Miscellaneous anaesthesia

Position

Sterilization

Pros and cons of anaesthetic rooms

Intravenous anaesthesia
Trendelenberg Position (head-down)

Adverse effects

CVS

↑ CVP, ↑ HR, ↑ CO
May precipitate failure, APO
May cause hypotension on return to level position

Respiratory

Abdominal contents press on diaphragm
↓ FRC, ↓ VC, ↓ compliance
↑ ventilation pressures in IPPV
↑ V/Q mismatch

PEEP may be helpful

Neurological

Neuropraxia from pressure
Shoulder rests for steep Trendelenberg
Brachial plexus and accessory nerve
Stirrups in gynaec laparoscopy
Superficial peroneal nerve
Sterilization

Why
- Prevention of disease transmission
- Medicolegal responsibilities
- Recent cases: HIV, Hep C transmission by anaesthetic techniques
- Protection of patients and staff

Cross infection
- Requires sufficient numbers of organisms transferred from patient to patient
- Wet equipment usually harbours sufficient pathogenic organisms
- Transfer has been shown to occur in the past
  - e.g. Pseudomonas, Streptococcus from humidifiers

High risk areas
- Equipment close to airway
- Organisms up to 1 m down tubing, mass transfer with droplets of sputum or vomitus
- Immune suppression related to anaesthesia and surgery: cellular, humoral and mechanical protection broken down.
- Some techniques limited by practicalities: airway handling and anaesthetic machine operation
- Cross infection is nonetheless rare

Risks of universal precautions
- Reassembly errors, misconnections, mechanical wear
- Latex allergy, exposure to antiseptic agents
- Cost

Sterilization techniques
- Disposable equipment: expensive, wasteful, poor quality
- Filters
- Good handling practices
- Cleaning and sterilization between cases
  - Sterilization produces known rates of elimination of all organisms
  - Disinfection is a gentler cleaning process without guaranteed sterility

Sterilization
- First step is cleaning: manual or dishwasher in a designated "dirty" area by dedicated staff
- Sterilization by heat or gas (ethylene oxide) or radiation
- Moist heat is autoclaving: for all reusable metal and plastic components
  - Cheap, quick, non-toxic
  - Specifications: commonly 134°C for 3 minutes with high pressure steam
  - Pre-wrapping in packs which can then be stored
  - Degrades: sharp edges, drugs, electrical circuits
- Dry heat
  - 150-180°C with convection for 30-60 min
  - Less blunting of needles
- Gamma radiation
  - Co^{60} emits γ rays
  - Suitable for packaged items which may be heat-labile
  - Used commercially
- Ethylene oxide used in industry for sensitive equipment
  - Cyclic ether \( C=\Box \)
  - Toxic, explosive, requires dry equipment, airing after sterilization
  - Contamination causes burns to mucous membranes

Disinfection
- By moist heat (Pasteurization) or liquid chemicals
- Pasteurization: hot water 70-90°C for specified time, drying with hot air

*Miscellaneous* 3.A.7.3 James Mitchell (December 24, 2003)
Suitable for more delicate equipment: laryngeal masks (can also be sterilized)
Liquid chemicals: last resort for equipment which can’t be sterilized
Cleaning surfaces, scopes
  Common agents: glutaraldehyde, 70% alcohol, sodium hypochlorite
  Requires cleaning of surfaces first, rinsing afterwards
  Fairly cheap and quick, corrosive to metals, alcohol flammable, toxic fumes

Filters
  Not 100% effective, particularly if wet
  Hygroscopic: large pore, high resistance if wet
  Hydrophobic: small pores, allow fluids to pass in small quantities, larger dead space
  Can obstruct the circuit
  Can’t be used with heated humidifiers
  Troublesome in prolonged prone cases: secretions into filter causes obstruction

Housekeeping practices
Hand washing
  Between cases, after patient contact, before drawing up next patient's drugs
Gloves
  Worn for all patient contact and removed immediately afterwards with hand washing between
Clothing
  Should be changed if dirty or between lists
Masks
  Partly for self-protection: e.g. orthopaedics
Placement of dirty items
  Airway equipment tray separate from drug tray
Multiuse of ampoules
  Requires one operator and rigid procedure (if at all)
Sharps handling
  Direct from use to sharps container

Where is cleaning done?
  Preliminary cleaning by tech in theatre
  Sterilization either in CSSD or in theatre (depending on required turnaround time)
  Verification system needs to be in place

Some things are just washed
  T-piece scavenge, laryngoscope handles, anaesthetic machine
  Some soda lime cannisters
Pros and cons of anaesthetic rooms.

Advantages

Allows preparation of the next patient while the theatre is in use, reducing turnaround time
- Preanaesthetic consultation (if not previously completed)
- Insertion of lines and application of monitoring
- Establishment of blocks

Allows performance of minor procedures during a case
- CVC insertion, lumbar puncture etc.
- Allows induction of anaesthesia in a less noisy and threatening environment than the OR

Disadvantages

Requires duplication of monitoring and some equipment
- If general anaesthesia is induced, extensive monitoring is mandated by college policy

May require extra staffing for either sedation or general anaesthesia
- If used for induction, transport into theatre requires a period of apnoea and inadequate monitoring

College Policy (relevant bits)

Recommended Minimum Facilities for Safe Anaesthetic Practice in Operating Suites (T1)

- Anaesthetic machine for each anaesthetizing location
- Safety devices required on every machine
- Separate emergency ventilating device
- Suction
- Monitoring, airway, IV… equipment
- Availability of difficult intubation, emergency… equipment

Sedation for Diagnostic and Minor Surgical Procedures (P9)

- Provided that rational verbal communication to and from the patient is continuously possible during the procedure, the operator may provide the sedation and be responsible for the care of the patient.
- Continuous pulse oximetry with alarms must be used on patients undergoing intravenous sedation.
Intravenous anaesthesia

Closed-loop control
- Drug infusion → patient → effect → monitor of effect → pharmacokinetic model
- Feasible for muscle relaxants, blood-pressure control
  - “Monitor” is difficult to build for hypnotic agents
  - Median EEG frequency, evoked potentials, bispectral index...
- Computed pharmacokinetic model is substituted in target-controlled infusion devices

Pharmacokinetic models
- Polyexponential model used for drug elimination
  \[ C(t) = I(t) \ast \sum_{i=1}^{n} A_i e^{-\lambda_i t} \]
  where \( C \) is concentration, \( I \) is infused drug, \( t \) is time
  - Usually not more than three compartments required
  - Compartments do not necessarily represent physiological spaces

Pharmacodynamic modelling
- Relating an effect to putative biophase concentration
  \[ D_{\text{biophase}}(t) = \frac{F(E(t), P)}{C_{\text{plasma}}(t)} \]
  where \( D \) is disposition, \( E \) is effect, \( F \) is a function relating effect and other parameters \( (P) \) to \( C_{\text{biophase}} \)
  - \( D_{\text{biophase}}(t) \) is modelled as a single term exponential equation
    \[ D_{\text{biophase}}(t) = k_{\text{eq}} e^{-k_{\text{eq}} t} \]
  - So effect over time of a bolus of drug can be modelled using “time to peak effect” and \( t'/k_{\text{eq}} \).

Application
- By deconvoluting the functions for pharmacokinetic and pharmacodynamic modelling and limiting the solutions to those involving only positive infusion rates \( (I(t) > 0) \), it is possible to derive an function for infusion rates to target a plasma concentration or end-effect

Determining target plasma levels
- An equivalent to the MAC of volatile agents for use with intravenous agents has been difficult to determine.
  - MIR is minimum infusion rate for a given effect in 50% of a population
  - \( C_{50} \) is a steady-state plasma concentration for a given effect in 50% of a population
  - Difficult to determine as steady-state plasma levels take a long time to achieve
  - Instead commonly based on pseudo-steady-state using mathematical modelling
- Plasma concentration required for a given reduction in MAC
  - Determined for opioids for hypnotic and analgesic end-points
  - More useful for practical application

Calculating initial bolus
- Bolus dose can be based on desired concentration and volume of distribution
  - Using the \( V_d \) for the central compartment produces a dose which achieves the desired concentration only for an instant
  - Using the \( V_{ds} \) gives a much larger dose with gross overshoot at the time of peak effect
  - \( V_{pe} \), the calculated effective \( V_d \) at the time of peak effect, gives a reasonable dose for an initial bolus
  - \( V_{pe} \) for fentanyl is about 1 l/kg, propofol 0.5 l/kg, remifentanil 0.25 l/kg

Calculating infusion rate
- At \( t = \infty \), maintenance infusion rate = target conc. x clearance
- At any earlier time, rate must be higher to account for redistribution
- Can be calculated from multicompartment distribution model
Or from nomogram based on model

Time to recovery
- At $t = \infty$, recovery time is determined by terminal elimination half-life and total drug in body
- At any earlier time, recovery is faster because of redistribution
- Context-sensitive half-time is a function of infusion duration and pharmacokinetics
  Describes time required for 50% decrease in plasma level
  Least dependent on infusion duration for drugs with short elimination half-lives
- Synergistic combinations of drugs for anaesthesia allow more rapid emergence because of lower concentrations of both drugs
  e.g. fentanyl 1-1.5 ng/ml plus propofol 3 $\mu$g/ml provides most rapid emergence of any combination of the two drugs

Specific drugs
All regimens require titration to surgical stimulus
- Fentanyl
  with volatile or propofol 1.5-3 $\mu$g/kg 0.01-0.04 $\mu$g/kg/min
  with $N_2O$ 5-15 $\mu$g/kg 0.03-0.1 $\mu$g/kg/min
- Remifentanil
  with volatile or propofol 0.5-1 $\mu$g/kg/min 0.1-0.2 $\mu$g/kg/min
- Ketamine
  alone 1-2 mg/kg 30-100 $\mu$g/kg/min
  with $N_2O$ 10-50 $\mu$g/kg/min
  with propofol 5-20 $\mu$g/kg/min
- Propofol
  with opiate or $N_2O$ 1 mg/kg 10,8,6 mg/kg/h (↓ every 10 min)