PAEDIATRIC ANAESTHESIA

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Definitions

- Neonate = first 30 days of life
- Infant = first year of life
- Child = 1-12 years of age

How the child differs from the adult

Physiological difference	Implication
1. Heart rate dependent cardiac output	Beware bradycardia → ↓Cardiac output
2. Faster heart rate	↓ Reserve
3. Lower blood pressure	
4. Faster respiratory rate, same V_T, thus ↑ V_M	Tire easily, fast onset of inhalational anaesthesia
5. Lower lung compliance	Beware barotrauma
6. Greater chest wall compliance	Chest wall collapses with inspiration → ↓RV
7. Lower FRC	Desaturates faster, even after pre-oxygenation
8. ↑ Ratio body surface area: Body weight	Loose heat faster
9. Parasympathetic system dominant	▪Prone to bradycardia (if ↓O_2, drug OD, reflexes) ▪Hypovolemia → hypotension without tachycardia
10. Hypoxic + hypercapnic ventilatory drive ↓	Depresses ventilation
11. VO_2 = 6 ml/kg (adult = 3ml/kg)	Desaturates faster, even after pre-oxygenation
12. > water content (70-75% vs 50-60% in adult)	Dehydrates faster after vomiting or diarrhoea

Anatomical difference	Implication
1. Noncompliant left ventricle	Beware fluid overload (→ CCF)
2. Residual foetal circulation	Paradoxical air embolism
3. Difficult venous and arterial cannulation	
4. Large head and tongue	Difficult intubation, needs pillow under shoulders to obtain adequate line of vision
5. Narrow nasal passages	Obstructs easily if mucus in passages
6. Anterior and cephalic larynx	Difficult intubation
7. Long epiglottis	Need straight (Magill) blade to lift epiglottis
8. Narrowest part of airway at cricoid (< 5yr) (adult = vocal cords)	▪Use endotracheal tube without a cuff ▪Must have air leak @ 25cmH_2O
9. Short trachea	Tube easily slides too deep or out of airway
10. Short neck	Difficult intubation
11. Prominent adenoids and tonsils	Easily obstructs, difficult intubation
12. Weak intercostal and diaphragmatic muscles	Tires easily, we don't allow spontaneous breathing for long periods
13. Small airways → high resistance to airflow	▪↑ work of breathing ▪obstructs with even small amount of mucus in airway
14. Horizontal ribs	Unable to increase ant-post distance of chest, thus if diaphragm is splinted (surgeon's arm etc) → ↓ air entry

Pharmacological differences	Implication
1. Immature hepatic biotransformation	↓ Production of pCE (suxamethonium →↑ duration of action)
2. Decreased protein binding	↑ free (active) fraction of drugs
3. Rapid rise in F_A/F_I (due to ↑ V_m)	Rapid induction and recovery (inhalational agents)
4. ↑ MAC	Need > MAC
5. > Volume of distribution (H_2O soluble drugs)	> dose muscle relaxants needed
6. Immature neuromuscular junction	▪↑ sensitivity to nondepolarising muscle relaxants ▪Resistance to suxamethonium
7. ↑ sensitivity of respiratory centre for opiates, opiates ↑ crossing of the immature BBB. ↓Metabolism of opiates (immature liver)	↑ Sensitivity for opiates (Respiratory depression)

Other differences	Implication
1. Nonshiver thermogenesis by metabolism of brown fat	▪Volatiles ↓ brown fat metabolism ▪Can't shiver, thus easily gets hypothermic
2. Immature renal function < 6 months	↓ excretion of drugs →↑$t_{½}$, ↓Na^+ retention→ ↓Na^+
3. 75% HbF at birth	≠ bind 2,3-DPG → O_2Hb dissociation curve shifts to left→↑ affinity of Hb for O_2 →↓ offloading of O_2 to tissues

Conduct of anaesthesia

1. Pre-operatively:
   - weigh child or estimate:
   - Nil per os:

Weight = (age x 2) + 9

Clear fluids	Breast milk	Solids or formula
2 hours	4 hours	6 hours

- Premedication:
  1. Midazolam 0.3 mg/kg po
  2. Tilidine drops 1mg/kg (2.5 mg/drop)

- # Preparation of theatre:

1. Laryngoscopes (different sizes, straight and curved blades)
2. Endotracheal tube – Size = age/4 +4
3. Jackson-Reese breathing circuit
4. Theatre temperature 23-28°C, Bair® hugger, overhead heater
5. Emergency drugs (atropine – prone to bradycardia)
   (suxamethonium – prone to laryngospasm)
6. Prepare drip: 200 ml R/L – add 10ml 50% dextrose (=2.5%)
   Fluid rate regulator (IVAC, dial-a-flow etc)
   60 dropper giving set

- 2. Intra-operatively

a). Induction: Adults: IV induction

Children don't tolerate drips → inhalational induction → Halothane
→ Sevoflurane

<20 kg: Jackson-Reese breathing system

No valves →↓ work of breathing
Light weight → doesn't pull on child
↓ dead space

BUT: you need high fresh gas flows (2.5 x V_m) to prevent rebreathing of CO_2

If child needs rapid sequence induction (risk of aspiration) we insert the drip when he/she is still awake. We can use EMLA (eutectic mixture of local anaesthetics) to numb the skin. We ALWAYS give atropine prior to suxamethonium in children (to prevent bradycardia)

If the child is very uncooperative, we can give an IM or p.o. sedation dose of Ketamine (5mg/kg) and do the inhalational induction or insert the IV line when the child has calmed down.

We allow a parent to accompany the child to theatre. It calms them down.

b). Intubation:

Adults: mostly after muscle relaxant
Children: can be intubated without relaxant

Can use one of 2 devices:
- endotracheal tube (ETT) if risk of aspiration or very small baby
- Laryngeal mask (LM) if no risk of aspiration + short procedure, thus spontaneous breathing allowed

ETT: 1. No cuff if <10 years of age
2. Size = age/4 + 4 (also keep ½ size smaller ETT ready)
3. Depth = age/2 +12 (cm)
4. Must have air leak past ETT at 25cmH_2O

c). Maintenance:

Mainly vapour @ 1 MAC with 50% O_2 (FiO_2 = 0.5) and 50% air or N_2O

Can use TIVA (total IV anaesthesia) if malignant hyperthermia risk. Then induction and maintenance with Propofol (avoid vapours).

d). Monitoring

1. Basic monitors: ECG, NIBP, O_2 saturation

2. Temperature, capnography

e). Temperature management:

- Bair® hugger
- Warm fluids
- Cover child (with orthopaedic wool)
- Theatre temperature 25-28˚C
- Overhead heater

f). Fluid management:

S = Starved
T = Third space losses
A = Acute losses
R = Regular maintenance fluid
T = Total

1. Maintenance: (give R/L)

4:2:1 rule: 1st 10 kg = 4ml/kg
2nd 10 kg = 2ml/kg
thereafter = 1ml/kg

2. Starvation period: Maintenance (4:2:1 rule) x hours starved (give R/L)
3. Third space losses: minor surgery = 1-2ml/kg/h (give R/L)
major surgery = 15 ml/kg/h (give R/L)
4. Acute losses:
< 10% blood loss – replace with crystalloids (3:1) or colloids (1:1)
> 10% blood loss – replace with packed cells (choose a formula):

$1.5 \times kg \times (Hct_2 - Hct_1)$ or $\frac{EBV \times (Hct_2 - Hct_1)}{\Delta Hct}$

(EBV = wt x blood volume) and Blood volume: neonate = 90ml/kg
toddler = 80ml/kg
adult male = 75ml/kg
adult female = 65ml/kg

Example of fluid management:

30 kg child, starved for 6 hours for minor surgery with minimal blood loss

1. Maintenance:
   - 4x10 = 40 ml
   - 2x10 = 20 ml
   - 1x10 = 10 ml

   } 70 ml/h

2. Starvation: 70 ml/h x 6 hours = 420 ml → give over 2 hours

3. Third space losses: 1ml/kg/h = 30 ml/h

4. Acute losses: No losses expected. Treat prn.

g). Pain management

Local blocks

Paracetamol

NSAID's

Opioids – Tilidine (Valaron) drops

3. Post-operatively

Extubate children wide awake

No pain allowed

Specific Problems:

1. Upper respiratory tract infection (URTI)

➔ Problem:

- Prone to laryngospasm/bronchospasm
- ETT blocks due to secretions
- Vapours suppress immune response → worsening of infection
- Fever → ↑ VO_2

➔ Management:

a). Light URTI - < 1 year old → cancel

> 1 year old → weigh benefits vs risks

b). Severe URTI - common cold → cancel x 2/52

- fever, cough, entire airway → cancel x 6/52

2. Prematurity

→ Problems:

- Post-operative apnoea
- Hypoglycaemia
- Hypothermia
- Retinopathy (associated with prematurity, ↑ F_iO_2, prolonged mechanical ventilation)
- Intra-cranial bleeding

→ Management:

- Monitor for apnoea post-operatively, no elective surgery < 50 weeks gestation
- Monitor glucose peri-operatively
- Monitor and manage temperature peri-operatively
- Avoid F_iO_2 > 0.4 in neonates
- Avoid intubating baby awake/avoid severe pain → sympathetic stimulation → intra-cranial bleeding