can still move legs and feel contractions but pain fibres are numbed<br>• post-operatively after a laparotomy (open abdominal surgery). |
| **Duration** | • 1-3 hours | Continuous infusion (monitoring may be needed) |
| **Procedure** | • Conscious patient<br>• local anaesthetic injected into CSF within the ***subarachnoid space*** (L3/4 or L4/5 spaces)<br>• Test w/ cold ice cube to determine if it is working (dermatomes) | • Conscious patient<br>• small tube (catheter) into the ***epidural space*** in the lower back (**outside *dura mater***) → *cervical, thoracic, lumbar or sacral*<br>• Diffuse to the surrounding tissues and spinal nerve roots<br>• can be converted into spinal block if needed |
| **Meds** | • Morphine (hydrophilic) | ***Local anaesthetic*** meds (e.g . ***Levobupivacaine +/- fentanyl)***<br>• Fentanyl = Longer acting and lipophilic → diffused into grey matter |
| **Dosage / onset** | • Small + quick onset | Large + slow onset |
| **A/E** | • Numbness and paralysis of the areas innervated by the spinal nerves **below** the level of the injection<br>• Cardiac arrest | • Headache if the dura is punctured, creating a hole for CSF to leak from ("***dural tap***") – **Rx: IVF**<br>• Motor weakness in the legs (cannot straight leg raise) → incorrect site (catheter may be in SAS not epidural) → **urgent anaesthetic review**<br>• Infection, including meningitis<br>• Epidural Haematoma (? spinal cord compression)<br>• Prolonged 2nd stage + increased probability of instrumental delivery |



# COMMON **ANAESTHESIA** MEDICATIONS

| | Type | MoA | Dosage | Indication | A/E |
|---|---|---|---|---|---|
| **Halothanes**<br>Sevoflurane (pleasant odour)<br>Desflurane (pungent odour) | Volatile agents | Unknown<br>➢ Reduces minute ventilation<br>➢ Bronchodilator | Sevo (2% MAC) – 2% metabolised<br>Des (6% MAC) – wake up quicker | MAC = min alveolar conc. to prevent reaction to surgical stimulus in 50% of patients at 1 atm pressure | HTN, tachycardia Malignant Hyperthermia<br>Bronchoconstrict (if Des) |
| **Nitrous Oxide**<br>"beware recreational use" | Volatile sparing agent | Stops methionine synthetase to produce analgesia<br>➢ Minimise prolonged use | High MAC (102%) | Simple procedures | **Malignant Hyperthermia**<br>**Megaloblastic anaemia (vit B12 def)**<br>Agranulocytosis |
| **Oxygen** | Volatile agents | | | | **ROP** |
| **Propofol**<br>**(*white lipid soln*)** | IV induction or sleeping agent (**emulsion / egg**) | **Non-barbiturate** GABA modulator<br>➢ ↓SVR + ↓ myocardial contractility<br>➢ ↓ CO (25%)<br>➢ ↓ Laryngeal reflex | 1 - 2mg/kg<br>(**rapid onset**) | ➢ GA<br>➢ Anti-emetic (5-HT3 Receptor) | ➢ Anaphylaxis to egg/soy<br>➢ Reduced airway reflexes<br>➢ HypoTN<br>➢ Stings when injected |
| **Thiopentane** | IV induction | **barbiturate** GABA agonist<br>➢ Reduces cerebral consumption | 3-7mg/kg<br>(**5-10mins**) | **Brain surgery, status epilepticus, raised ICP** | Tachycardia<br>Vasodilated (↓SVR) |
| **Ketamine**<br>"special K" or "K-hole" | IV induction dissocative /conscious anaesthesia + analgesic | • Phencyclidine derivative created from Vietnam War → (**NMDA receptor antag)**<br>• ↑ **SNS** = ↑HR, ↑ CO, ↑BP, ↑ Cardiac O2 cons. | 1-2mg/kg<br>0.2-0.5 mg/kg analgesia | ➢ Trauma pt<br>➢ Seizures | HypoTN → reduce dose NOW |
| **Midazolam** | Sedative | GABA receptor agonist (benzo) | IV 0.02-0.1mg/kg | Sedation + anxiolysis | Headache, delirium, N/V, drowsy |
| **Adrenaline** | Vasopressor<br>• Lower dose = vasodilate (B1, B2)<br>• Higher dose = vasoconstrict (a1) | • **A1 vasoconstrictor** (2-3 min half life)<br>• ↑HR, ↑BP, ↑RR, O2 cons.,<br>• Glycogenolysis, Lipolysis | 0.01-0.1 mg/kg/ min IV in ICU<br>Or 1mg ED (ALS)<br>Or IM 1:10000 | ➢ HypoTN<br>➢ Anaphylaxis<br>➢ Severe asthma (bronchodilator) | Lactic acidosis<br>Higher mortality in HF patients |
| **Ephedrine** | Vasopressor<br>• Indirect SNS – release NORAD | • **Potent A1 (↑NORAD) AND B activity**<br>• ↑HR, ↑CO, ↑RR, O2 cons.<br>• bronchodilate | IV bolus **ONLY** | HypoTN | Higher mortality |
| **Phenylephrine** | Vasopressor<br>• last 5 minutes | • **Selective A1 vasoconstrictor**<br>• ↑SVR ➔ ↑BP ➔ ↑Coronary artery flow | IV bolus or infusion | HypoTN | reflex bradycardia (↑SVR) |
| **Metaraminol** | Vasopressor<br>• Lasts 20-60mins<br>• Longer acting | • **A1 vasoconstrictor (mainly)**<br>• ↑SVR ➔ ↑BP ➔ ↑Coronary artery flow, + pulm. Vasc. pressure | IV bolus or infusion | Acute HypoTN | ➢ reflex bradycardia (↑SVR)<br>➢ Higher mortality |
| **Vasopressin** | Vasopressor<br>last 5 minutes | • **Selective V1 vasoconstrictor**<br>• ↑SVR ➔ ↑BP ➔ ↑Coronary artery flow | IV via CVC | | |
| **Levosimendan** | Positive Inotrope (increase contractility) | • PDE3 inhibitor | IV via CVC | mainly cardiac pts | |
| **Milrinone** | Positive Inotrope (increase contractility) | • Increases heart muscle sensitivity to calcium | IV via CVC | | |
| **-curium or -curonium** *(e.g. rocuronium)* | Muscle relaxant / paralytic | Non-depolarising neuromuscular blocking agent → Competitive inhibitors against nAChr<br>• Slower action → muscle relaxant | IV | • **Keep Ventilation**<br>• **Prevent asp. pneumonia if NOT fasted** | Muscle pain and salivation<br>**Reversal agent** = sugammedex 16mg/kg |
| **Suxamethonium** | Muscle relaxant/ paralytic<br>• Check K levels<br>• Caution in burns pt | • Rapid onset<br>• Depolarising NMJ blocking agent<br>• Metabolised by pseudocholinesterase | IV | Initially causes twitches and fasciculations before relaxation<br>• Raises IOP | **Hyper K, hypoTN, fever**<br>**CI** = *malignant hyperthermia, glaucoma OR eye trauma*<br>**Reversal agent** = neostigmine |
| **Neostigmine** | Reversal agent | Inhibits ACHE at NMJ ➔ ↑ ACh | Given with anti-chol (atropine) | Reverse paralytic | **Cholinergic effects** (bronchospasm, bradycardia) |
| **Glycopyrrolate** | Anti-cholinergic / .anti-muscuranic | ↓Ach ➔ ↑HR (mildly increase) | 200mcg | Mild Bradycardia | Dry mouth, blurred vision, urinary retention, drowsy<br>➢ Non-opposed-tachycardia |
| **Atropine** | Anti-cholinergic | ↓Ach (acts on SA node)➔ ↑HR (greater)<br>Blocks CNX on heart | ED = 3mg | Bradycardia | |
| **Parcoxib** | **Analgesic - NSAID** | COX-2 selective | | | 1. Constipation<br>2. Sedation/ drowsy<br>3. Nausea / vomit<br>4. Dependence |
| **Remifentanil** | **Analgesic - opioid** | Ultra SA opioid<br>• Fast onset + offset of action | IV | ICU or theatre for tube tolerance | |
| **Fentanyl** | **Analgesic – opioid** | SA + potent opioid<br>• **Lipid soluble →diffuse** | 5-15mcg | Analgesia → spinal blocks OR patch epidurals | |
| **Alfentanil** | **Analgesic – opioid** | V. short acting opioid<br>• Less potent than fentanyl (10 min duration of action) | | Analgesia for shorter cases or bridging | |
| **Morphine** | **Analgesic – opioid** | Gold standard analgesic<br>• Hydrophilic | 100-300mcg | analgesia | |
| **Procaines** *(cocaine, tetracaine, benzocaine)* | ***Ester***-linkage LA | ➢ Short-acting (broken down by plasma esterase)<br>➢ Vasodilatation | | Short duration analgesia w/ slow onset of action | |
| **Bupivacaine** | ***Amide***-linkage LA | Long-acting (broken down by liver enzymes)<br>➢ High plasma protein binding = longer duration of action<br>➢ High potency (as high solubility) | | Nerve block or Regional anaesthetics | |
| **Lidocaine** | ***Amide***-linkage LA + anti-arrhythmic | | | RA onset of action for Short procedures:<br>➢ Lower pKa = more ionised = faster action | |
| **Penicillins** | Antibiotic | • Amoxil = B-lactam (prevent PG synthesis by cross-linking)<br>• Co-amoxiclav = + B-lactamase inhibitor | 500mg qid PO/IV 1.2 g IV | Skin– cellulitis, impetigo, diabetic foot, mastitis<br>Otitis media,URTI, UTI | ATN |
| **Cephalosporins** | Antibiotic | Cefuroxime = 2nd gen Cephalosporin (only 2nd gen that **crosses BBB)** | IV 2g | Broad spectrum (g +ve and g -ve) | ATN |
| **Linosamides** | Antibiotic | Clindamycin | | 2nd line if penicillin or cephalosporin allergy | |
| **Aminoglycosides** | Antibiotic | Gentamicin | | UTI? UROLOGY | Nephrotoxic, ototoxic |
| **Oxytocin** | Obstetric (syntocinon) | • ↑uterine contractions | | induce labour or post-LCSC bleed (PPH) | |
| **Tranexamic acid** | Antifibrinolytic | • Stop clot breakdown | | Trauma, surgery, ortho, menorrhagia | VTE |
| **Ondansetron** | Anti-emetic (PONV) | **5HT3 receptor in CTZ →** vomiting centre<br>➢ Do ECG prior (?prolonged QT) | 4mg IV | N+ V | Fatigue, drowsy, constipation, **prolonged long QT** |
| **Metoclopramide** | Anti-emetic (PONV) | **D2 receptor antag** + prokinetic | | | Caution in **sedation**, constipation, **prolonged QT** |
| **Dexamethasone** | Anti-emetic (PONV) | 40-50x more potent than hydrocortisone and longer lasting | | N+ V, odynophagia, systemic illness | Steroid issues – caution in DM and immunocomp. |
| **Cyclizine** | Anti-emetic (PONV) | **H1 anatag** | | | Caution w/ HF and elderly |

## INTRA-OP CONSIDERATIONS: Pain, TEMP, PRESSURE SORES,

| | Concern | Solutions |
|---|---|---|
| **Pain** | **CVS** – HTN, tachycardia, DVT<br>**Resp** – atelectasis, impaired cough, pneumonia<br>**GI** – reduced gastric motility<br>**Neuroendocrine** – impaired wound healing, increased catabolic hormones (++ BSL) | ➢ **Choose appropriate analgesia** → dosage and duration |
| **Temperature** | **Anaesthesia causes loss of thermoregulation**<br>➢ Heat loss by conduction, radiation, convection | ➢ **Pre-warming = best** (bair hugger, warm blankets)<br>➢ **Warmed fluids** (esp. blood products, fluids)<br>➢ **Theatre temperature control** (esp. in paediatrics!!) |
| **Pressure area** | **Long surgical time** | ➢ **Patient positioning** – protect skin and nerves<br>➢ **Padding** – surgical table, heels<br>➢ **Protect vulnerable nerves** (e.g. median, ulnar – thumb's up) |

## POST-OP NAUSEA & VOMITING (PONV) MANAGEMENT

### *PONV risk factors: **APFEL criteria***

- Assume all patients have 25% have post-operative
- Each 1 will increase by 25% = (1) **Hx of PONV**, (2) **female**, (3) **non-smoker**, (4) **Patient will need opiate post-op**

| | |
|---|---|
| **Patient** | Female > Male, ratio 2.5 : 1 |
| | Anxiety |
| | Previous history of PONV |
| | History of motion sickness |
| | Non-smoker |
| | Pain |
| | Presence of gastric contents |
| **Anaesthetic** | Volatile agents |
| | Nitrous oxide |
| | Opioids |
| | Intravenous anaesthetics (ketamine, etomidate) |
| | Neostigmine |
| | Stomach insufflation |
| | Spinal anaesthetic (with hypotension) |

| | |
|---|---|
| **Surgical** | ENT, especially middle ear operations, adenoids and tonsillectomy |
| | Squint surgery |
| | Gynaecological surgery |
| | Gastrointestinal surgery |
| | Laparoscopic procedures |
| | Intestinal obstruction |
| **Medical** | Hypoxia |
| | Uraemia |
| | Metabolic disorders, e.g. hypoglycaemia, hypercalcaemia |

## RARE BUT IMPORTANT MALIGNANT SYNDROMES

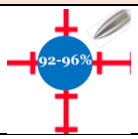
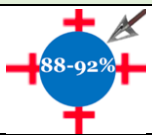
| | Cause | Sx | Rx |
|---|---|---|---|
| **Neuroleptic malignant syndrome** | ➢ **dopamine receptor-blocking drug**s → antipsychotic agents (e.g. chlorpromazine, haloperidol) and some antiemetics (metoclopramide).<br>➢ **OR sudden withdrawal from dopaminergic drug** (e.g. levodopa, bromocriptine) | ➢ muscle rigidity,<br>➢ bradyreflexia,<br>➢ bradykinesia,<br>➢ altered mental status,<br>➢ EPSE<br>➢ hyperthermia. | **bromocriptine** (a dopamine agonist) PO or NGT<br>➢ Start at 2.5 mg 8-hourly, >><br>➢ increasing to 5 mg every 4 h (maximum 30 mg/day) in moderate to severe cases |
| **Malignant hyperthermia syndrome** | ➢ autosomal dominant disorder after receiving an inhalational anaesthetic or suxamethonium | ➢ muscular rigidity,<br>➢ tachypnoea,<br>➢ tachycardia,<br>➢ hypertension,<br>➢ mottled diaphoretic skin<br>➢ cardiac arrhythmias. | ➢ **dantrolene 1 mg/kg IV for** severe muscle rigidity and hyperthermia.<br>➢ Further doses of 1–2.5 mg/kg (up to a maximum of 10 mg/kg/24 h) may be required |

## ACUTE RESPIRATORY DISTRESS SYNDROME (ARDs)

1. Acute onset < 1 week
2. Predisposing condition
3. bilateral opacities consistent with APO must be present (detected via chest CT or CXR)
4. PF ratio <300mmHg with a minimum of 5 cmH20 PEEP
5. must not be fully explained by cardiac failure or fluid overload,

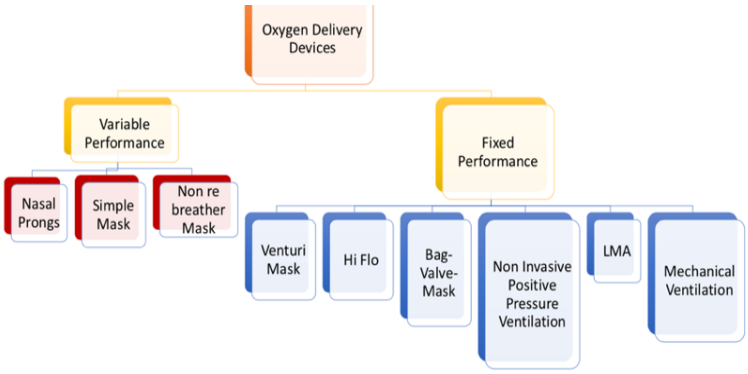
# RESPIRATORY SUPPORT

## Targeted Oxygen Therapy

| In the **absence** of COPD | | In the **presence** of COPD | |
|---|---|---|---|
| Where SpO2 is ***<92%*** <br>➢ titrate oxygen to maintain SpO2 ***92-96%*** |   | With a SpO2 ***<88%*** <br>➢ titrate oxygen to achieve a SpO2 ***88-92%*** using a **Venturi mask delivering** a FiO2 24%-28% |   |

## What/When to use?

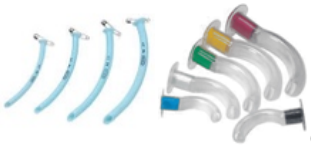
- **Mainly for acute respiratory distress syndrome (ARDs)**
- Respiratory support ONLY buys times until underlying problems can be managed
- Chest physiotherapy and suction = helps to clear secretions and improve respiratory function
- **Remember O2 is a drug (XS oxygen ➔ can lead to ROP)**




**Acute respiratory Distress:**
- ➢ Atelectasis (alveolar collapse)
- ➢ APO (NOT due to fluid overload)
- ➢ Reduced lung compliance
- ➢ Fibrosis of lung tissue

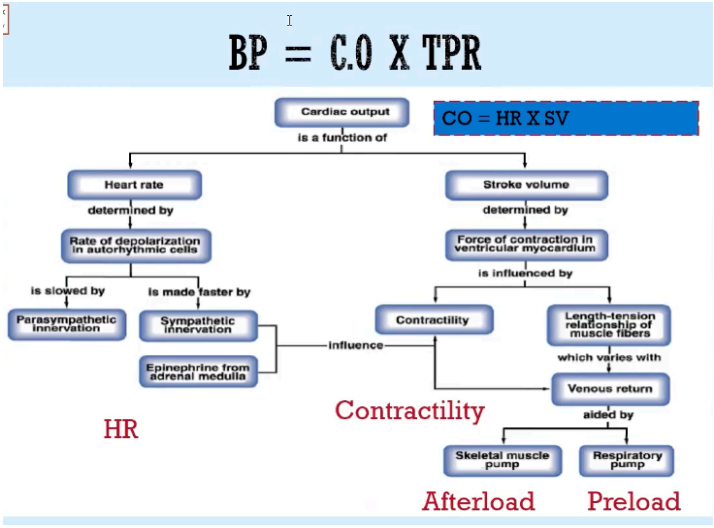
**Investigations**
- ➢ ABG - Hypoxia
- ➢ CXR: bilateral infiltrates

**General Mx:**
1) Respiratory support
2) Prone positioning (lying on front)
3) Fluid and electrolyte management (avoid XS fluid in lung)

| | Minimally invasive | Flow Rate (L/min) | FIO2 (%) | Indication for use |
|---|---|---|---|---|
|  | **Nasal Cannula/Prongs** | 1-4 | 25-35 | • Minimal resp. distress (≈90%)<br>• Less claustrophobic, low cost, can eat and speak |
|  | **Simple Face Mask** | 5-10 | 40-60 | • Moderately hypoxic<br>• Risk of CO2 retention |
|  | **Non-Rebreathing Mask**<br>*Reservoir bag MUST be inflated + tight fit needed | 15 | > 60% | • Post-cardiac or respiratory arrest<br>• Severely hypoxic patients<br>**Patients have adequate ventilation but require high O2 concentrations* |
|  | **Venturi Mask**<br>(blue – white- orange – yel -red-green)<br>(2 -------4 ------6 ------8 – --10 –-15) | 2-10 [adaptor] | 24-60% (fixed( | • COPD patients (i.e. avoid CO2 retention) or patients using hypoxic drive to breath<br>• Transition to non-rebreathing mask in emergency or it patient is not well |
|  | **Hi Flow Nasal Cannula**<br>*"humidified O2 delivery under pressure"* | High flow nasal cannula: ≤60 | 0.24-0.8 | • Low level prep → applied nasally or via tracheostomy<br>• Increases FiO2 + provides PEEP |
|  | **Bag-Valve- Mask Resuscitator** | 15 | >0.8 | • **Need adjunct** → nasopharyngeal or oropharyngeal (Guedal) airway or BOTH<br>○ **Place upright** horizontally in (avoid pushing tongue back into oropharynx) → rotate when at oropharynx<br>• Need to optimize patient position, bed height etc.<br>  <br>**(oropharyngeal)** **(guedel)** |
| | **Non-invasive positive end expiratory pressure (PEEP)**<br>**(CPAP, BPAP)** | | | **Prevent airway collapse → reduce atelectasis and improve alveolar ventilation to recruit more alveoli for more gas exchange and decrease WoB**<br>• CPAP = T1RF – constant pressure to keep airways expanaded)<br>• BPAP = T2RF = inspiratory positive airway pressure (air forced into lungs) and expiratory PEEP (prevent airways collapse) |
| | **Mechanical ventilation** | | | • Endo-tracheal tube = definitive airway to maintain airway patency<br>• Control FiO2, RR, TV, Peak flow rate, PEEP<br>• Tracheostomy (emergency) |
| **Adjuncts** | **LMA (laryngeal mask airway)** | | | • Non-definitive airway |
| **Dynamic manoevres** | **Prone Position** | | | • Reduce compression of lungs by adjacent organs<br>• Improve blood flow to lungs – esp. to well-ventilated areas<br>• Improve overall oxygenation and secretion clearance<br>• Reduce assistance needed from Mechanical ventilation |

***Fraction of Inspired Oxygen*** **(FiO2) concentration ≈ (Flow Rate x 4 ) +** 21 (FiO2 in room air)

# CARDIOVASCULAR SUPPORT




## DETERMINANTS OF CARDIAC OUTPUT

Low MAP = tissue ***hypoperfusion***, leading to ***hypoxia***, ***anaerobic respiration***, ***lactate*** production and damage to the tissue.

| | Decrease | increased |
|---|---|---|
| **HR** | PSNS = opiate | SNS = Shock, stress |
| | Inotropes | BB |
| **Preload (CVP = RAP) =** *heart muscle tension or pressure filling ventricle (central venous pressure)* | Volume loss = bleeding | ↑ vol. to heart = ↑RA =↑EDV (e.g. pregnancy) |
| | IV fluid or MTP | Diuresis |
| **Afterload (≈TPR or intrathoracic pressure) =** force needed to pump against aorta (aortic pressure) | MR<br>Vasodilating (e.g. Anaphylaxis) | Viscous blood<br>L-side (systemic HTN, AR, MR)<br>R side (PHTN) |
| | Vasopressors | Anti-coags, |
| **Contractility =** *affected by HR, preload, afterload* | Ischaemia | SNS |
| | Inotropes | BB, CaB |
| **Venous return** | Vasopressors | Resp. pump<br>SKM pump<br>SNS systemic veins<br>Abdo compression reflex |

**Monitoring**:

- **Non-invasive**
  1) HR
  2) Peripheral BP
  3) Pulse Oximeter
  4) Continuous ECG
- **Invasive**
  1) ABG (arterial line)
  2) Central venous pressure (preload) and O2 sats (via CVC)
  3) Pulmonary artery O2 sats and wedge pressure (pulmonary artery catheter)
  4) ECHO (TTE, vs TOE)
- **Intensive:**
  1) Oseophageal doppler monitor (assess blood flow through thoracic aorta to measures SV and CO)

*Other cardiac interventions:*

- Impella
- Swan ganz catheter
- ECMO → replace heart + lung
- Cardio-pulm bypass circuit

**General Treatment for HypoTN**:

- Increase contractility → positive ionotropes (e.g. milirone, levisemindan, dobutamine, adrenaline, isoprenaline)
- Increase afterload → vasopressors (E.g. adrenaline, vasopressin)

**General treatment for bradycardia:**

- Reduce PSNS – e.g. atropine, glycopyrrolate

**General treatment for tachycardia:**

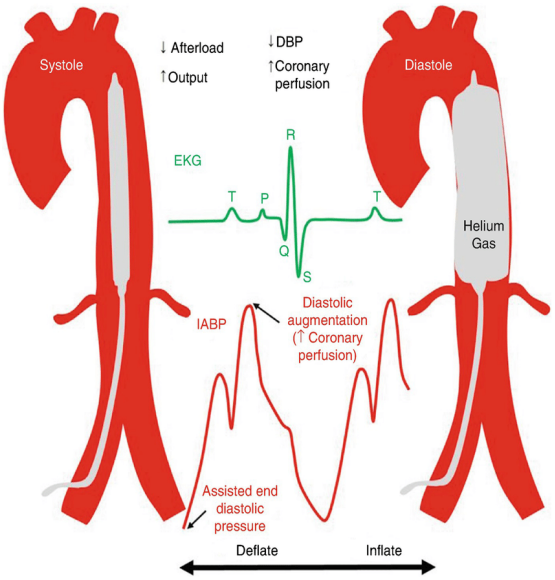
- BB, CaB, Flecainide

**When do we us an intra-aortic balloon pump?**

- Cardiogenic shock
- ACS (UA, NSTEMI, STEMI)
- Immediately after heart surgery

**How does it work?**

- Inserted via femoral artery up to descending thoracic aorta → linked to special machine synchronized with heart contractions
- Inflate balloon during diastole (relaxed heart) push blood into coronary artery to (1) **improve coronary perfusion**
- Deflate during systole (2) **reduce afterload and (3) increase cardiac output**




# RENAL SUPPORT – RENAL FAILURE

**INDICATIONS**:

- **A –** acidosis (pH < 7.1)
- **E –** electrolyte (hypeK)
- **I –** ingestion of drugs
- **O –** overload fluids
- **U –** ureamic encephalopathy

**AIM:** Removing excess fluid, solutes and waste products

**Types of dialysis used in ICU:**

- ***Continuous renal replacement therapy (RRT)*** involves continuously performing dialysis 24 hours a day.
  1) Most patients requiring haemodialysis in ICU will be on CRRT.
- ***Intermittent haemodialysis*** involves running the machine and performing dialysis for set periods, for example, 3-12 hours, before taking a break from dialysis.

**Considerations for dialysis:**

- Need 2-lumen CVC (Vas Cath) to have abundant blood supply access
- Anti-coag with citrate of heparin
- Dialysate (the fluid where solutes filter out from blood) into

# POST-OP COMPLICATIONS

| Immediate | Early | |
|---|---|---|
| 1. **Anaesthetic**<br>○ *CVS*: arrythmia, HTN, HypoTN, MI/Stroke,<br>○ *RESP*: irregular RR<br>○ *Hypothermia (lost due to conduction, radiation, convection)*<br>○ *General*: teeth/lip/tongue damage, hyperthermia, allergies,<br>2. **Haemorrhage** – check drain, obs, FBC, HCT | 1. Dehydration<br>2. Electrolyte imbalance<br>3. Infection – systemic Vs. local<br>4. VTE<br>5. Wound or anastomotic breakdown | 6. Bed sores<br>7. Delirium (4AT – identify cause)<br>8. Post-op ileus<br>9. Post-op falls |

## SPECIFIC SURGICAL COMPLICATIONS

### GENERAL SURGERY

| Gastrectomy | SBO/LBO | Biliary / cholecystectomy |
|---|---|---|
| ➢ Dumping syndrome<br>➢ Malabsorption<br>➢ Anastomotic ulcer<br>➢ PUD / gastric cancer<br>➢ Bacterial overgrowth<br>➢ Gas bloating | ➢ Ileus<br>➢ Anastomotic leak (usu 5-10 days post-op)<br>➢ Stoma retraction<br>➢ Intra-abdo collection / abscess<br>➢ Adhesions → SBO/LBO<br>➢ Pre-sacral plexus damage | ➢ CBD injury / stricture or bile leak<br>➢ Anastomotic leak<br>➢ Bleeding into biliary tree (jaundice)<br>➢ pancreatitis |

### VASCULAR SURGERY

| CABG/stent | Graft/stent/bypass |
|---|---|
| ➢ reperfusion arrythmias<br>➢ post-op ACS<br>➢ ionotropes usage may cause peripheral organ hypoperfusion | ➢ graft vs host disease<br>➢ haemorrhage / haematoma<br>➢ infection<br>➢ re-thrombosis<br>➢ limb/organ ischaemia<br>➢ AV fistula<br>➢ Cholesterol embolism (trash foot)<br>➢ Contrast (anaphylaxis, AKI)) |

### ENDOCRINE

| Thyroidectomy | Parotidectomy |
|---|---|
| ➢ *Airway obstructed 2º to heamorrhage → URGENT opening of wound*<br>➢ *hypoCa (removal of PTH glands)*<br>➢ *recurrent laryngeal palsy = hoarseness* | ➢ *CN7 palsy* |

### Orthopaedics

| ANY ORTHO | THR |
|---|---|
| ➢ Prosthetic infection<br>➢ Loss of position / failure to fix<br>➢ Non-union/mal-union/delayed union<br>➢ Neurovascular injury<br>➢ Compartment syndrome | ➢ Sciatic nerve damage<br>➢ Dislocation<br>➢ LLD<br>➢ Loosening + wear → repeat surgery<br>➢ Pain + hip # = delirium |

### Urology

| Cystoscopy /TURP |
|---|
| ➢ UTI<br>➢ Absorbed glycine irrigation fluid = hypoNa<br>➢ Impotence /retrograde ejaculation<br>➢ Sphincter dysfunction<br>➢ Urethral stricture |

### Other

| Endovascular | LN dissection | Neck dissection |
|---|---|---|
| ➢ Retroperitoneal haemorrhage (e.g. SADPUCKER)<br>➢ **Any vascular surgery** = bleeding and dementia | ➢ Lymphodema (e.g. axillary nodes)<br><br>NB: any plastics surgery = high level of immobilisation | ➢ CN 11/12 palsy |

## THE UNWELL POST-OP PATIENT

### Post-op Fever

| | Post-op | Cause | Ix | Rx |
|---|---|---|---|---|
| **Wind** | < 24 HRS | atelectasis, URTI/ pneumonia<br>• **Pseudomonas (ventilator) 3-7 days**<br>• Chest infections causing suboptimal ventilation inducing basal atelectasis, UTIs | CXR, sputum culture | Abx (benzyl + doxy) OR (azithro + cef) |
| **Water** | 3-5 days | UTI, Fluid depletion → check IDC, fluid balance | UA (M/C/S) | Abx (**trimethorprim**) + IVF |
| **Walking** | 4-6 days | ➢ DVT/PE<br>➢ Pressure ulcers<br>➢ Ileus (post-abdo surgery) | | ➢ **Mobilise + calf compressor**<br>➢ SC clexane → warfarin → DOAC) – check INR 2.5-3.5 |
| **Wound infection** | 5-7 days | wound site infection → lines, chest drain, surgical site or anastomotic leak | | ➢ Remove lines and Clean wound +/- incision or debride<br>➢ IV ABx |
| **Wonder drugs** | >7 days | transfusion/drug reactions (e.g. serotonin syndrome, thyroid storm) | | ➢ Stop drug<br>➢ DIC – meds,<br>➢ CT scan → drainage/abscess |

### Post-op HypoTN

| Shock type | Pulm. Artery pressure | CVP | SVR | CO | Cause |
|---|---|---|---|---|---|
| **Septic** | Low | Low | Low | High | Infection |
| **Cardiogenic ((pump failure))** | High | High | High | Low | • **Surgical stress** = ↑ACS risk (. 48 hrs post-op)<br>• **Epidural analgesia or high block** (T5 and above) = lose SNS outflow = vasodilatation + cardio shock<br>• **Fluid overload + HF** |
| **Hypovolaemic** | Low | Low | High | Low | ➢ Long operations, XS sweating,<br>➢ haemorrhage, reduced PO intake |
| **Obstructive** | High /normal | High | High | Low | PE, Pneumothorax, tamponade |

**Check for:**
1) Poor perfusion signs
   a. Prolonged CRT
   b. Pallor
   c. Cold peripheries
   d. Tachycardia
2) Organ dysfunction
   a. pH< 7.1
   b. lactate > 2
   c. reduced UO (< 0.5mL/kg/hr)
   d. confusion

### Low UO

| Physiological Cause | Cause |
|---|---|
| Pre-renal (most common) | Hypovolaemia – heamorrhage? Reduced CO? |
| Renal | Nephrotoxic drugs (e.g. Contrast, aminoglycosides, salicyclates, metformin) |
| Post-renal | BPH or ++ intra-abdo pressure causing ureter compression |

Normal > 0.5mL/kg/hr
**Check for:**
1) Fluid status (input VS output)
   a. 3rd space losses into bowel or tissues
   b. Med review
   c. Examine IDC + bladder scan

### Pain

| | Physiology | Clinical Signs |
|---|---|---|
| **CVS** | ↑HR, ↑BP, ↑hypercoagulability | ACS<br>VTE (DVT/PE) |
| **RESP** | ↓ Lung vol.<br>↓ cough (retain secretion) | ➢ Atelectasis<br>➢ Pneumonia<br>➢ Hypoxemia |
| **GIT** | ↓ bowel motility<br>↓ gastric emptying | ➢ Constipation, anorexia<br>➢ Paralytic ileus (causes hypoTN) |
| **General** | Medication overuse headache for any drugs (regular overuse for > 3 mths) | |

Consult pain specialists / anaesthetics
➢ WHO step ladder for analgesia