Contents

General principles

Increased demand for anaesthesia outside of normal OT environment:

- diagnostic; imaging (CT, MRI, Angio, U/S, fluoroscopy)
- therapeutics; invasive radiological procedures (angio, radiotherapy, brachytherapy)
- others; ECT, cardioversion, TOE, radiofrequency ablation, lithotripsy, cystoscopy, scopes, ERCP, biopsy, dental, cosmetic surgery, war, terrorism, vet

Anaesthetic goals remain the same, despite location!

Approach

1. Patient factors – presenting complaint, clinical assessment, contra-indications
2. Anaesthetic factors – environment, personnel, drugs, equipment, monitoring, recovery
3. Surgical factors – preparation, position, stimulation, safety, recovery

Issues/Physical/Environment

1. Access
2. Illumination
3. Monitoring
4. Ventilation monitoring

Anaesthetic plan

- maintain tissue oxygenation
- provide optimal surgical conditions
- determine level of sedation sought – conscious sedation, deep sedation, GA
- minimise side effects of surgery and anaesthesia
- maximise safety of patient and staff
- quality information

Personnel

- me
- proceduralist
- assistant for me (must know technical aspects of monitoring and equipment)
- enough people to position patient

Equipment

- anaesthetic machine capable of accurately measuring O2 and volatiles concentration accurately
- IV infusions
- multiple types and sizes of airway devices
- a separate means of providing O2 to the patient (bag-mask device)
- protection – gloves, masks and eye shields
- a stethoscope
- 2 laryngoscopes
- IV access equipment
- sharps container
- scavenging system
- difficult airway equipment
- equipment for rapid IV infusion
- suction
- defibrillator
- chest drains
- equipment to heat or cool patient
- local anaesthesia equipment
- emergency call system
- good lighting

- trolleys for transfer
- appropriate cleaning and restocking
- piped gas or cylinders

Drugs

- standard drugs
- controlled drugs
- drugs to manage all emergencies (anaphylaxis)

Monitoring

- visual and auditory alarms
- BP
- ECG
- pulse
- colour
- RR
- SpO2
- O2 analyser
- ventilator disconnection or failure
- ETCO2 monitor
- volatile concentration analyser
- temp
- neuromuscular function
- depth of anaesthesia monitor
- others where clinically indicated – CVP, Art line, TOE, cardiac output monitor

Recovery

- transport equipment
- all staff must be adequately trained in the recovery of anaesthetised patients.

Interventional Radiology

Indications for Anaesthesia

- still for long periods
- painful procedure
- paeds

Practical Points

- scavenging often not possible ⟹ TIVA

Angioplasty/Stenting/Coiling

- paediatric & adult
- haemodynamically stable during pressure\flow measurements
- anti-coagulation & blood loss
- operation specifics:
    - vascular & cardiac - often dont need GA
    - Endovascular repair of AAA (EVAR):
        - assoc with ↓mortality
        - favoured if poor LV function
        - use regional (epidural + sedation) or GA

- Intracranial angioplasty & Stenting:
  - GA needed as must remain motionless with repeated breath holds
  - good neuro anaesthetic vital

Embolisations

- painful & GA requiring procedures = AVM, alcohol embolisation
- ETT or LMA
- Massive PPH ⟹ uterine artery embolisation. can do prophylactically with balloons if anticipated major bleed

Radiofrequency Ablations

- tumour destroyed by heating in eg hepatic & renal masses, difficult to reach tumours, frail patients
- may need to be prone
- LMA or ETT
- may be up to 40mins
- painful ⟹ GA

Cryoablation

- not painful ⟹ sedation only

Thrombolysis

- GA rarely required
- minimally invasive
- directed therapy at vasc beds, DVT, coronary emboli, PEs, thrombosis in fistulae

Cardioversion

- fasting
- #'s
- synchronised ECG\fibrillation

Therapeutic Radiology

- extremes of age
- potent radiation
- remote monitoring
- postures
- repeated treatment

ECT

- other treatment for depression (TCA's, MAOI's, Lithium)
- co-morbidities
- physiological impact - arrhythmias, HT, cerebral metabolism increased
- #'s
- O2
- repeat treatment
- short anaesthetic

CT

Main Issues:

1. Immobility
2. High quality scan
3. Safety of patient and staff

Physics

- ionised radiation -> harmful so anaesthetist should be outside room, otherwise where protection
- this builds up pictures of different tissue densities

General

- type of equipment not restricted
- space is often issue
- patient, anaesthetic machine and monitors should be visible during scan
- head is accessible during scan
- risk of lines and tubes being pulled out when patient moved (have a trial run)

Contrast

- highly iodinated, non-ionic, water soluble compounds
    - ↳ up to 300-320mg iodine/ml
    - ↳ may use volumes up to 150mls
- shouldn't be injected down CVL -> may burst lines
- patient may be allergic
- may cause renal failure: adequate hydration

Practical issues

- metal containing objects -> artefact
- breath-holds may be required (can hand bag patient and do an inspiratory hold)
- LMA is a accepted technique if not contraindications
- arms may need to be above head for trunk scans
- ICU patients take time

MRI

Main issues:

1. Restricted access to patient
2. Remote monitoring
3. Safety of patient and staff
4. Acquisition of high quality images
5. Magnet specific equipment

Physics

- works on ferromagnetic objects
- protons in H2O produce as spin that acts as a local magnetic field
- normally these are randomly orientated
- however, when place in a strong magnet (0.1-2 Telsa) they can be aligned within a field
- they can be flipped out of their alignment by bursts of radio-frequency energy
- the hydrogen nuclei can take up this energy and then release it as they relax
- the energy is measured using a radio-frequency coil
- amplitude of signal proportional to (1) properties of tissue and (2) timing of MR pulse sequence

- T1 and T2 relaxation are dependent on tissue relaxation rates
- IV contrast media:
    - no iodine but do have narrow therapeutic window
    - SEs incl headache, N&V, local burning, wheals, anaphylactoid reactions
    - gadolinium can increased T1 signal intensity and decrease T2 signal intensity (very safe agent)
- magnetic field gradients also applied -> helps with spatial encoding

Radio-frequency screening (the Faraday cage)

- the entire unit is contained within a radio-frequency shield (Faraday cage) to protect against extraneous radio frequencies.
- a hollow brass tube can be built into the cage to allow for monitoring and infusions lines to pass into control room without breaking the integrity of the radio frequency screening.

The magnetic field

- field created by superconductors cooled by liquid helium
- the magnetic field falls away exponentially
- pacemaker line = line of safety
    - 0.5 mTesla (further away)
    - line where pacemakers malfunction and where unscreened personnel should not proceed
- within 5mT of scanner (closer):
    - risk of ferromagnet objects becoming projectiles
    - electric motors eg syringe drivers act erratically
    - magnetic strips may be erased
- safe for scanner room are non-ferromagnetic objects eg
    - hypodermic needles
    - aluminium laryngoscopes

- never assume field is off & if in doubt do not take object in

Safety

Patient

- absolute contraindications – cochlear implants, pacemakers and ICD's, intraocular metallic F/B, ferromagnetic neurovascular surgical clips
- surgical clips, joint prostheses, artificial heart valves and sternal wires are safe as they are fixed by fibrous tissue and magnetic field is insignificant
- xrays can be used to search for metallic foreign objects
- need ear protection
- burns – monitoring has caused burns to patients (must be fiberoptic or carbon fibre cabling)
- quenching magnet – emergency shut down of magnet -> helium released and causes dramatic fall in FiO2 ∴ hypoxaemia

Staff

- same precautions apply to staff
- pregnant staff should not work in MRI (particularly first trimester)
- if magnet shut down in an emergency (quenching) -> helium can be released inducing hypoxia

- 2 systems:
    - specialist equipment used within scan room
    - standard equipment used outside room

Anaesthesia

PreOperative

- adequate pre-assessment:
    - indications for anaesthesia,
    - chart review and

    - full medical history and focussed examination,
    - type of anaesthetic,
    - plan for recovery and discussion of risks and benefits
- planning:
    - transfer –
        - plan for rapid transfer of patient from MRI and to anaesthetic area +
        - plan for transfer to a recovery environment must be thought through
    - personnel:
        - Anaesthetist or a adequately experienced and supervised trainee +
        - an adequately trained assistant +
        - personnel for positioning patient
- patients; children, intellectually impaired, claustrophobia, patients requiring repeat scans, ICU patients
- problems = duration long + requires immobility (3% adults unable to tolerate)
- drugs – access to standard anaesthetic drugs including emergency drugs important.

Peri-Operative

Induction

- sedation has been used successfully -> requires MDT approach and experienced, familiar staff
- induction in dedicated anaesthetic room next to MRI scanner
- MRI non-ferrous trolley for transfer
- airway completely inaccessible
- airway:
    - ETT with ferromagnetic spring in cuff (tape down),
    - use RAE, LMA
- need plastic connectors
- airway based on pt factors:
    - neonate & young baby (<2 months) = fed, wrapped & placed on side ⟹ sleep through it
    - <15kg or neuro concern (↑ICP) = paralyse & intubate
    - larger children & adults = LMA

Maintenance

- maintenance with IV or volatiles (infusion pumps are strongly ferromagnetic)
- MRI compatible machines and ventilators available now OR machines and ventilators outside magnetic field
- breathing circuit to decrease dead space (Bain (Mapelson D) for adults, Ayer's T-piece for children)
- measured airway pressures may not be accurate (may be reading pressure from end of ETT)
- breathing circuit:
    - typically 10meters
    - delivered TV will be less than measured because of 'compression losses' of gases within system and expansion of tubing during inspiration
    - use Ayres T piece (Mapleson D or E)
        - ∴ dead space unaffected by length
        - but ↑exp resistance ⟹ ↑ing PEEP with ↑FGF
    - or coaxial Bain system
    - airway pressures at ventilator end different to pressures at pt end

Post Op

- recovery – where, whom, environment, how, efficiency – issues need to thought of before proceeding

Special points

- if cardiac arrest:
    - do not allow team in room
    - do not attempt ALS in room
    - start chest compressions & BMV in room & get pt out of room asap

Monitoring

- all equipment needs to be MR compatible (non-ferromagnetic)
- all monitoring should be placed in control room outside of the magnet environment
- use of fibre-optic or carbon fibre cabling:
    - standard cabling ⟹ risk of burns

    - expensive, fragile but don't effect image
- visual alarms because of noise from MRI
- ECG - can look like hyperkalaemia (Farradays law) + subject to interference -> use braided, short MRI compatible leads placed in a narrow triangle on chest
- ETCO2 -> because of length of tubing 20 second delay.

ICU patients

- tape ETT pilot balloon (with ferromagnetic spring) away from site being imaged
- minimise infusions
- theoretic risk of microshock with CVL, PA catheters or pacing wires -> remove wires if possible
- remove pacemakers, bolts, conventional ECG leads

ERCP

- remote surgery
- Issues:
    - Prone
    - difficult access
    - Old equipment

Patient

- 60 mins
- Nausea
- bradycardia with smooth mm distension
- risk of perforation

Procedure

- shared airway
- sedation vs GA:
    - risks of GA in otherwise unwell pt
    - risk of hypoxia with sedation
- Bean bag positioning
- can monitor EtCO2
- can place FM over bite block with side hole

ECT

= anaesthesia for a short electrically induced generalised tonic clonic seizure
- 5-10min procedure
- patient supine
- indication Rx of:
    - severe depression unresponsive to drugs
    - catatonia
    - high suicide risk or self neglect
- 2 current application methods:
    - unilateral - non dominant hemisphere (minimised cognitive affects)
    - bilateral - ↑ed speed of clinical recovery
- perfect length of seizure unknown - 10 sec to 120sec
- typically performed x2/wk until no further improvement (usually 3-4weeks)

Preoperative assessment and management

- remote anaesthesia
- avoid sedative premeds
- preoperative assessment including consent and chart review
    ↳ use doses from previous ECTs

- absolute contraindications
  - recent MI or CVA (3 months)
  - phaeochromocytoma,
  - intracranial mass (↑ICP)
  - intracranial or aortic aneurysm
- relative contraindications
  - uncontrolled angina or CCF,
  - severe OP or bone #'s,
  - glaucoma, retinal detachment
  - DVT not anticoagulated
  - cochlear implants - although possible to do unilateral ECT on other side if able
- avoid pre-medication
- glycopyrulate 0.1-0.3mg IV – reduce secretions and attenuate bradycardia
- consent (in NZ):
  - usually informed consent from patient
  - if incompetent -> two psychiatrists can agree that treatment is in best interests after liaising with family

Intra-operative management

Goals

1. **Short GA**
2. **Muscle relaxation**
3. **Decreased risk of trauma**
4. **Attenuation of physiological effects**
5. **Rapid recovery**
6. **Adequate seizure**

Physiology

- 2 phases:
  - initial 15sec : parasympathetic discharge – bradycardia and hypotension
  - then (5mins): sympathetic discharge – tachycardia, hypertension, increased myocardial O2 requirement
    ↳ LV function can remain ↓ed for up to 6hrs post
- CNS: increased CBF, increased ICP, increased cerebral O2 requirement
- Other: increased IOP and intra-gastric pressure, hyper-salivation

Procedure

- preO2
- induction:
  - methohexital - original gold standard as least anti-seizure properties of barbiturates. limited availability now
  - propofol - ↓SNS response but ↑ed shortens seizure
  - etomidate - ↓ed seizure shortening BUT ↑SNS response, ↑PONV
  - ketamine - less suitable, ↑SNS response, ↑ICP
  - sevo inhalation (takes longer)

  ↳ very common to use small dose propofol 0.5-1mg/kg & remifentanyl 1-2mcg/kg
- muscle relaxation;
  - sux 0.5-1mg/kg
  - mivacurium - need at least 0.15mg/kg
- bite block
- face mask + IPPV
- be prepared to maintain anaesthesia with propofol if required for 2nd stimuli
- attenuate sympathetic response with alfentanil (10mcg/kg) or esmolol (0.25mg/kg)
- seizure augmentation; caffeine, theophylline, hyperventilation
- if seizure last longer than 3 min -> terminate with IV midazolam

Special Patients

- cerebral aneurysm:
  - c↑in CBF velocity during ECT less with propofol
  - ß blockers useful
- Intracranial lesion:
  - pre-ECT steroids

    - hyperventilation before stimuli
- PMs or implanted defibs:
    - unlikely electrical stimuli will reach device
    - PM: temp conversion to fixed rate pacing suggested
    - ICD: deactivate then reactivate immediately after
- Neuroleptic malignant syndrome:
    - produced by some antipsychotic drugs
        - clinically presents (similar to MH):
            - mm rigidity
            - fever
            - ↑CK
            - delirium
            - autonomic instability
    - avoid MH triggers ie sux & volatiles
- Pregnancy:
    - safe & may be preferable to some drug therapies
    - complications:
        - aspiration
        - prem labour
        - spont abortion
    - later pregnancy - use sevo to ↓uterine tone

Post-operative management

- complications:
    - confusion and agitation in 10% -> calming environment, reassurance and IV midazolam
    - headache – simple analgesics
    - drowsiness & cognitive impairment - should resolve within few hours
    - memory loss – usually reversible by 6months
    - others: N&V, IHD, #'s or dislocations/dental injury, laryngospasm
- ECT does not ↑risk of other types of seizure

ECT; physiological effects and how to modify them

CVS

- initially; bradycardia and hypotension (15 seconds) from parasympathetic discharge – pre op glycopyrollate
- followed by; tachycardia and hypertension, increased Q, increased SVR, increased myocardial O2 consumption (use of propofol, alfentanil, esmolol, glycopyrulated 0.1-0.3mg IV – reduce secretions and attenuate bradycardia)
- difficulty monitoring patient because of electrical interference

RESP

- apnoea from induction agent and muscle paralysis (preoxygenate and ventilate while apnoeic)
- decreased response to PaO2 and PaCO2 (administer 100% O2, and ventilate via bag-mask)

GI

- hypersalivation (glycopyrulate)
- tongue biting (use a bite block)
- anorexia
- nausea and vomiting (anti-emetic if required)

CNS

- induced seizure (if seizure >3min terminate with diazepam 10m IV)
- headache (simple analgesics if not contra-indicated)
- confusion (environment, reassurance and IV midazolam)
- improved mood (used for treatment of depression)

- cognitive impairment (avoiding ECT in the already confused, prolonged seizures, bilateral electrode placement, use of old high every ECT machines)
- memory loss (usually reversible)
- drowsiness (use short acting agents rather than longer ie. propofol rather than thiopentone)
- increased ICP
- increased CBF
- increased IOP

METABOLIC

- increased BSL
- increased metabolic rate

MUSCO

- muscle aches (analgesia, minimise dose of suxamethonium used or use non-depolarising NMBD)
- weakness

GYNAE

- amenorrhoea