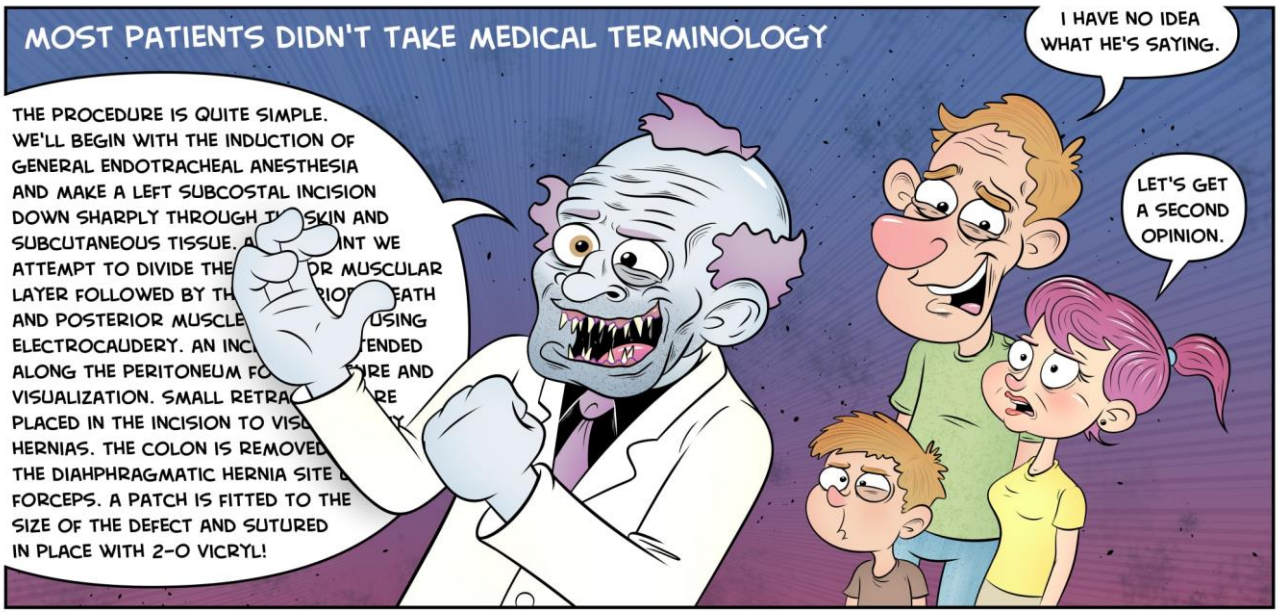


American Society of Anesthesiologists Physical Status Scoring System (ASA)

ASA grade	Description
1	No organic physiological, biochemical or psychiatric disturbance. The surgical pathology is localised and has not invoked systemic disturbance
2	Mild or moderate systemic disruption caused either by the surgical disease process or though underlying pre-existing disease
3	Severe systemic disruption caused either by the surgical pathology or pre-existing disease
4	Patient has severe systemic disease that is a constant threat to life
5	A patient who is moribund and will not survive without surgery

Preparation for Surgery

Elective and emergency patients require different preparation.

Elective cases

- Consider pre admission clinic to address medical issues.
- Blood tests including FBC, U+E, LFT's, Clotting, Group and Save
- Urine analysis
- Pregnancy test
- Sickle cell test
- ECG/ Chest x-ray

Exact tests to be performed will depend upon the proposed procedure and patient fitness.

Risk factors for development of deep vein thrombosis should be assessed and a plan for thromboprophylaxis formulated.

Diabetes

Diabetic patients have greater risk of complications.
Poorly controlled diabetes carries high risk of wound infections.
Patients with diet or tablet controlled diabetes may be managed using a policy of omitting medication and checking blood glucose levels regularly. Diabetics who are poorly controlled or who take insulin may require a intravenous sliding scale. Potassium supplementation should also be given.
Diabetic cases should be operated on first.

Emergency cases

Stabilise and resuscitate where needed.
Consider whether antibiotics are needed and when and how they should be administered.
Inform blood bank if major procedures planned particularly where coagulopathies are present at the outset or anticipated (e.g. Ruptured AAA repair)
Don't forget to consent and inform relatives.

Special preparation

Some procedures require special preparation:

- Thyroid surgery; vocal cord check.
- Parathyroid surgery; consider **methylene blue** to identify gland.
- Sentinel node biopsy; radioactive marker/ patent blue dye.
- Surgery involving the thoracic duct; consider administration of cream.
- Pheochromocytoma surgery; will need alpha and beta blockade.
- Surgery for carcinoid tumours; will need covering with octreotide.
- Colorectal cases; bowel preparation (especially left sided surgery)
- Thyrotoxicosis; lugols iodine/ medical therapy.

Pre-operative Fluid Management

Fluid management has been described in the British Consensus guidelines on IV fluid therapy for Adult Surgical patients (GIFTASUP) and by NICE (CG174 December 2013)

The Recommendations include:

- Use Ringer's lactate or Hartmann's when a crystalloid is needed for resuscitation or replacement of fluids. Avoid 0.9% N. Saline (due to risk of hyperchloraemic acidosis) unless patient vomiting or has gastric drainage.
- Use 4%/0.18% dextrose saline or 5% dextrose in maintenance fluids. It should not be used in resuscitation or as replacement fluids.
- Adult maintenance fluid requirements are: Na 50-100 mmol/day and K 40-80 mmol/day in 1.5-2.5L fluid per day.
- Patients for elective surgery should NOT be nil by mouth for >2 hours (unless has disorder of gastric emptying).
- Patients for elective surgery should be given carbohydrate rich drinks 2-3h before. Ideally this should form part of a normal pre op plan to facilitate recovery.
- Avoid mechanical bowel preparation.
- If bowel prep is used, simultaneous administration of Hartmann's or Ringer's lactate should be considered.
- Excessive fluid losses from vomiting should be treated with a crystalloid with potassium replacement. 0.9% N. Saline should be given if there is hypochloraemia. Otherwise Hartmann's or Ringer lactate should be given for diarrhoea/ileostomy/ileus/obstruction. Hartmann's should also be given in sodium losses secondary to diuretics.
- High risk patients should receive fluids and inotropes.
- An attempt should be made to detect pre or operative hypovolaemia using flow based measurements. If this is not available, then clinical evaluation is needed i.e. JVP, pulse volume etc.
- In Blood loss or infection causing hypovolaemia should be treated with a balanced crystalloid or colloid (or until blood available in blood loss). A critically ill patient is unable to excrete Na or H_20 leading to a 5% risk of interstitial oedema. Therefore 5% dextrose as well as colloid should be given.
- If patients need IV fluid resuscitation, use crystalloids that contain sodium in the range 130-154 mmol/l, with a bolus of 500 ml over less than 15 minutes (NICE Guidance CG 174).

Intra-operative Fluid Management

Composition of commonly used intravenous fluids $mmol^{-1}$

	Na	K	Cl	Bicarbonate	Lactate
Plasma	137-147	4-5.5	95-105	22-25	-
0.9% Saline	153	-	153	-	-
Dextrose / saline	30.6	-	30.6	-	-
Hartmann's	130	4	110	-	28

Recommendations for intra operative fluid management

The latest set of NICE guidelines produced in 2013 relating to intravenous fluids did not specifically address the requirements of intra operative fluid administration. The reason for this is that administration of fluids in this specific situation does not lend itself to rigid algorithms.

With the introduction of enhanced recovery programmes 10 years ago there was an increasing emphasis of the concept of fluid restriction. Historically, patients received very large volumes of saline rich solutions peri-operatively. Clearing the sodium load of a single litre of saline may take up to 36 hours or more. This can have deleterious effects on the tissues including the development of oedema. This results in poor perfusion, increased risk of ileus and wound breakdown. A tailored approach to fluid administration is now practiced and far greater usage is made of cardiac output monitors in providing goal directed fluid therapy.

Intravenous Access

Venous access

A number of routes for establishing venous access are available.

Peripheral venous cannula

Easy to insert with minimal morbidity. Wide lumen cannulae can provide rapid fluid infusions. When properly managed infections may be promptly identified and the cannula easily re sited. Problems relate to their peripheral sites and they are unsuitable for the administration of vaso active drugs, such as inotropes and irritant drugs such as TPN (except in the very short term setting).

Central lines

Insertion is more difficult and most operators and NICE advocate the use of ultra sound. Coagulopathies may lead to haemorrhage following iatrogenic arterial injury.
Central lines (and particularly subclavian lines) are risk factors for the development of **pneumothorax**.
Femoral lines are easier to insert and iatrogenic injuries easier to manage in this site however they are prone to high infection rates. Internal jugular route is preferred. They have multiple lumens allowing for administration of multiple infusions. The lumens are relatively narrow and thus they do not allow particularly rapid rates of infusion.

Intraosseous access

This is typically undertaken at the anteromedial aspect of the proximal tibia and provides access to the marrow cavity and circulatory system. Although traditionally preferred in paediatric practice they may be used in adults and a wide range of fluids can be infused using these devices.

Tunneled lines

Tunneled lines such as Groshong and Hickman lines are popular devices for patients with long term therapeutic requirements. These devices are usually inserted using ultrasound guidance into the internal jugular vein and then tunneled under the skin. A cuff of woven material is sited near the end and helps to anchor the device into the tissues. These cuffs require formal dissection to allow the device to be removed. Tunneled lines can be linked to injection ports that are located under the skin. These are especially popular in paediatric practice.

Peripherally inserted central cannula

Referred to as PICC lines, these are popular methods for establishing central venous access. Because they are inserted peripherally they are less prone to major complications relating to device insertion than conventional central lines.

Atropine

Atropine is a muscarinic receptor antagonist (competitive antagonist for the muscarinic acetylcholine receptor). It therefore inhibits parasympathetic activity.It was traditionally used as a premedication for anaesthesia because it reduced bronchial secretions, salivary secretions and bradycardia from increased vagal tone on anaesthetic induction. Modern anaesthetic techniques have reduced the need for routine use of this drug. Its other effects include urinary retention and pupillary dilatation.

Local Anaesthetic Agents

All local anaesthetics have a chemical bond linking an amine to either an amide or an ester. Most local anaesthetics are of the **amino-amide** types, these have a more favorable side effect profile and are more stable in solution.
Procaine and benzocaine have **amino-ester** groups, these are metabolized by pseudocholinesterases.

Lidocaine / Xylocaine / Lignocaine

- An amide
- Local anaesthetic and a less commonly used antiarrhythmic (affects Na channels in the axon)
- Hepatic metabolism, protein bound, renally excreted
- Toxicity: Due to IV or excess administration. Increased risk if liver dysfunction or low protein states. Note acidosis causes lidocaine to detach from protein binding.
- Drug interactions: Beta blockers, ciprofloxacin, phenytoin
- Features of toxicity: Initial CNS over activity then depression as lidocaine initially blocks inhibitory pathways then blocks both inhibitory and activating pathways. Cardiac arrhythmias.
- Increased doses may be used when combined with adrenaline to limit systemic absorption.

Cocaine

- Pure cocaine is a salt, usually cocaine hydrochloride. It is supplied for local anaesthetic purposes as a paste.
- It is supplied for clinical use in concentrations of 4 and 10%. It may be applied topically to the nasal mucosa. It has a rapid onset of action and has the additional advantage of causing marked vasoconstriction.
- It is lipophilic and will readily cross the blood brain barrier. Its systemic effects also include cardiac arrhythmias and tachycardia.
- Apart from its limited use in ENT surgery it is otherwise used rarely in mainstream surgical practice.

Bupivacaine

- Bupivacaine binds to the intracellular portion of sodium channels and blocks sodium influx into nerve cells, which prevents depolarization.
- It has a **much longer duration** of action than lignocaine and this is of use in that it may be used for topical **wound infiltration at the conclusion of surgical procedures** with long duration analgesic effect.
- It is cardiotoxic and is therefore contra indicated in regional blockage in case the tourniquet fails.
- Levobupivacaine (Chirocaine) is less cardiotoxic and causes less vasodilation.

Prilocaine

- Similar mechanism of action to other local anaesthetic agents. However, it is far less cardiotoxic and is therefore the agent of choice for intravenous regional anaesthesia e.g. **Biers Block**.

All local anaesthetic agents dissociate in tissues and this contributes to their therapeutic effect. The dissociation constant shifts in tissues that are acidic e.g. where an abscess is present, and this reduces the efficacy.

Doses of local anaesthetics

Agent	Dose plain	Dose with adrenaline
Lignocaine	3mg/Kg	7mg/Kg
Bupivacaine	2mg/Kg	2mg/Kg
Prilocaine	6mg/Kg	9mg/Kg

These are a guide only as actual doses depend on site of administration, tissue vascularity and co-morbidities.

Maximum total local anaesthetic doses

- Lignocaine 1% plain - 3mg/kg - 200mg (20ml)
- Lignocaine 1% with 1 in 200,000 adrenaline - 7mg/kg - 500mg (50ml)
- Bupivacaine 0.5% - 2mg/kg- 150mg (30ml)

Maximum doses are based on ideal body weight
1% contains 10mg/ml, 0.5% contains 5mg/ml

Effects of adrenaline

Adrenaline may be added to local anaesthetic drugs. It prolongs the duration of action at the site of injection and permits usage of higher doses (see above). It is contra indicated in patients taking MAOI's or tricyclic antidepressants. The toxicity of bupivacaine is related to protein binding and addition of adrenaline to this drug does not permit increases in the total dose of bupivacaine, in contrast to the situation with lignocaine.

For toxicity see Emergency Medicine chapter...

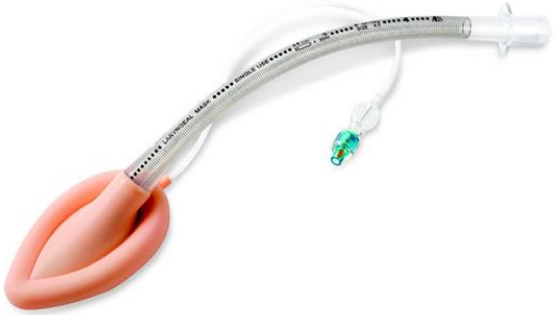
Anaesthetic Agents

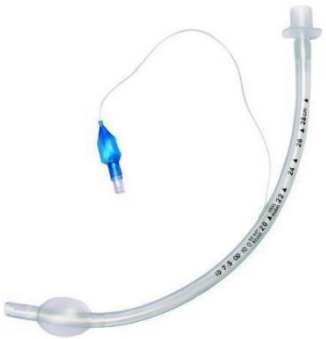
The table below summarises some of the more commonly used IV induction agents

Agent	Specific features
Propofol	• Rapid onset of anaesthesia • Pain on IV injection • Rapidly metabolised with little accumulation of metabolites • Proven **anti emetic** properties • Moderate myocardial depression • Widely used especially for maintaining sedation on ITU, total IV anaesthesia and for daycase surgery
Sodium thiopentone	• **Extremely rapid** onset of action making it the agent of choice for rapid sequence of induction • Marked myocardial depression may occur • Metabolites build up quickly • Unsuitable for maintenance infusion • Little analgesic effects
Ketamine	• May be used for induction of anaesthesia • Has moderate to strong analgesic properties • Produces **little myocardial depression** making it a suitable agent for anaesthesia in those who are haemodynamically unstable • May induce state of dissociative anaesthesia resulting in nightmares
Etomidate	• Has favorable cardiac safety profile with very little haemodynamic instability • **No analgesic properties** • Unsuitable for maintaining sedation as prolonged (and even brief) use may result in adrenal suppression • **Post-operative vomiting** is common

Airway Management

Oropharyngeal airway	• Easy to insert and use • No paralysis required • Ideal for very short procedures • Most often used as bridge to more definitive airway
Laryngeal mask	• Widely used • Very easy to insert • Device sits in pharynx and aligns to cover the airway • Poor control against reflux of gastric contents • Paralysis not usually required • Commonly used for wide range of anaesthetic uses, especially in day surgery • Not suitable for high pressure ventilation (small amount of PEEP often possible)
Endotracheal tube	• Provides optimal control of the airway once cuff inflated • May be used for long or short term ventilation • Errors in insertion may result in oesophageal intubation (therefore end tidal CO_2 usually measured) • Paralysis often required • Higher ventilation pressures can be used
Tracheostomy	• Reduces the work of breathing (and dead space) • May be useful in slow weaning • Percutaneous tracheostomy widely used in ITU • Dries secretions, humidified air usually required





Muscle Relaxants

Suxamethonium	• Depolarising neuromuscular blocker • Inhibits action of acetylcholine at the neuromuscular junction • Degraded by plasma cholinesterase and acetylcholinesterase (affected by lack of acetylcholinesterase) • Fastest onset and shortest duration of action of all muscle relaxants • Produces generalised muscular contraction prior to paralysis • Adverse effects include hyperkalaemia, malignant hyperthermia, delayed recovery
Atracurium	• Non depolarising neuromuscular blocking drug • Duration of action usually 30-45 minutes • Generalised histamine release on administration may produce facial flushing, tachycardia and hypotension • Not excreted by liver or kidney, broken down in tissues by hydrolysis • Reversed by neostigmine
Vecuronium	• Non depolarising neuromuscular blocking drug • Duration of action approximately 30 - 40 minutes • Degraded by liver and kidney and effects prolonged in organ dysfunction • Effects may be reversed by neostigmine
Pancuronium	• Non depolarising neuromuscular blocker • Onset of action approximately 2-3 minutes • Duration of action up to 2 hours • Effects may be partially reversed with drugs such as neostigmine

Malignant Hyperthermia

Overview

- Condition seen following administration of anaesthetic agents (rate of 1 in 15,000)
- Characterised by hyperpyrexia and muscle rigidity
- Cause by excessive release of Ca^{2+} from the sarcoplasmic reticulum of skeletal muscle
- Associated with defects in a gene on chromosome 19 encoding the ryanodine receptor, which controls Ca^{2+}release from the sarcoplasmic reticulum
- Neuroleptic malignant syndrome may have a similar aetiology

Causative agents

- Halothane
- Suxamethonium
- Other drugs: antipsychotics (neuroleptic malignant syndrome)

Investigations

- CK raised
- Contracture tests with halothane and caffeine

Management

- Dantrolene - prevents Ca^{2+} release from the sarcoplasmic reticulum

Tourniquets

Tourniquets are used during surgery to minimize blood loss and ensure a clear operative field. They must be correctly applied and monitored. They are applied to extremities and in most cases are inflated using a pressure monitoring system.

There are a number of systemic effects that can accompany tourniquet use, these can be divided into those which occur following inflation and those that occur once the tourniquet is deflated.

Post inflation

- Increased systemic vascular resistance, increased CVP and increased BP
- Slower gradual increase in BP over time
- Induced hypercoagulable state
- Slow increase in core temperature

Post deflation

- Fall in CVP, BP and SVR
- Increased end tidal carbon dioxide
- Enhanced fibrinolysis
- Fall in core temperature
- Raised serum potassium and lactate levels

Contra indications

Absolute	Relative
• AV fistula • Severe peripheral vascular disease • Previous vascular surgery • Bone fracture or thrombosis at the site of tourniquet application	• Sickle cell disease • History of thromboembolic events • Skin grafts • Localised infection • Lymphoedema

Local complications

- Damage to skin
- Damage to muscle (rarely compartment syndrome)
- Damage to vessels
- Neuropraxia

Blood Products - Cross Matching

Whole blood fractions

Fraction	Key points
Packed red cells	Used for transfusion in chronic anaemia and cases where infusion of large volumes of fluid may result in cardiovascular compromise. Product obtained by centrifugation of whole blood.
Platelet rich plasma	Usually administered to patients who are thrombocytopaenic and are bleeding or require surgery. It is obtained by low speed centrifugation.
Platelet concentrate	Prepared by high speed centrifugation and administered to patients with thrombocytopaenia.
Fresh frozen plasma	• Prepared from single units of blood. • Contains clotting factors, albumin and immunoglobulin. • Unit is usually 200 to 250ml. • Usually used in correcting clotting deficiencies in patients with hepatic synthetic failure who are due to undergo surgery. • Usual dose is 12-15ml/Kg^{-1}. • It should not be used as first line therapy for hypovolaemia.
Cryoprecipitate	• Formed from supernatant of FFP. • Rich source of Factor VIII and fibrinogen. • Allows large concentration of factor VIII to be administered in small volume.
SAG-Mannitol Blood	Removal of all plasma from a blood unit and substitution with: • Sodium chloride • Adenine • Anhydrous glucose • Mannitol Up to 4 units of SAG M Blood may be administered. Thereafter whole blood is preferred. After 8 units, clotting factors and platelets should be considered.

Cross matching

Must be cross matched	Can be ABO incompatible in adults
Packed red cells	Platelets
Whole blood	FFP
Cryoprecipitate	

(See Post-op Management chapter for 'Massive Hemorrhage' and 'Hypovolemia and the Surgical Patient')

Thromboprophylaxis in Surgical Patients

Deep vein thrombosis may develop insidiously in many surgical patients. Untreated it may progress to result in pulmonary embolism.

The following surgical patients are at increased risk of deep vein thrombosis:

- Surgery greater than 90 minutes at any site or greater than 60 minutes if the procedure involves the lower limbs or pelvis
- Acute admissions with inflammatory process involving the abdominal cavity
- Expected significant reduction in mobility
- Age over 60 years
- Known malignancy
- Thrombophilia
- Previous thrombosis
- BMI >30
- Taking hormone replacement therapy or the contraceptive pill
- Varicose veins with phlebitis

Mechanical thromboprophylaxis

- Early ambulation after surgery is cheap and is effective
- Compression stockings (contra -indicated in peripheral arterial disease)
- Intermittent pneumatic compression devices
- Foot impulse devices

Therapeutic agents

Agent	Mode of action	Uses
Low molecular weight heparin	Binds antithrombin causing inhibition of factor Xa	Thromboprophylaxis or treatment of thromboembolic events in those with normal renal function. It is given as once daily subcutaneous injection
Unfractionated heparin	Binds antithrombin III affecting thrombin and factor Xa	Effective anticoagulation, administered intravenously it has a rapid onset and its therapeutic effects decline quickly on stopping and infusion. Its activity is measured using the APTT. If need be it can be reversed using protamine sulphate
Dabigatran	Orally administered direct thrombin inhibitor	Used prophylaxis in hip and knee surgery. It does not require therapeutic monitoring. It should not be used in any patient in whom there is a risk of active bleeding or imminent likelihood of surgery. It is reversed using Idarucizumab

Summary

All high-risk patients should receive chemical prophylaxis (e.g. LMWH) + stocking/pumps during hospital stay

Patients who have LL or pelvic surgery will probably require prophylaxis post-discharge for a certain period

Peripheral neuropathy / claudication	LMWH, No stocking
Lower limb lymphedema	LMWH + compression pump
Spinal or Epidural anesthetic	LMWH can be given (discuss with anesthetist) + stocking / pump
Spinal surgery	Avoid LMWH/UH (spinal hematoma), discuss with surgeon + stocking / pump
Renal impairment	UH (or Adjust dose of LMWH according to renal function) + stocking / pump

Proactive Care of Older People Undergoing Surgery (POPS)

- Comprehensive geriatric assessment
- MDT assessment preoperatively
- Main predictors of complications are co-morbidities cardiac disease and reduced functional capacity - preoperative assessment is the key to preventing adverse postoperative outcomes
- Patients screened for risk factors (albumin <30, co morbidities)
- Management plan made and disseminated to all involved
- Patients education: pain relief, post op exercises, nutrition

Outcomes:

- Fewer postoperative medical complications
- Reduced length of stay by 4.5 days