GENERAL ANAESTHESIA

Criterea for Intubation

1. Maintenance of a clear airway
2. Airway protection
   - gastrointestinal contents
   - blood or secretions
3. Application of mechanical ventilation
4. Maintenance of oxygenation
   - control of F_IO_2
   - application of PEEP
5. Pulmonary toilet

Criteria for Extubation General

1. Absence of threat of airway soiling, or
   Ability to protect the airway
2. Adequate spontaneous ventilation
3. Adequate oxygenation
4. Ability to clear secretions

Criteria for Extubation Specific

1.	F_IO_2	< 50%	
2.	PEEP	≤ 5	cmH_2O
3.	PaO_2	> 60	mmHg
4.	$PaCO_2$	< 50	mmHg
5.	IMV	≤ 4	bpm
6.	VC	≥ 30	ml/kg
7.	SRR	≤ 30	bpm
8.	a resolving CXR		(ie. no new findings)
9.	no other major organ system failure or instability		

Rapid Sequence Induction

- ***Criterea***

1. reasonable certainty that ***intubation*** will be possible, ***if not*** →
   i. awake intubation under local anaesthesia
   ii. awake tracheostomy under local anaesthesia
2. risk of ***gastric aspiration***
   i. full stomach — - per fasting guidelines
- "presumed" due to uncertainty
   ii. trauma
   iii. intra-abdominal pathology — - intestinal obstruction
- inflammation
- gastric paresis (drugs, pain, diabetes, uraemia)
- peptic ulcer disease
   iv. oesophageal disease — - symptomatic reflux
- motility disorders
   v. pregnancy
   vi. obesity
3. risk of ***other aspiration*** — - blood or secretions
4. abnormal facial anatomy — - where mask ventilation is impractical
- trauma, craniofacial abnormalities

- ***Performance***

1. denitrogenation with 100% O_2 for 3 minutes, or
   at least 4 vital capacity breaths (Gold *et al.*)
2. administration of a sleep dose of thiopentone ~ 4 mg/kg
3. application of cricoid pressure ***as*** consciousness is lost,
   maintained until cuff inflation and confirmation of ETT placement
4. rapid establishment of paralysis
   i. suxamethonium 1.5 mg/kg, unless contraindicated
   ii. vecuronium or atracurium using the "priming principle"
   iii. ? rocuronium when available
5. endotracheal intubation & ***confirmation***,
   i. direct vision if possible
   ii. $ETCO_2$ for ≥ 6 breaths if available
   iii. breath sounds & chest movement * unreliable
   iv. SpO_2 * changes occur too late
6. confirmation of a small leak in children

Complications of Intubation

- ***Laryngoscopy Mechanical***

1. damage to teeth
2. damage to lips, gums or other soft tissues
3. coughing, laryngospasm, bronchospasm[§]
4. vomiting ± aspiration[§]
5. cervical injury
6. TMJ dislocation

[§]with light anaesthesia

*preexisting disease

- ***Laryngoscopy Physiological***

1.	cardiovascular responses	- hypertension, tachycardia, arrhythmias - bradycardias in children - myocardial ischaemia
2.	respiratory responses	- coughing, laryngospasm, bronchospasm ~ 2x increase in resistance ***above*** R_{ETT}
3.	raised ICP	- increased CBF $\propto$ $CMRO_2$ - raised MAP - decreased venous drainage with coughing
4.	hypoxaemia / hyperbarbia	- difficult or prolonged attempts

- ***Tracheal Intubation***

1.	failed intubation	
2.	oesophageal intubation	
3.	mechanical obstruction	- kinking, cuff overinflation/herniation - bevel directed into tracheal wall - blood, mucus, foreign body - endobronchial intubation
4.	mechanical damage	- pharynx, larynx, cords, trachea, oesophagus - blunt injury, dissection, perforation - ETT or stylet
5.	endobronchial intubation	

- ***Prolonged Intubation***

1. ***laryngeal complications***
   - pressure at cricoid cartilage & vocal processes of the arytenoids (cords)
   - movement during flexion/extension, swallowing, "coughing"

   i. acute post-extubation oedema, hoarseness ± laryngospasm
   ii. granuloma formation & perisitent hoarseness
   iii. laryngeal stenosis
   iv. swallowing disorders
2. ***tracheal complications***

   i. tracheomalacia ± perforation
   ii. tracheo-oesophageal fistula
   iii. tracheal stenosis
3. ***infective complications***

   i. local infection - retrocricoid abscess
   ii. tracheitis / nosocomial pneumonia
   iii. microaspiration / lung abscess
   iv. sinusitis / otitis
   v. septicaemia
4. ***dislodgement***
5. ***obstruction*** - endobronchial misplacement
   - secretions, blood, kinking, foreign body
   - cuff overinflation, herniation
6. ***dry gases*** - dehydration, hypothermia
   - thickened secretions, inspissation
7. ***loss of cough*** - inspissation, segmental / subsegmental collapse
   - infection, V/Q mismatch

- ***Nasal Intubation***

1. failure to pass a tube
2. haemorrhage - coagulopathy
   - pregnancy
   - polyps, adenoids, other local pathology
3. bacteraemia - CNS spread of infection
   - endocarditis risk
4. membrane necrosis / ulceration[§]
5. sinusitis ± otitis[§] [§]usually long-term intubation
6. basilar skull perforation *usually base of skull #

- ***Complications of Extubation***

1. failure → - hypoxaemia / hyperbarbia
   - exhaustion
2. respiratory responses - coughing, laryngospasm, bronchospasm
   - vomiting ± aspiration
3. cardiovascular responses - hypertension, tachycardia, arrhythmias
   - bradycardias in children
   - myocardial ischaemia

Laryngeal Mask

- ***Indications***

1. spontaneous ventilation anaesthesia
   i. convenience
   ii. airway difficult by other means
   iii. measurement of RR, V_E, $ETCO_2$
   iv. use of a HME/bacterial filter
2. as an aid to intubation
   i. passage of a bougie through the mask
   ii. passage of a 6.0 mm uncut ETT through the mask
   iii. passage of a fibreoptic bronchoscope
3. as a failsafe in difficult intubation drills
   i. can't intubate & anaesthesia must procede
   ii. can't intubate & can't ventilate
   iii. prone extubation - interim oxygenation

- ***Limitations / Contraindications***

1. ***does not*** protect the airway
2. causes pharyngeal discomfort in most patients
3. insertion may result in pharyngeal trauma
4. limited use for IPPV
   i. gentle IPPV - described, but risks of gastric distension & regurgitation
      - not recommended
   ii. high resistance/poor compliance respiratory systems absolute C/I
5. failure to pass
6. obstruction of the upper airway

Assessment of Airway

1. ***history***
   i. letters etc. re previous difficult intubation
   ii. previous anaesthetic records
2. ***examination*** → **"MOUTHS"**
   i. **M**andible
      - thyromental distance > 6 cm, 3 "finger-breadths"
      - alveolar-mental distance < 2 cm
      - "receeding", length
      - subluxation
      - obtuse mandibular angles

   ii. **O**pening
      - incisor gap > 4 cm

   iii. **U**vula
      - Mallampati grades I-IV - as per Samsoon & Young

   iv. **T**eeth
      - prominent upper incisors, "buck" teeth
      - solitary incisors, "nuisance" teeth
      - loose teeth
      - crowns, caps, plates & dentures

   v. **H**ead & Neck
      - flexion, extension, lateral flexion & rotation
      - tracheal position, neck masses, upper mediastinal masses

   vi. **S**ilhouette
      - obesity
      - Dowager's hump
      - "no neck"
      - craniofacial anomalies
3. ***investigations***
   i. direct or indirect awake laryngoscopy
   ii. fluoroscopy
   iii. XRays (Bellhouse)
      - mediastinal masses & tracheal position / diameter
      - effective mandibular length
      - atlanto-occipital distance & C_1-C_2 interspace
      - anterior-posterior thickness of the tongue

   iv. CT scan
      - tracheal deviation, luminal diameter
      - intrathoracic trachea, mediastinal masses

Therapeutic Applications of Ventilation

1. general anaesthesia with muscle relaxation
2. cardiopulmonary resuscitation
   - i. respiratory / cardiac arrest
   - ii. severe LV failure / acute pulmonary oedema
3. acute / chronic respiratory failure
   - i. maintenance of adequate ***gas exchange*** → parenchymal failure
   - ii. minimise ***work of breathing*** → pump failure
4. manipulation of CO_2 excretion
   - i. induced hypocapnia
     - metabolic / respiratory acidosis
     - raised ICP
     - acute head injury
   - ii. ∝ ↑ CO_2 production
     - MH, thyroid storm
   - iii. manipulation of PVR
     - pulmonary hypertension ± cor pulmonale
     - CHD with R→L shunt
     - transitional circulation in the newborn
5. "prophylactic" ventilation
   - severe flail chest
   - major, chest & upper abdominal surgery
   - unstable patients for transport

Guidelines for Institution of Ventilatory Support

Factor	Unacceptable Limit		Normal Values	
Mechanical				
respiratory rate	**> 35**	**bpm**	10-20	bpm
tidal volume	**< 5**	**ml/kg**	5-7	ml/kg
vital capacity	**< 15**	**ml/kg**	65-75	ml/kg
peak inspiratory pressure	**< 25**	**cmH_2O**	75-100	cmH_2O
Oxygention				
P_aO_2 (F_IO_2 > 0.6)	**< 60**	**mmHg**	75-100	F_IO_2 = 0.21
$P_{A-a}O_2$	**> 350**	**mmHg**	25-65	F_IO_2 = 1.0
Ventilation				
P_aCO_2	**> 60**	**mmHg**	35-45	mmHg
V_D/V_T	**> 0.6**		0.3	

Hypoxia

Def'n: a disorder of oxygen metabolism, characterised by failure of mitochondrial ***oxidative phosphorylation***, due either to,

i. an insufficient mitochondrial P_{O2}

ii. a metabolic block of oxygen utilisation within the mitochondria

▪ *Medical Classification*

a. ***hypoxaemic*** hypoxia

b. ***anaemic*** hypoxia

c. stagnant, or ***cardiogenic*** hypoxia

d. ***histotoxic*** hypoxia

NB: not well suited to anaesthesia / ICU → causes are often ***multifactorial***
∴ classify by → ***Supply / Demand***

▪ *Decreased Supply*

1. anaesthetic machine
   - hypoxic mixture, O_2 delivery < VO_2
   - pipeline error, crossed lines to/within machine
   - low pressure leak, blockage, rotameter configuration
   - line failure / empty cylinders
2. anaesthetic circuit
   - leak, blockage, entrainment, valve malfunction
   - misconnection
3. ventilator
   - V_T / V_D too low → inadequate V_A
   - incorrect settings, failure, leak
   - overpressure, barotrauma
4. ETT
   - oesophageal intubation, RMB intubation
   - cuff failure, herniation
   - obstruction, intraluminal / extraluminal
5. pulmonary
   i. ventilation
      - $\bar{}$ $\mathbf{V_A}$: obstruction, ↑ R_{AW}, FRC < CC
      - ↓ zone III: ↑ V_D^{Alv}, ↑ P_{AW}
      - lung resection, alveolar destruction
      - infection, oedema, fibrosis, contusion, soiling
      - effusion, haemothorax, chest wall failure

   ii. circulation
      - - $\mathbf{Q_S/Q_T}$: congenital, age, smoking, drugs, posture
      - hypovolaemia: ↓ zone III, ↑ V_D^{Alv}, ↑ P_{AW}
      - embolism: air, CO_2 , clot, AFE
      - RVF: 1°/2° failure

   iii. alveolar membrane
      - alveolar-capillary block
      - infection, oedema, fibrosis, infiltration, contusion

6. <u>cardiovascular</u>

i.	1° pump failure	- AMI: RVF ↓ zone III, ↑ P_{AW} effects LVF ↓ DO_2, ↓ P_{vO2} - valvular heart disease - arrhythmia, contusion, post-CABG - infection, infiltration
ii.	2° pump failure	- hypovolaemia: ↑ V_D^{Alv}, ↓ zone III, ↑ P_{AW} effects - RVF: pulmonary hypertension, PTE, AFE - LVF: systemic hypertension, anaemia - tamponade: blood, effusion, constriction, tumour - metabolic, ***hypoxaemia***, post-CABG
iii.	R→L shunt	- ASD/VSD + Eisenmenger's, cor pulmonale - CHD - severe CAL, hepatic failure - Osler-Rendu-Weber syndrome, AV malformation
iv.	circulatory failure →	↑ systemic shunt, failure of distribution - SIRS (sepsis syndrome), MOSF, post-CABG - DIC, microvascular angiopathy - anaphylaxis, toxins, metabolic / nutritional - spinal shock, drugs (vasodilators)
v.	local vasculopathy	- coronary artery disease - cerebrovascular disease - peripheral vascular disease, etc.
vi.	HbO_2 failure	
	• anaemia	- ↓ C_{aO2}, ↓ P_{vO2}, ↑ LVF/IHD
	• left shift	- ↑ pH, ↓ P_{aCO2}, T., 2,3-DPG (mostly theoretical)
	• dyshaemoglobin	- MetHb, COHb, SulphHb
	• haemoglobinopathy	- HbS, thallasaemia

7. <u>tissue/cellular</u>

i.	interstitial	- oedema, infection, infiltration
ii.	cellular/mitochondrial block →	causes of ***lactic acidosis*** type II
	• drug induced	- phenformin, metformin, fructose - ethanol, methanol, sorbitol, xylol - salicylates - cyanide
	• enzyme deficiency	- G6PD, F-1,6-diphosphatase deficiency
	• other	- septicaemia - diabetes - renal failure, liver failure, pancreatitis - tumour (lymphoma, leukaemia) - thiamine deficiency

- ***Increased Demand***

1. exercise, sexual activity
2. pregnancy
3. paediatrics
4. sepsis & SIRS
5. hyperthermia
6. malignant hyperthermia
7. thyrotoxicosis, thyroid storm

NB: increased demand *per se* is infrequently a cause of hypoxia, (except MH), unless combined with decreased supply

HYPOXIA

Cause	P_{aCO2}	δP_{A-aO2}	δP_{aO2} µ 100%
low F_IO_2	low	low	large increase
hypoventilation	high	normal	large increase
V/Q mismatch	normal	high	large increase
low DO_2	normal	high	increase
R→L shunt	normal	very high	small increase

Smoking & Anaesthesia

Policy Document P12 (1991)

- ***Adverse Effects***

1. ***carboxyhaemoglobin***
   - normal range < 1-2%, smokers < 15%
   - normal half-life ~ 4 hrs on room air, 40-80 min at F_IO_2 =1.0
   - shifts HbO_2 curve to the ***left*** & decreases available Hb for O_2 carriage
   - increases frequency of arrhythmias & negatively inotropic
   - tolerated in "normal" individuals, may be significant with decreased CVS reserve
   - theoretical beneficial effects with cessation > 12 hrs
   - long-term results in ***polycythaemia*** & increased blood ***viscosity***
   - these require cessation for several days
2. ***nicotine***
   - results in ↑ HR, BP (SAP & DAP), and SVR
   - improvement is seen with cessation for several days
3. ***respiratory***
   i. hypersecretion of mucus
      - declines over a 6 week period, majority in the first few weeks

   ii. impaired ciliary activity & clearance of secretions

   iii. small airways narrowing & increased airways irritability
      - improved after 1 month, further at 2 months and continuing to 6 months
      - irritability & sputum production may actually ***worsen*** in the first few weeks

   iv. ↑ postoperative chest infections

   v. ↑ frequency & severity of hypoxaemic events post-surgery, greater requirement for supplemental O_2

   vi. ↑ CAL - predominantly obstructive or restrictive

   vii. ↑ bronchogenic carcinoma
4. ***cardiovascular***
   i. ↑ ***coronary artery disease*** - major risk factor

   ii. ↑ peripheral vascular disease/cerebrovascular disease

   iii. ↑ hypertension

   iv. factors
      - polycythaemia
      - increased viscosity
      - increased platelet adhesiveness
      - hypoxaemia
      - vasoconstriction
5. ***immunoparesis***
   - decreased function demonstrable & requires ~ 6 months for recovery

- ***Recommendations***

1. patients should be encouraged to cease ***6-8 weeks*** prior to an operation
2. they should not be allowed to smoke for ***12 hours*** preceeding operation
3. they should be encouraged to abstain from smoking for as long as possible postoperatively
4. all patients should be encouraged to give-up smoking indefinitely

Blood Transfusion

- ***Indications***

1. increase the O_2 carrying capacity of blood $\rightarrow$ $\uparrow DO_2$
2. increase circulating blood volume

- ***Complications***

1. ***rate dependent***
   - i. over / under-transfusion
   - ii. hypothermia
   - iii. impaired O_2 transport / delivery
   - iv. coagulopathy
     - thrombocyotpaenia
     - factor deficiency
     - DIC
   - v. electrolyte disturbance
     - hyperkalaemia / delayed hypokalaemia
     - citrate toxicity / hypocalcaemia
     - hypernatraemia
   - vi. acid-base disturbance
     - acidaemia
   - vii. vasoactive reactions
     - kinins, platelet aggregates, etc.
2. ***rate independent*** - relatively !
   - i. acute haemolytic transfusion reaction - immediate generalised reaction
   - ii. delayed haemolytic transfusion reaction
   - iii. febrile, non-haemolytic transfusion reaction
   - iv. non-immunogenic reactions
     - out-of-date, incorrectly stored
     - frozen, or overheated blood
     - mechanical destruction
   - v. infection
     - primary
     - secondary
   - vi. immunoparesis
   - vii. post-transfusion jaundice
     - more dependent upon volume cf. rate
3. ***chronic transfusion***
   - i. iron overload
     - haemochromatosis

Infection & Anaesthesia

- ***Unversal Precautions***

Def'n: strategies to be used with ***all*** patients, in an attempt to reduce transmission of blood-borne diseases to the health care worker

1. engineering controls
   i. protective barriers & clothing - especially hands, eyes & face
   ii. needle-free injection ports
   iii. protected needle devices
   iv. artificial ventilation devices to prevent the need for mouth-to-mouth ventilation
   v. puncture resistant "sharps" containers in workplaces
2. work practice controls
   i. prohibition of "recapping"
   ii. meticulous routines for disposal of sharps
   iii. non-exposure of personnel with open skin lesions/wounds
   iv. handwashing following removal of gloves & as soon as practicable following exposure to infected material
3. employee education
   i. risks of transmission
   ii. modes of transmission
   iii. risk reduction techniques
   iv. immediate action upon exposure
   v. follow-up & documentation
4. vaccination
   i. HBV
   ii. TB

- ***Hepatatis B***

1. ***seroconversion*** from percutaneous exposure HBeAg (+)'ve **~ 30%**
2. ↑ risk proven by higher incidence of serum markers in anaesthetic personnel
   i. USA blood donors ~ 3-5%
   ii. anaesthesia residents ~ 9-18%
   iii. specialist anaesthetists ~ 19-49% ?? immunisation
3. strategies for prevention
   i. universal precautions
   ii. HBV vaccination ~ 95% seroconversion after 3 doses
   - use of "booster dose" after several years

- ***Hepatatis C***

1. seroconversion from percutaneous exposure HCV (+)'ve **~ 3%**
2. majority of cases of non-A-non-B hepatitis
   i. non-A-non-B hepatitis → ~ 90% of post-transfusion hepatitis
   ii. post-transfusion → ~ 6-10% non-A-non-B hepatitis
   ? remainder IV drug users etc.
3. increased serum markers of HCV in health care workers
   - 2-3% of all cases of HCV in USA occur in HCW's
4. ***hyperimmune IgG*** suggested as prophylaxis following needle-stick injury
5. no vaccine presently available

- ***Human Immunodeficiency Virus***

1. ***seroconversion*** from,
   i. percutaneous exposure HCV (+)'ve **~ 0.3-0.5%**
   ii. mucous membrane exposure ~ 0% (0/162 & 0/3058)
   iii. blood transfusion
      - USA ~ 1:40,000-100,000
      - UK < 1:3,000,000
      - Australia < 1:1,000,000 - unknown, probably < UK
   iv. social contacts **~ 0%**
      - longitudinal studies of households in USA
      - no reported cases in non-sexual partners, or outside of birth
2. patients may be ***Ab negative*** and infectious,
   i. acute infection in window period ~ 4-6 weeks
   ii. non-seroconverters
3. patients may be ***Ab positive*** and ***virtually noninfectious***
4. average time from HIV to AIDS syndrome ~ 8 years
5. long relatively noninfectious period following initial infection
   → 2nd infection wave anticipated
6. some centres offer prophylactic therapy with ***zidovudine (AZT)***

Laparoscopic General Surgery

- first reported series of laparoscopic general surgery in 1989
- now treatment of choice for ***cholecystectomy***
- other procedures for which laparoscopic surgery has been advocated,
    i. heriorrhaphy
    ii. appendicectomy
    iii. hemicolectomy, colectomy, anterior resection
    iv. oesophagectomy, oesophagomyotomy, fundoplication
    v. vagotomy
    vi. thoracic procedures
    vii. nephrectomy
    viii. pelvic lymph node dissection

- ***Advantages***

1. smaller wound, less tissue trauma
2. less postoperative pain, lower analgesic requirements
3. shorter hospitalisation periods, earlier return to normal activities
4. suitable for day surgery in some individuals
5. reduction in cost

- gynaecological laparoscopy in fit young women → ***mortality ~ 4-8:100,000***
- however, patients for general laparoscopic surgery are,
    1. usually older
    2. have a greater incidence of concurrent disease
    3. may be being operated upon for acute pathology

- ***Intraoperative Problems***

1. ***trauma*** to intra-abdominal structures
2. ***gas insufflation***
    i. peritoneal
    ii. extraperitoneal
    iii. venous gas embolism
3. tension ***pneumoperitoneum***
4. ***hypercarbia*** & systemic absorption of CO_2
5. patient ***position***

- ***Inadvertent Damage to Intra-Abdominal Structures***

1. liver, spleen
2. stomach, small & large intestines
3. uterus
4. aorta, IVC, iliac, epigastric or splenic arteries

NB: presentation may be delayed, and may be 2° to ***haemorrhage*** or ***sepsis***

- ***Gas Insufflation***

1. arrhythmias → bradycardia, AV dissociation, nodal rhythm, asystole
   - more pronounced with ***rapid inflation*** and at the begininning of insufflation
   - ***vagally mediated***
   - worsened by ***hypercarbia & halothane***
2. extraperitoneal insufflation
   - subcutaneous emphysema
   - pneumomediastinum, pneumopericardium, pneumothorax
   - dissection into the diaphragm, falciform ligament or retroperitoneally
3. displacement of intra-abdominal fluid
   - ascites or peritoneal lavage
   - most commonly → ***pleural effusion***
4. ***venous gas embolism***
   - effects are dependent upon,
   i. the rate, quantity and nature of the gas introduced
   ii. pre-existing cardiorespiratory disease
   - magnitude of physiological derrangement with CO_2 ~ 6x ***less than*** that for air, due to the greater blood solubility of CO_2
   - provokes neutorphil clumping, activation of coagulation and platelet clumping
   - ***PMN degranulation*** → - pulmonary vasoconstriction & raised PVR
     - bronchospasm & pulmonary oedema
     - rarely delayed pulmonary haemorrhage
   - PVR is further raised as - gas bubbles adhere to fibrin deposits
     - platelet aggregates marginate on endothelium
   - - ***RV afterload*** → - acute RVF, ↑ CVP & PAP, ↓ PAOP
     - arrhythmias, hypotension
   - paradoxical embolism through a patent ***foramen ovale***
   - results in ↑ West zone 1, ↑ $V_D^{Alv.}$ and ↑ P_{aCO2} - $ETCO_2$ gradient
   - portal venous embolism may result in trapping of gas in the ***liver*** and gradual release may result in delayed manifestations in the postoperative period

- ***Tension Pneumoperitoneum***

NB: effects are ∝ ↑ IAP

1. ***respiratory***
   - ↓ lung volumes, especially FRC
   - ↓ compliance & ↑ P_{AW}
   - ↑ haemodynamic effects of IPPV & risk of barotrauma
   - ↑ V/Q mismatch → hypoxia & hypercarbia
   - ↑ regurgitation & ***aspiration risk***
   - cephelad movement of the diaphragm may result in RMB intubation
2. ***cardiovascular***
   - ↑ SVR ∝ ↑ IAP
   - effects upon venous return & CO are pressure & volume dependent
   - ***biphasic response***

   i. low ↑ IAP → ↑ VR & CO ↔ SVR

   ii. high ↑ IAP → ↓ VR & CO ↑ SVR
   - the point of inflexion is lower (~ 15 mmHg) in upper GI surgery, due to the requirement for reverse Trendenenburg, cf. gynae procedures (~ 20 mmHg)
3. renal & hepatic function
   - **IAP > 20 mmHg** → ↓ RBF & GFR ↑ renal R_V
     ↓ CO
     ↓ glomerular filtration pressure
   - massive ↑ IAP results in lactic acidosis ↓ CO
     ↓ hepatic lactate clearance

- ***Hypercarbia & Systemic Absorption of CO_2***

1. hypercapnia- peritoneal absorption of CO_2 (predomonant)
   - ventilatory effects of pneumoperitoneum & position
2. more significant in patients with pre-existing ventilatory insufficiency
3. effects are composite of direct & indirect CO_2 effects

   i. tachycardias, arrhythmias

   ii. high CO, low SVR

   iii. increased MRO_2

NB: → main argument for ***intubation & hyperventilation*** with IPPV

Patient Position

1. Trendelenburg "head-down"
   - upward displacement of the diaphragm
   - aggravation of the pulmonary effects of tension pneumoperitoneum
   - high P_{IP}, atelectasis, V/Q mismatch and hypoxaemia
   - reduced alveolar V_D & increased CO 2° venous return limit these effects
   - venous congestion of the head & neck may compromise cerebral perfusion pressure
   - prolonged procedures may be associated with laryngeal oedema
2. reverse Trendelenburg "head-up"
   - minimal displacement of the diaphragm
   - decreased venous return and CO
   - increase zone 1 and alveolar dead space
   - exacerbated effects of IPPV

NB: effects are usually greater with,

i. extremes of position
ii. obesity
iii. high inflation pressures
iv. absence of muscle paralysis
v. relative hypovolaemia

Thoracoscopic Procedures

1. procedures include
   - sympathectomy, vagotomy
   - oespohagomyotomy, oesophagectomy
   - sealing of ruptured bullae
   - diagnostic
2. complete isolation/collapse of one lung is required →***DLT mandatory***
3. requires careful regulation of the ***deliberate pneumothorax***
   i. overpressure & tamponade from insufflation
   ii. suction and evacuation of gases may result in re-expansion or negative 'tension'
4. risk of laceration of the lung parenchyma and postoperative pneumothorax
   - ***always*** insert an intercostal tube postoperatively
5. proximity of the heart to the surgical site
   - direct trauma
   - diathermy & arrhythmias

- ***Anaesthetic Management***

1. ***general anaesthesia***
   - GA with ETT / IPPV and muscle relaxation
   - ***muscle relaxation*** reduces IAP and mean P_{AW}
   - important to avoid excessive mask ventilation and insufflation of the stomach
   - may be beneficial to pass ***N/G tube*** prior to cannulation if difficult mask ventilation
   - large minute ventilation may be required for CO_2 excretion, however large tidal volumes may have adverse CVS effects, \ individually optimise ventilation
   - use of $\mathbf{N_2O}$ is questioned,

   i. ***does not*** result in significant distension of the bowel

   ii. postoperative ***emesis***
      - no increase in general procedures
      - increases in gynaecological procedures ~ 32%

   iii. must be discontinued if ***gas embolism*** occurs
   - halothane increases the incidence of ***arrhythmias*** → ***isoflurane***
   - due to "learning curve" of surgical team may be a prolonged procedure
   - may require conversion to ***open laparotomy***

2. ***local anaesthesia & sedation***
   - usually only for short diagnostic procedures
   - use N_2O for insufflation as less irritant than CO_2
   - SV results in less cardiorespiratory disturbance cf. GA / IPPV
   - excessive sedation should be avoided,

   i. potential for regurgitation & aspiration

   ii. increased respiratory embarrasment

   iii. prolonged recovery similar to GA & ∴no advantage in DSU

3. ***epidural anaesthesia***
   - technically feasible, but shoulder tip pain and shivering may be problematic
   - levels to T_4 are required for upper abdominal procedures,

   i. sympathetic denervation may aggravate ***hypotension***

   ii. vagally mediated ***bradyarrhythmias*** may be potentiated
   - intravenous ***sedation*** should be kept to a minimum

4. ***monitoring***

   i. ECG, NIBP, F_IO_2 / S_pO_2, $ETCO_2$, spirometry and P_{AW} are mandatory

   ii. PNS and temperature are optional depending upon length of procedure

   iii. bladder catheterisation - lower abdominal procedures for access
   - long upper GI procedures

   iv. N/G tube - upper abdominal procedures for access

   v. other monitors as directed by patient status

5. ***$ETCO_2$***
   - in healthy patients under GA, $P_{a\text{-}E'CO2}$ ~ 2-9 mmHg
   - gradient is ***increased*** by - intrinsic lung disease
     - hypovolaemia, reverse Trendelenburg
   - gradient is ***decreased*** by - increased CO or CO_2 production
     - eg., pregnancy, paediatrics
   - gradient is small in gynaecological procedures, and in relatively healthy patients undergoing general procedures
   - valuable in early detection of ***gas embolism***

6. ***postoperative course***
   - following cholecystectomy most patients are discharged the following day
   - selected patients may be done as day cases
   - N&V is the commonest cause for delayed discharge **~ 7%**
   - ***antiemetics*** are required in ~ 50%
   - FVC is reduced ~ 27% cf. 48% following open procedures
   - pulmonary function returns to normal within 24 hours, cf. 72 hours open
   - however, significant decrement may occur in patients with pre-exisitng disease which lasts longer
   - pulmonary dysfunction following laparoscopic procedures is ***not*** improved by epidural anaesthesia

Prolonged Anaesthesia

Def'n: procedures lasting > 4-8 hours

1. ***preparation***
   - i. theatre geometry
   - ii. drugs, infusions, warming & ancillary devices
   - iii. placement of "lines" and monitoring devices
2. ***position***
   - i. head-up
     - venous pooling & stasis in lower limbs & risk of DVT
     - foot & heal pressure
   - ii. head-down
     - oedema & congestion of airway → delayed extubation
   - iii. pressure care
     - supine: - heels, buttocks, elbows, knees
     - lateral: - hip, shoulder, upper/lower arms
     - prone: - hips, knees, face, eyes, chest
     - lithotomy: - legs, hip joints
     - eyes - also require lubrication
   - iv. nerve damage
3. ***temperature control***
   - warmed IV fluids
   - warming blanket - on top better than on table
   - HME or humidified gases
   - cover exposed parts
   - removal of wet drapes, or sheilding from moisture
   - monitoring
   - use of convective air-heaters postoperatively
4. ***fluid therapy***
   - i. maintenance fluids
   - ii. replacement of 3rd space losses (child replacement figures)
     - peripheral procedures → 0-2 ml/kg/hr
     - intracavity procedures → 3-5 ml/kg/hr
     - major abdominal/thoracic → ≤ 15 ml/kg/hr
   - iii. replacement of blood-loss
   - iv. monitoring
     - all should have a urinary catheter & hourly output
     - requirement for CVP/PAOP on an individual basis

5. ***anaesthetic maintenance***
   - i. ***IPPV*** mandatory in all but "exceptional" circumstances
     - use high volume/low pressure cuffed ETT
   - ii. ***nitrous oxide*** (Nunn, BJA)
     - ≤ 0.5 hr → no effect, but cumulative if interval < 3 days
     - ≥ 2 hr → hepatic ***methionine synthetase*** will be depressed
       effects on DNA synthesis unpredictable
     - ~ 24 hr → reasonable for healthy patient
       megaloblastic bone marrow & abnormal dU-suppression
     - > 24 hr → absolute contraindication
   - iii. ***air***
     - absolute requirement if N_2O not used
     - development of ***absorption atelectasis*** with high F_IO_2's
   - iv. ***volatile*** → isoflurane ∝ low tissue solubility & % metabolism
   - v. ***neuromuscular blockade***
     - long half-life agents - pancuronium, doxacurium, pipercuronium
     - short half-life agents - use by infusion
       - more rapid offset for any given level of blockade
     - monitoring - TOF with PNS
       - relaxograph, closed-loop systems
     - ? requirement for deep paralysis & relationship to ***DVT***
   - vi. ***IV agents***
     - supplemental analgesia - opioid infusions
       - intermittent doses
     - supplemental hyponosis - propofol, midazolam/diazepam
     - anaesthesia - favourable kinetics with propofol
       * excessive cost
   - vii. attention maintenance routine for the anaesthetist

6. ***emergence / recovery***
   - i. residual anaesthetic effects amplified
   - ii. pain management
   - iii. all require supplemental O_2 for first 24-48 hours
   - iv. requirement for observation in HDU/ICU

Acute Pain

- ***Factors***

1. neuroendocrine — - catecholamines
   ↑ MRO_2, glucose intolerance, catabolism
2. protein catabolism — ↑ urinary nitrogen excretion
3. respiratory reserve — - decreased diaphragmatic function
   - atelectasis, hypoxia
4. ↑ myocardial work
5. thrombosis
6. sleep, anxiety, perception, psychological dysfunction
7. hyperalgesia, wind-up, spasm
8. chronic pain — ↑ cFOS, δDNA

- ***Patient Controlled Analgesia***

1. failure of conventional IM analgesia
   - medical staff under-treat & under-administer (Donovan 1987)
   i. ~ 61% awake in pain
   ii. ~ 58% describe this as terrible
   iii. on average patients receive ~ 25% of the prescribed dose
2. improved drug delivery
   i. ↓ administration variability
   ii. ↓ absorption variability
   iii. ↓ peaks & troughs
3. interpatient variability → kinetic & dynamic variation
   ~ 8x variation in dose requirement
   * ***age*** >> ***weight*** as factor
4. intrapatient variability → varying requirement over postoperative course
   * major ↓ dose days 1-4

- Stapleton (FMC 1980): patients vary from severe to no pain over a very narrow concentration range → ***minimum effective analgesic concentration***
- lead to graphical comparison of IM vs. IV infusion vs. infusion + bolus vs. PCA

- Owen (FMC) studied boluses using 0.5 and 1.0 mg, patients ***did not*** titrate to a plasma corridor
- ∴concluded that MEAC was not a valid concept → ***fixed demand***
- study criticised as used background infusion rates, ∴some may have been within MEAC

- ***Mechanisms***

1. MEAC ?? fact or artifact
2. fixed demand concept
   - diminution of pain perception with administration
   - "placebo"-like effect
3. control vs non-control
   - ie. an internal locus versus an external locus

- ***Modes of Delivery***

1. demand dosing
2. continuous infusion
3. demand dosing & continuous infusion
4. demand infusion
5. variable rate infusion & demand dosing

- ***Parameters***

1. loading dose
2. loading dose infusion rate
3. patient bolus dose
4. patient bolus dose infusion rate
5. lockout interval
6. drug concentration

- ***Safety Features***

1. locked syringe cage
2. locked program sequence
3. safety program default settings
4. set protocols for administration
5. set protocols for dose increase/reduction
6. set protocols for treatment of side-effects
7. nursing protocols for cross-checking
8. acute pain services - daily review by accredited personnel
9. continuing education - medical & nursing

▪ ***Background Infusions***

• ***no evidence*** to suggest people use less, or require less during the night
• studies poorly controlled or retrospective
• presently studies looking at background & non-background and the "catch-up" dose requirements in the early morning hours

NSAID's

• ***prostaglandins*** are cofactors with bradykinins & other tissue factors in ***nociception***
• side effects include,

1. ***gastric*** ↓ mucosal blood flow
   ↓ basal cell migration
   - petechiae, errosions
   - silent ulcers ~ 0.33:1,000 patients on NSAID's cf. normal ~ 0.22:1,000
   - Ketorolac > 120 mg/d → petechiae, errosions on endoscopy
     ∴ use < 120 mg/d
2. ***renal*** ↓ RBF, renin secretion
   ↑ renovascular resistance
   ↑ susceptibility to ATN from hypovolaemia
   - Kenny showed no change in creatinine clearance, but this was not a good study
   - generally recommended ***not*** to be used with ↓ RBF, hypertension, CCF, CRF
3. ***platelet inhibition***
   - *in vitro*, 30 mg→ no significant ↑ bleeding
   - however, there were a number of "outliers" with severe bleeding, ∴? sensitive gp.
   - *in vivo*, surgical studies show no increase in blood-loss, but this is a poor marker
   - ∴use ***clinical criteria*** of the risk of bleeding
4. ↓ coronary blood flow
5. altered stress/immune response to surgery

▪ ***Use of Ketorolac***

1. ***opioid sparing*** effect ~ 20-35% reduction in dose
   - 30 mg ~ 10 mg of morphine
2. combination therapy → additive or ***synergistic***
3. pretreatment
4. no use in major surgery due to risk of haemorrhage
5. cost - more expensive
   - no advantage over other oral/enteral preparations

NB: recently withdrawn from routine use at RAH due to occurrence of ***rhabdomyolysis*** and myoglobinuria; predominantly in young muscular individuals ~ 1:500,000

• US cohort study comparing ketorolac & opioids, factors associated with an increased risk of ***GIT bleeding***,

1. age > 65
2. history of peptic ulceration
3. concurrent R_X with anticoagulants or other NSAID's
4. total daily dose > 120 mg
5. duration of treatment > 2 days

• recommendations of the Committee on Safety of Medicines (UK),

1. starting dose reduced to 10 mg
2. subsequent doses 10-30 mg, 4-6 hourly prn
3. total ***daily dose*** **< 90 mg** ***adults***
   < 60 mg ***elderly***
4. maximum duration of therapy is 2 days in ***all*** age groups

■ ***Contraindications***

1. history of peptic ulceration or GIT bleeding
2. haemorrhagic diathesis
3. history of a confirmed or suspected intracerebral bleed
4. operations associated with a high risk of haemorrhage
5. a history of asthma
6. moderate or severe renal impairment - serum creatinine > 160 µmol/l
7. hypovolaemia or dehydration from any cause
8. hypersensitivity to aspirin or other NSAID's
9. pregnancy
10. therapy with the following drugs
    i. other NSAID's
    ii. anticoagulants - ***including*** low dose heparin

■ ***Causes of Death***

1. GIT bleeding / perforation ~ 48%
2. renal impairment / insufficiency ~ 20%
3. asthma / anaphylaxis ~ 7%
4. haemorrhagic reactions ~ 5%
5. unexplained / miscellaneous ~ 20%

Epidural Analgesia

1. ↓ neuroendocrine stress response
2. ↓ catabolism
3. ↓ DVT incidence
4. ↑ respiratory function
5. ↑ coronary blood flow & ↓ ischaemic episodes

- ***Epidural Opioids***

1. complications of ***morphine***
   - i. respiratory depression - age, dose, respiratory disease, operation site
   - ii. nausea & vomiting
   - iii. pruritis
   - iv. urinary retention
   - v. breakthrough pain
   - vi. HSV-type 1 ~ 24% chance of reactivation
     ~ 50% of population HSV-Ab positive
2. management of ***pruritis*** ↓ dose
   - anti-histamines
   - κ-agonists
   - μ-antagonists
   - propofol
3. epidural fentanyl versus IV infusion
   - if used at a dermatomal level → ↓ dose requirement
     ↓ side-effects
   - \ ***does*** have an effect at the spinal cord level
4. PCEA vs. epidural infusions → ↓ dose requirement
5. LA / opioid combinations
   - effective providing the bupivacaine dose ≥ 13 mg/hr

- ***Assessment of Outcome***

1. attenuation of stress response
2. decrease in side-effects
3. discharge from hospital
4. major morbidity
5. mortality

Spinal Anaesthesia

- ***Indications***

1. surgical procedures ***amenable*** to spinal anaesthesia
   - predominantly procedures below the umbilicus
   - upper abdominal anaesthesia to T_4 "as invasive" as general anaesthesia
2. ***circumscribed procedures***, where physiological trespass is minimal
   - rectal & perianal procedures
   - TURP
3. where an ***awake patient*** is advantageous
   i. procedure related - TURP → CCF, hypoosmolar syndrome
      - day case surgery
   ii. patient related - severe cerebrovascular disease, diabetes, elderly
4. procedures where there is ***proven benefit***
   i. hip or knee joint replacement surgery - PE, blood loss, hospital stay
   ii. lower limb amputation - phantom pain
   iii. previous history of DVT / PE ? proven
5. ***obstetric*** anaesthesia*
   i. awake mother
   ii. absence of neonatal drug effects
6. preferrable to ***avoid GA***
   i. full stomach - arguable as must be prepared to give GA
   ii. potential, or known difficult intubation*, unstable spine
   iii. severe respiratory or cardiac disease
   iv. muscular diseases, MHS
7. ***patient request***

- ***Contraindications - Absolute***

1. patient refusal
2. documented allergy to local anaesthetics
3. skin/soft tissue infection at the intended injection site
4. meningeal infection
5. coagulopathy
6. severe / uncorrected hypovolaemia
7. raised intracranial pressure
8. inability to remain still during the procedure

- ***Contraindications - Relative***

1. hypovolaemia
2. surgical procedure with a high risk of major blood loss
3. systemic sepsis
4. "minor" coagulation deficiency
   - mini-dose heparin
   - aspirin
   - chronic renal failure
   - PE with low platelets (> 100,000)
5. surgical procedure of indeterminate length
6. pre-existing neurological disease
7. chronic severe backache, deformities of the spinal column
8. major surgical procedures above the umbilicus
9. afterload/preload dependent heart disease
   - valvular heart disease
   - HOCM
   - congenital heart disease
10. young patient - high risk of PDPH
11. inexperienced operator

- ***Complications***

1. physiological consequences of blockade
   i. cardiovascular
   ii. respiratory
   iii. other
2. failure of blockade
3. backache
4. post-dural puncture headache
5. neurological sequelae
   i. neurolytic - ***all*** agents are neurotoxic in high concentrations
      - 4 cases of ***cauda equina syndrome*** described with continuous SA technique
   ii. direct trauma - nerve roots / cord
   iii. compressive - intraspinal / epidural haematoma
   iv. infective - meningeal
   - epidural
   v. inflammatory - drugs, additives, wrong drug
   vi. multifactorial - ***anterior spinal artery*** & cauda equina syndromes
   vii. by association - exacerbation of pre-existing disease, etc.
6. local anaesthetic allergy - rare & no cross sensitivity

Epidural Anaesthesia

- ***Indications - General***

1. obstetric anaesthesia *see below
2. epidural anaesthesia alone
   → indications for spinal anaesthesia, plus
   i. where the abrupt ***onset*** of sympathectomy is undesirable / contraindicated
   ii. where the ***duration*** of the procedure is extended / unpredictable
   iii. where ***extension of pain relief*** into the postoperative period is desirable
   iv. young patients where the risk of ***PDP headache*** is high
   - this has been modified recently by the reduction in PDPH with fine gauge pencil-point needles
3. combined epidural & general anaesthesia
   → indications for epidural anaesthesia, plus
   i. major and upper abdominal / thoracic procedures
   ii. prolonged procedures
   iii. procedures requiring "uncomfortable" positioning
   iv. patient request - ie. epidural but asleep

- ***Indications Obstetric***

1. ***maternal*** *minimise ***stress response***
   i. pain relief
   ii. pre-ecplamsia
   iii. cardiorespiratory disease
   iv. other diseases requiring minimal stress
   - diabetes
   - cerebrovascular disease
2. ***foetal*** *high chance of ***instrumental delivery***
   i. multiple foetuses
   ii. large foetus
   iii. malpresentation
   iv. premature foetus
   v. deformed/dead foetus
3. ***uterine*** *normalisation of ***abnormal physiology***
   i. uterine hypertonicity / incoordinate action
   ii. cervical dystocia
   iii. placental vascular insufficiency
   iv. ?? trial of scar

- ***Complications***

1. allergy to local anaesthetics
2. ***systemic toxicity*** * CVS & CNS
   i. relative / absolute overdose
   ii. accidental intravascular injection
3. ***local toxicity***
   i. nerves - ***all*** agents are neurotoxic in high concentrations
   * 4 cases of cauda equina described with continuous SA technique
   ii. injection of the "wrong" drug, or a contaminated drug
4. ***needle*** related problems
   i. backache
   ii. venous puncture
   iii. subdural placement
   iv. dural puncture - total spinal blockade
   - post-dural puncture headache
5. ***catheter*** related problems
   i. venous puncture
   ii. inability to inject *fibrosis is marked at 2-3 days
   iii. accidental displacement
   iv. subarachnoid migration[§]
   v. cutaneous infection
6. ***total spinal*** anaesthesia[§]
7. ***neurological*** sequelae
   i. direct trauma - nerve roots, cord
   ii. compressive - haematoma, abscess
   iii. infective - meningitis
   - epidural abscess
   iv. inflammatory - drugs, additives, wrong drug
   - adhesive arachnoiditis
   v. multifactorial - anterior spinal artery & cauda equina syndromes
   vi. broken catheter - rarely a problem in the absence of infection
   * consensus view is leave it in place
   vii. "by association" - exacerbation of pre-existing disease, etc.
8. ***physiological*** sequelae
   i. cardiovascular - hypotension, tachycardia or bradycardia
   - reduction in preload & afterload
   ii. respiratory - abdominal paralysis & decreased cough, PEFR
   iii. other

DAY SURGERY ANAESTHESIA

1. why use outpatient surgery - advantages & disadvantages
2. which patients
3. preoperative screening & assessment
4. which procedures
5. premedication & fasting
6. methods of anaesthesia - regional vs. general
7. discharge criteria

▪ *Advantages of Outpatient Surgery*

1. reduction in ***cost*** ~ 25-75% for most operations
2. less disruption to ***patient lifestyle***
3. reduction in ***nosocomial infection*** - paediatrics
   - oncology & immunocompromised
4. reduction in ***postoperative complications*** ? PTE, infection
5. increased availability of hospital beds for "sicker" patients

▪ *Patient Selection*

1. ***willing*** to accept surgery on a day case basis
2. ***reliable*** to follow pre/postoperative instructions
3. ***located*** within 1 hour travelling time of a major medical facility
4. accompanied by a reliable ***guardian*** for 24 hours postoperatively
5. ***medically acceptable***
   i. all ASA I & II patients
   ii. ***stable*** ASA III & IV patients
   iii. absence of contraindication to day surgery
      - MHS, MAO inhibitors, acute substance abuse
      - morbid obesity

NB: ***age*** does not appear to affect recovery time or complication rate (Meridy A&A 1982), stable ASA III patients are ***not*** at higher risk for postoperative complications

FASA (Federation of Ambulatory Surgery Association) in > 87,000 patients,

"little or no cause & effect relationship between ***pre-exisiting disease*** and the incidence of ***postoperative complications***"

- ***Patient Screening***

1. unscreened ~ 7% cancellation rate
2. medical questionnaire *good correlation with more extensive investigation
   i. telephone questionnaire
   ii. medical questionnaire & nursing assessment
3. all patients screened by anaesthetist
4. laboratory investigation
   i. routine screening for all - costly, inefficient, insensitive, nonspecific
   ii. ***only*** as directed by medical history

- ***Procedure Selection***

NB: virtually any procedure ***except*** those with,

1. significant risk of ***haemorrhage***
2. severe postoperative ***pain***
3. delayed return of normal physiological function,
   i. RS - airway protection & respiratory function
      - apnoea in neonates < 60/52 PGA
   ii. CVS - haemodynamic instability
      - significant blood loss & risk of postoperative haemorrhage
   iii. CNS - airway protection, self injury
   iv. GIT - ileus, bowel surgery, N&V
   v. GUS - haemorrhage, obstruction

NB: as a generalisation, this excludes ***open*** procedures within the cranium, thoracic or abdominal cavities, though exceptions exist,

most authors agree, the selection procedure should be ***patient oriented*** not procedure oriented

- ***Preoperative Instructions***

1. required time of arrival & time of surgery
2. fasting requirements
3. routine medications ± premedication
4. notification of intercurrent illness
5. escort arrangments

NB: these should be ***written & verbally*** explained to the patient

Premedication

• preoperative anxiety ~ 65% (Egbert *et. al.*)
• methods to reduce anxiety include,

1. preoperative anaesthetic visit ~ 35% incidence of anxiety
2. minimal waiting time from arrival to surgery
3. positive, calm support for the patient
4. pharmacotherapy

• most prospective studies have ***not*** found an prolonged recovery after the use of premedication in the outpatient setting (White, RDM)
• however, these medication may impair reactive & coordination skills up to 12 hours
• sedative analgesic agents ***do not*** increase the percentage at risk of aspiration pneumonitis
• the use of opioid based regimes is associated with a higher incidence of postoperative N&V
• factors associated with a higher incidence of ***N&V*** include,

1. body habitus
2. medical condition
3. type of surgery - laparoscopy, orchiopexy, stabismus surgery, VTOP
4. use of assisted mask ventilation
5. anaesthetic and analgesic medications - volatiles, N_2O, opioids
6. postoperative hypotension

• ***droperidol*** (5-15 µg/kg) is effective antiemesis, ***does not*** prolong recovery time, however does increase postoperative sedation
• combination with ***metoclopramide*** (0.15 mg/kg) is more effective than droperidol alone
• ultra-low dose droperidol (3-7 µg/kg, or 0.25-0.5 mg/70 kg) may be as effective, with less sedative effect
• metoclopramide alone produces varying results and is less effective for antiemesis

• Ong *et al.* found ~ **85%** of ***outpatients*** with gastric volumes > 0.4 ml/kg & pH < 2.5
• other studies have found 40-60% of patients "at risk" for aspiration, despite fasting overnight
• however ***aspiration***, in the absence of risk factors, is rare **< 1:35,000** (Olsson 1986)

• both ranitidine & cimetidine are effective, though the former is associated with fewer side-effects and may be given enterally with a peak effect within 2 hours
• cf. fasted patients, those given ranitidine & clear fluids 2-3 hours preoperatively have significantly lower residual volumes & higher gastric pH's, with less subjective thirst
• metoclopramide will reduce gastric volume without altering pH, and increases LOS tone
• "at risk" patients include,

1. hiatal hernia, chronic reflux, peptic ulcer disease
2. morbid obesity
3. late mid-trimester abortion ?? all VTOPs
4. anticipated difficult airways

Anaesthetic Techniques

- ***General Anaesthesia***

1. intravenous agents
   - i. ***thiopentone***
     - single induction dose → impaired coordination/reflexes for 6-8 hours
     - familiarity, efficacy, lack of side-effects in healthy patients
   - ii. methohexital
     - slightly shorter awakening & recovery times than STP
     - similar duration of impaired coordination
     - greater incidence of pain in injection, hiccup & involuntary movement
   - iii. ***midazolam***
     - prominent amnesic action, but prolonged recovery & residual amnesia
     - recovery with flumazenil antagonism is still slower than with propofol
   - iv. etomidate
     - minimal depressant effects on the myocardium
     - myoclonic movements, pain in injection, N&V, transient suppression of adrenal function
     - requires the use of prophylactic antiemetics
   - v. ***propofol***
     - rapid onset/offset of action, subjectively "better" recovery cf. STP & MOX
     - low incidence of postoperative N&V
     - pain on injection, significant CVS depression & apnoea problematic
     - larger variability in dose requirements cf. STP, especially with age
     - rare but significant emergence problems (opisthotonus)
     - despite quick recovery, still impairs coordination/reflexes for 3-4 hrs
     - recovery is comparable to isoflurane for short procedures
2. intravenous analgesics
   - decrease sedative-hypnotic & volatile requirements, may ***shorten*** recovery
   - decrease postoperative analgesic requirements
   - even small preinduction doses of opioids result in increased ***postoperative N&V***
   - i. ***fentanyl***
     - greater potency, faster onset/offset cf. morphine or pethedine
     - significant kinetic & dynamic variability, plus potential accumulation in adipose storage sites makes "standard" doses unpredictable
     - 1-3 µg/kg highly effective in reducing incidence of complications, (movement, ↑HR/BP, airway reactivity) cf. barbiturate & N_2O
   - ii. sufentanyl
     - 7-10x greater potency & slightly shorter elimination half-life
     - cf. isoflurane for laparoscopy, resulted in less analgesic requirement and shorter PACU stay

iii. alfentanyl
- less potent derivative, but faster onset/offset
- decreased lipid solubility, limited ionisation, short elimination $t_{½\beta}$ (60-90m) and decreased potential for accumulation in lipid storage sites
- most studies show more rapid recovery cf. fentanyl but N&V ~ the same

iv. ***ketorolac***
- potent parenteral NSAID, now also available in ***enteral*** form but no studies showing any increase efficacy cf. other enteral NSAID's
- 30-60 mg significantly decreases postoperative analgesic requirements
- studies have ***not*** found a decreased incidence of N&V
- opioid related side-effects, eg. respiratory depression, are less

3. <u>muscle relaxants</u>

i. ***atracurium*** slightly more likely than ***vecuronium*** to result in haemodynamic changes, but essentially identical in other respects

ii. ***mivacurium***
- onset of 2-3 minutes and a spontaneous offset in 30-45 min
- may result in transient reductions in MAP due to ***histamine release***
- hydrolysed by BuChE at ~ 90% the rate of suxamethonium
- lower incidence of myalgias and N&V cf. suxamethonium
- ?? need for reversal, plus complicated kinetics,
  potential for prolongation of action with anticholinesterase agents
  potential rapid reversal with rDNA-BuChE administration

iii. ***rocuronium*** ORG-9426
- lower potency non-depolarising agent
- rapid onset, intermediate between vecuronium & suxamethonium
- duration ~ vecuronium

4. <u>inhalational agents</u>

i. ***sevoflurane***
- methyl-isopropyl ether
- B:G solubility ~ 0.6-0.7, MAC ~ 1.7-2.6%, SVP_{20C} ~ 21%
- non-pungent, ∴excellent for ***gasseous induction***
- degraded by soda-lime, but only at high temperature & no toxic metabolites clinically, with ~ 2% being biotransformed & excreted in the urine

ii. ***desflurane***
- fluorinated, methyl-ethyl ether
- B:G solubility ~ 0.42, MAC ~ 5-10%, SVP ~ 87-92%
- similar pungency cf. isoflurane, ∴not recommended for gasseous induction
- very rapid kinetics, ∴potential for overdosage / awareness
- $T_{BP.}$ ~ 23.5, ∴requirement for specialised administration equipment

iii. ***nitrous oxide***
- non-flammable, non-pungent, non-irritating gas with low B:G solubility
- significantly decreases the requirement for other amnesic/analgesic agents
- problems of expansion of gas-filled spaces, diffusion-hypoxaemia, and probably an increased incidence of ***postoperative N&V***

- ***Intravenous Sedation / Analgesia***

• 85% of patients in a cross-over study preferred surgery under ***LA + sedation*** to LA alone
• patient satisfaction is higher with more profound sedation, irrespecitive of the form of administration
• risk of ventilatory depression necessitates the use of respiratory monitoring,

i. S_pO_2
ii. CO_2
iii. precordial stethescope

• 40% of patients who ***do not*** receive supplemental O_2 during sedation experience clinically ***significant desaturation***
• large doses of benzodiazepines impair driving skills for at least 10 hrs, and may prolong recovery to a ***greater*** extent than general anaesthesia
• with respect to sedation, ***midazolam*** is ~ 2-4x as potent as diazepam
• the apparent recovery time may be reduced with the use of ***flumazenil***

• use of supplemental opioid, ***fentanyl***, increases the incidence of desaturation and administration of O_2 is mandatory
• combination with ***ketamine*** has the advantage of relatively little cardiorespiratory depression,

a. midazolam ~ 0.07-0.15 mg/kg ~ 7 mg
b. ketamine ~ 0.25-0.5 mg/kg ~ 25 mg

• the α_2-agonists, such as ***clonidine*** also provide supplemental analgesia, but are asociated with an increased incidence of bradycardia, hypotension and sedation

QUALITY ASSURANCE

Def'n: ***Quality Assurance:*** a ***system*** or program that provides an organised procedure for the ***evaluation*** of the ***level of care*** provided (quality of care assessment) and establishment of mechanisms for ***improvement*** of such care.

Def'n: ***Risk Management:*** programs devised to reduce or eliminate injuries (and their costs) to persons and to prevent or minimise losses to property, usually related to specific risks.

▪ ***Reasons for Prominence***

1. ***ethical responsibility*** to provide "best possible" health care
   - "*primum non nocere*" → above all do no harm
   - extended to "do good (***beneficence***) but at least do no harm (***non-malificence***)
   - other ethical aspects include ***autonomy*** & ***justice***
2. raised public expectations with increased education, ***consumer awareness***
3. health care ***costs*** in terms of %GDP
   - requirement to provide the maximal health care per $ spent
4. ***medicolegal*** costs

▪ ***Study Types***

1. ***mortality & severe morbidity studies***
   - Beecher & Todd (1954)
   - Confidential Enquiry into Perioperative Deaths (CEPOD, UK)
   - NH&MRC triennial Report on Deaths Associated with Anaesthesia 1988-1990
   - definitive end-point, but "tip of iceburg" assessment
   - small frequency occurrence cf. total volume of anaesthesia
   - may not reflect factors contributing to "near misses"
2. ***closed claims studies***
   - biased population sample, USA only ~ $1/8^{th}$ of injured patients enter a claim
   - ***assessment bias***, due to the tendency to link ***inappropriate care*** with ***severe injury***
   - shown by cross-over assessments of the adequacy of care, using different outcomes
   - this may impede the objective evaluation of risk factors for adverse outcome
3. ***critical incident reporting***
   - requirement for voluntary reporting system
   - collection and analysis of large amounts of data
   - APSF formed in May 1987 & several thousand AIMS entries

- ***Outcome Predictors***

1. ASA status
2. age
3. emergency or elective procedure
4. minor or major procedure

- ***Monitoring & Evaluation JCAHO / USA***

1. assign responsibility
2. delineate the scope of care provided
3. identify the important aspects of care
   - i. problems which occur frequently
   - ii. problems associated with serious morbidity or mortality
   - iii. high volume / high risk / problem-prone aspects
4. identify ***indicators*** related to these aspects of care
   - i. death, cardiac arrest, AMI, respiratory arrest, acute pulmonary oedema
   - ii. failed intubation, reintubation in recovery, aspiration, dental trauma
   - iii. brain / spinal cord injury, PDPH, eye injury, peripheral nerve injury
   - iv. unplanned admission from DSU
     - persistent N&V, excessive pain, bleeding
   - v. unplanned ICU admission
   - vi. patient satisfaction
5. establish ***threshold limits*** related to indicators, ie. what incidence is "acceptable"
   - i. unplanned admission from DSU $< 1.5\%$
   - ii. dental trauma $\sim 0\%$
6. collect data & analyse at determined intervals
   - tends to be labour intensive & costly
7. formulate plans / procedures / protocols / training to improve the standard of care
8. assessment of the effectiveness of the implemented change
9. communicate & disseminate the relevant information

NB: steps $6 \rightarrow 7 \rightarrow 8$ may be repeated as required
as the body of data grows, the "value" of individual indicators may be assessed, the chosen indicators may then be reviewed to provide greater specificity & sensitivity of the evaluation process

- ***Ancillary Activities***

1. ***credentialling***
   - i. education & training
   - ii. current competence - more difficult
   - iii. recertification[§] * cf. airline pilots
2. ***safety activities***
   - i. evaluation of equipment prior to use
   - ii. routine servicing of equipment
   - iii. checklists for activities
   - iv. routine machine checking
   - v. RSI, etc.

NB: [§]recertification is no longer the preferred term,

→ ***certification of maintenance of standards***

RECOVERY

- ***Common Problems***

1. respiratory insufficiency
   - airway obstruction
   - hypoventilation
   - hypoxaemia, $\downarrow S_pO_2$
2. prolonged "sedation"
3. agitation / disorientation
4. pain
5. nausea & vomiting
6. hypotension / hypertension
7. arrhythmias
8. bleeding
9. oliguria

- ***Assessment***

1. airway, breathing & circulation
2. routine postoperative vital signs
   i. HR, BP, S_pO_2, urine output
   ii. confirm aberrant readings
3. patient history
   i. preoperative
   ii. anaesthetic / intraoperative
   iii. recovery
4. appropriate physical examination
5. investigations as directed by history & exam
6. consultation with allied specialists where appropriate

- ***Hypoventilation***

1. ***central depression***
   - residual effects of anaesthetic agents - especially elderly
     - absolute / relative overdosage
   - intracranial pathology - stroke, ICH, oedema
   - metabolic/endocrine - hypothermia
     - hypoglycaemia
     - hypo/hypernatraemia
     - hypothyroidism
   - post-hyperventilation
   - pain
2. ***neuromuscular weakness***
   - residual neuromuscular block - absolute/relative overdosage
     - renal or hepatic disease
   - drug effects - aminoglycosides, tetracycline
     - phenytoin, procainamide, quinidine
     - frusemide, lithium
     - chlorpromazine, d-penicillamine, azathioprine
   - metabolic/endocrine - hypokalaemia, hypermagnesaemia
     - hyperthyroidism, hypothyroidism
     - Addisonian crisis, Cushing's
   - neuromuscular diseases - Myasthenia gravis, myasthenic syndrome
     - motor neurone diseases, etc.
   - genetic defects - homozygous sensitivity to suxamethonium
     - familial periodic paralysis
3. ***chest wall*** abnormalities
   - abdominal distension - obesity, ascites, obstruction, packs
   - extrapulmonary ↓ compliance - pleural effusion, pneumothorax, empyema
     - kyphoscoliosis, ankylosing spondylitis
4. ***upper airway*** obstruction
   - insufficient upper airway tone - tongue, pharyngeal muscles
   - abnormal anatomy - obesity, OSAS
   - airway oedema - allergic
     - positional
     - surgical
     - infective
   - foreign body - throat pack, secretions
   - layngospasm
5. ***respiratory***
   - aspiration
   - infection
   - bronchospasm
   - pulmonary oedema - respiratory & cardiac origins

- ***Hypertension***

1. factitious - especially NIBP machines
   * check the reading manually x2
2. pain
3. hypoxia, hyperbarbia
4. hypothermia
5. hypervolaemia
6. pre-exisiting hypertension - inadequately treated
   - acute withdrawal of medication
   - exaggerated response to trauma, pain, hypoxia
7. intercurrent disease - Cushing's, Conn's
   - phaeochromocytoma
   - renal artery stenosis
   - hyperthyroidism
   - spinal hyperreflexia
8. raised ICP
9. drug related
   i. direct effect - inotrope infusions, vasopressors
   ii. interactions - MAOI's, oxytocics, ergot alkaloids
   iii. withdrawal states
   iv. wrong drug
10. ***surgery specific***
    i. CEA - baroreceptor dysfunction
    ii. TURP - hypo-osmolar syndrome
    iii. AAA - pain, hypothermia, hypervolaemia, and (6)
    iv. CABG
    v. AVR - acute relief of LV outflow obstruction

- ***Hypotension***

1. ***assessment*** - airway, breathing, circulation
2. ***factitious*** * check the reading manually x2
   ? normal BP for patient, may be normally "hypotensive"
   - abnormal → ± 20%
3. residual effects of ***anaesthesic agents***
4. ***hypovolaemia***
   i. ***absolute***
   - inadequate perioperative fluid replacement
   - continuing blood-loss
   - excessive use of diuretics
   - rewarming - especially post-bypass

   ii. ***relative***
   - post-spinal or epidural anaesthesia
   - vasodilator drugs
   - anaphylaxis, anaphylactoid reactions
   - sepsis
   - spinal shock
5. ***cardiogenic*** "pump failure"
   - ischaemia, AMI
   - arrhythmias
   - hypoxia, hypercarbia, acidosis
   - electrolyte abnormalities
   - tamponade, tension pneumothorax
   - cardiomyopathy - infective
     - infiltrative
     - endocrine/nutritional
   - embolism - air, amniotic fluid, thrombus
   - valvular malfunction

- ***Prolonged Unconsciousness***

1. hypoxia, hypercarbia
2. anaesthetic agents
   - elderly, sensitive patients
   - absolute/relative overdosage
   - total spinal
   - central cholinergic syndrome
3. intracranial pathology
   i. stroke - TIA, RIND, thrombotic, ICH
   ii. subdural, extradural haematoma
   iii. oedema
4. metabolic / endocrine
   - hypothermia
   - hypoglycaemia
   - hypo/hypernatraemia
   - myxoedema
   - ketoacidosis, hyperosmolar coma
   - thiamine deficiency
   - porphyria
   - uraemia, hyperammonaemia
5. hypotension
   i. hypovolaemia
   ii. cardiogenic failure
   iii. sepsis
   iv. drugs
6. preoperative sleep deprivation

- ***Cyanosis / Collapse Following LUSCS***

1. ***hypoxia*** ± hypercarbia
   i. airway obstruction
   ii. residual neuromuscular blockade
   iii. aspiration
   iv. opioid-induced respiratory depression
   v. pneumothorax
   vi. laryngospasm / severe bronchospasm
   vii. acute LVF / pulmonary oedema
2. ***embolism***
   i. air
   ii. thrombus
   iii. amniotic fluid
3. ***shock***
   i. hypovolaemia / haemorrhage
   ii. eclampsia
   iii. total spinal
   iv. acute LVF
4. ***anaphylaxis*** / anaphylactoid reactions
   i. drug induced
   ii. blood product related

- ***Problems Associated with Epidurals***

1. efficacy of blockade
   i. block too high
   ii. block too low
   iii. block incomplete, patchy
2. secondary to local anaesthetics
   i. hypotension
   ii. respiratory insufficiency, dyspnoea, failure
   iii. urinary retention
3. secondary to opioids
   i. nausea / vomiting
   ii. pruritis
   iii. urinary retention
4. related to the catheter
   i. accidental removal
   ii. disconnection of the filter/catheter
   iii. inability to inject
   iv. pain on injection
   v. intravascular migration - aspiration of blood
      - acute LA toxicity
   vi. intrathecal migration - aspiration of CSF
      - total spinal

T-Wave Inversion In Recovery

• Breslow, (Anesth. 1986), T-wave inversion is commonly seen in recovery and pathological significance is questionable

1. 394 patients, 71 (19%) had new T-wave changes
2. ***no*** adverse outcomes
3. ***no*** difference if a preceeding history of IHD
4. more comon with abdominal surgery

NB: cause is ***unknown***, but ***may*** represent myocardial ischaemia
other possible causes,

i. autonomic imbalance
ii. pain
iii. hormonal
iv. hypothermia
v. electrolyte imbalance

• the main problem is of how to manage an otherwise healthy patient, admitted for day stay surgery, ***asymptomatic***, who develops isolated T wave inversion
• suggested management,

1. history & examination of patient
2. compare with previous ECG if available
3. consult cardiology opinion if available
4. recommend,
   i. admit overnight
   ii. repeat ECG & cardiac enzymes the following morning
   iii. discharge without follow-up if normal
   iv. referral to cardiologists if abnormal

Criterea for Discharge

1. awake & oriented
2. able to protect own airway
3. adequate ventilation & oxygenation
4. haemodynamically stable - HR & BP within 20% of "normal" x3
5. adequate control of pain