INTRODUCTION TO ANAESTHETIC DRUGS

Introduction

These notes are intended as an introduction to some of the commonly used anaesthetic agents and techniques used in PICU. They are guidelines only and do not replace the more comprehensive texts available, or the need for skilled assistance from senior colleagues.

The agents described are usually used to facilitate intubation, control seizure activity, decrease CMRO₂ (and consequently ICP) or provide sedation.

**Monitoring**
- pulse oximetry/capnography/ECG/BP/agent monitoring

**Intubation**
- ETTs/laryngoscopes/introducers/suction/assistance

**DRUGS**

1 **Induction Agents**

**Propofol (Diprivan)**

- solvent is an intralipid-like substance consisting 10% soyabean oil, 2.25% glycerol, 1.2% egg phosphatide. Patients allergic to eggs should be able to tolerate propofol as egg allergies usually arise to egg albumen
- preferred to thiopentone in asthmatic children
- causes hypotension due to vasodilatation.
- pain on injection common especially small hand veins
- CVS & respiratory depression similar to thiopentone
- Infusion ≈ 4–10 mg/kg/h (titrate to effect) NOTE; unexplained metabolic acidosis reported with prolonged infusion in children.

**Thiopentone**

- Supplied as a yellowish powder, mixed with water to form a 2.5% solution (25mg/ml), shelf life 48 hours
- pH 10.5 – can cause necrosis if injected subcutaneously or intra-arterially, respiratory depressant
- hypotension 2º vasodilatation peripheral vascular bed. This effect can be minimised by slow injection
- CANS depression SNS>PNS →laryngeal spasm, coughing, bucking
- Recovery is rapid (≈ 10 min after a single dose) due to redistribution of drug in body

**Ketamine**

- Dissociative agent
- Stimulates sympathetic system but direct myocardial depressant
- Increases secretions
- Bronchodilator
- May increase muscle tone
- Patient may appear to be awake
- Usual dose 2mg/kg induction then 1mg/kg every 20-30mins for anaesthesia
- Powerful analgesic and can be used by infusion in low doses to provide analgesia (0.2-1 mg/kg/h)

**Midazolam**
- 0.1-0.2 mg/kg, infusion 2 mcg/min/kg
- cardiorespiratory depression in compromised patient ESPECIALLY if given with opioids
- not painful in peripheral iv (cf. diazepam)

**Etomidate**
- Very CVS stable steroid derivative
- Causes adrenal suppression
- Induction dose is 03 mg/kg

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2. Muscle Relaxants

i. Depolarising Agents

Cause activation at NM junction then stay bound causing muscle relaxation.

**Succinylcholine**
- structure and action similar to acetylcholine
- produces initial muscle twitching and fasciculation followed by paralysis for 2-4 min
- can cause bradycardia, especially after 2⁻rd dose, atropine (0.01 mg/kg, max 0.6 mg) will ameliorate effect
- transient small increase in K⁺ to fasciculation. This effect may be associated with hyperkalaemic arrhythmias and arrest in patients with pre-existing Hyperkalaemia / gross tissue damage (e.g. burns, crush injuries)/ immobilisation /Myopathies / stroke. Avoid using in these patients.
- succinylcholine is metabolised by pseudocholinesterase in plasma. The occasional patient is deficient and muscular block is prolonged for hours. Contraindicated in MH

ii. Competitive/non-depolarising relaxants

Compete with Ach at NM junction

**Rocuronium**
- Rapid onset vecuronium derivative
- Very CVS stable. Can give 1mg/kg to speed onset but lasts approx 60min.
- Dose = 0.6 mg/kg (onset approx 1 min)
- Intermediate duration action (10 min)

**Pancuronium**
- dose 0.1 mg/kg
- duration of action ≈ 30-45 min
- usually minimal effect on circulation (mild tachycardia & hypertension).
  occasionally profound tachycardia.
- urinary excretion (prolonged effect in renal failure)

**Atracurium**
- dose 0.5 mg/kg
- duration of action \( \approx 20-30 \text{ min} \)
- Mild hypotension, occasional histamine release
- Not dependent on kidneys or liver for metabolism

**Vecuronium**
- dose 0.1 mg/kg
- duration of action \( \approx 20-30 \text{ min} \)
- occasional mild bradycardia
- partly metabolised in liver and small amounts excreted in urine

### 3. Opioids

**Morphine**
- 0.1-0.2 mg/kg, infusion 10-50 mcg/min/kg
- cardiorespiratory depression, nausea, vomiting, histamine release
- duration \( \approx 1 \text{ h} \)

**Fentanyl**
- related chemically to pethidine
- 0.1 mg fentanyl \( \approx 10 \text{ mg morphine: dose 1-2 mcg/kg iv} \)
- infusion 2-4 mcg/kg/h
- duration of analgesia 20-30 min
- respiratory depression, nausea, vomiting
- can use for induction - dose 10 mcg/kg (beware chest wall rigidity)

**CLINICAL SITUATIONS**

**Usual induction agent is propofol 2mg/kg in stable patient**
**Usual muscle relaxant is succinylcholine 1mg/kg in children, higher doses (2 mg/kg used in neonates)**

**Some clinical situations require a different approach as outlined below**

1. **Upper Airway Obstruction** – croup / epiglottitis / tracheitis

*Problem* - airway obstruction/inability to ventilate using PPV/inability to intubate.

*Preferred technique* - gaseous induction with sevoflurane. Senior anaesthetic assistance \( \pm \) ENT assistance is always required.

*Breathing System:* - Ayers T-piece with Jackson Rees modification
  - flow 6-8L/min
- FiO2=1

Technique: Sevoflurane 0.5% in 100% O2 is administered using an appropriate sized face mask. Sevoflurane concentration is increased every 5 breaths to a maximum of 8%. Partial occlusion of the open rebreathing bag adds CPAP which is often needed as the child initially goes to sleep. CPAP maintains FRC and helps splint the upper airway open. Gentle assisted breathing may be helpful but make sure that it is timed to patient effort. A Guedel airway may be necessary but great care must be taken to avoid laryngospasm by inserting it while the patient is too light. Anaesthesia is satisfactory when pupils are central and breathing is regular and diaphragmatic...at this stage it is often wise to wait a further 2 minutes before attempting intubation. Induction of anaesthesia is slow and can take over 15 min.

Sevoflurane: - non-irritant
- rapid induction/emergence
- MAC 2.5%
- metabolism 3-4%
- respiratory/circulatory effects similar to halothane

2. The Convulsing Child

Problem: - obtunded child (post ictal/hypoxia/anti-convulsant medication e.g. diazepam, phenobarbitone, phenytoin)
- aspiration due to potential full stomach

Technique: - depends on degree of obtundation – always maintain airway and oxygenate. This includes cricoid pressure and skilled assistance
- if flat – intubate with no further CNS depressants
- if fitting – rapid sequence induction with thiopentone 4 mg/kg or propofol 2-3 mg/kg, succinylcholine 1 mg/kg

NB Do not give long acting muscle relaxants to fitting children as they may mask seizures.

3. Asthma

- intubation in these situations is a last resort after ineffective medical management using sympathomimetics and bronchodilators
- ketamine 2 mg/kg or propofol 1-2 mg/kg are useful for induction
- succinylcholine 1 mg/kg or rocuronium 0.6 mg/kg achieve good intubating conditions within 60 sec

4. Head Injury

Problems: - other associated trauma, especially to airway and cervical spine
- hypotension due to blood loss
- prevention of secondary injury (hypotension, hypoxia, ↑CMRO2 e.g. fitting)
- prevention ↑ICP, maintain CPP
**Technique:**
- rapid sequence induction with propofol (1-2 mg/kg) or thiopentone 2-4 mg/kg (dose titrated to clinical scenario, e.g. reduce in face of hypotension) and succinylcholine (1 mg/kg). This technique achieves rapid control of the airway without massive rises in ICP
- may require in line stabilisation of cervical spine during intubation
- always give thought to possible intubation difficulties prior to rushing into a rapid sequence induction

5. **Burns, Crush Injury, Hyperkalaemia, Spinal Injuries, Myopathies**
- avoid succinylcholine because of massive K+ release that can occur after administration
- alternatives - rocuronium for rapid sequence induction
  - if no concern about airway/full stomach then a longer acting muscle relaxant can be used (e.g. vecuronium, atracurium, pancuronium)
  - gaseous induction using sevoflurane.
  - rarely awake intubation under local anaesthesia in older children

6. **Neonatal Intubation**

   Neonates in PICU are usually given the benefit of anaesthesia during intubation. Awake intubation is rarely performed. The drugs used are individualised depending on pathology, but invariably include an induction agent (thiopentone, propofol, ketamine, fentanyl) and a neuromuscular blocking drug (succinylcholine, rocuronium, atracurium, vecuronium, pancuronium)

7. **Trauma**

   Problems relate to nature of trauma, secondary insult and pre-existing pathology.

   Always consider:  
   - head injury/cervical spine
   - hypovolaemia
   - crush injury
   - difficult airway
   - full stomach

   and give anaesthetic drugs accordingly.

   A rapid sequence induction using preoxygenation, cricoid pressure, propofol 1-2 mg/kg and succinylcholine 1 mg/kg remains popular. However, the induction technique must be adapted to each patient's particular circumstances.

8. **Shocked Child**

   These children have obvious cardiovascular compromise and the use of drugs such as thiopentone or propofol can cause profound collapse. Ketamine 1-2mg/kg is a useful alternative in this situation but it maintains blood pressure indirectly by stimulating the sympathetic nervous system, but it is in fact a myocardial depressant.
A safer alternative for induction is fentanyl 10 mcg/kg. This will maintain CVS stability but fentanyl doesn’t induce sleep and it can cause muscle rigidity (does go away once muscle relaxant working). If available etomidate is a reasonable drug to use.

When intubating these children you need to have IV fluids and vasopressor and/or inotrope immediately available because any induction agent plus positive pressure ventilation can precipitate CVS collapse. Remember that they will all have a slow circulation time which means that drugs will take longer to act when given.

Rapid control of the airway and ventilation is often required in these patients as it decreases the work of breathing and facilitates line placement.

**NOTE**
These notes are GUIDELINES only and do not replace skilled advice from colleagues with airway maintenance experience.