

Anaesthesia for Special Groups Paediatric

Dr Peter Brooks
Chelsea & Westminster Hospital

Case Outline

Child	Anaesthetic Management	Adult
	Preop Assessment	
	Equipment	
	Induction	
	Maintenance	
	Surgery	
	Pain Management	

Are Children just small adults?



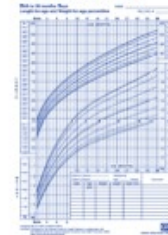
What makes children different?

- Anatomy
- Physiology
- Pharmacology
- Psychology.....Parents
- Pathology
- Procedures

Case Outline

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Growth



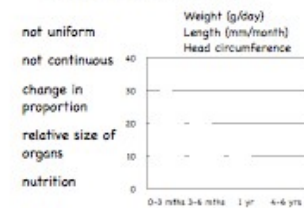
Are Children just small adults?

2 Hernia Cases



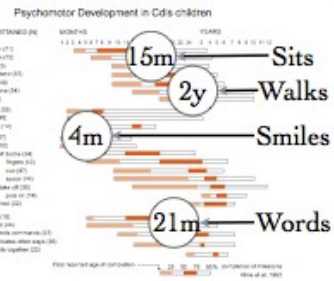
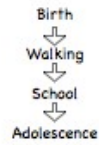
Is the Anaesthetic Management the same?

Rates of Growth



Development

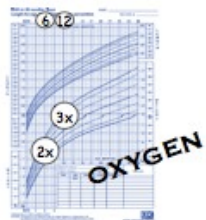
increase in complexity & functional capacity
genetic & environmental influences
transitions



Neurological Development

- Brain growth proportional to wt gain
- Neuronal
 - division
 - growth
 - migration
 - differentiation
 - increasing connectivity
 - selective cell death
 - myelination (later)
 - Decrease in neuron numbers but increase in complexity of synaptogenesis
 - growth spurt
 - experience expectant
 - experience dependent
 - neuronal apoptosis after exposure to some anaesthetic agents animal model

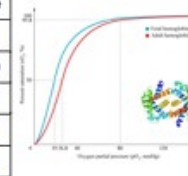
Growth



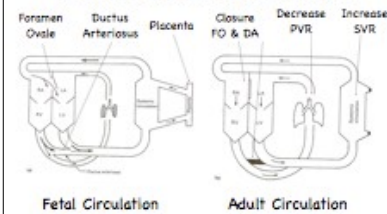
Physiology

	Neonate	Infant	2 Year	5 Year	Adult
O ₂ Consumption (ml/kg/hr)	6	5	5	4	3
Systolic BP (mmHg)	65	90	95	95	120
Heart Rate (beats/min)	130	120	120	90	77
Blood Volume (ml/kg)	85	80	80	75	70
Haemoglobin (g/dl)	17	11	12	13	14

	Neonate	Adult
O ₂ Consumption (ml/kg/hr)	6	3
Systolic BP (mmHg)	65	120
Heart Rate (beats/min)	130	77
Blood Volume (ml/kg)	85	70
Haemoglobin (g/dl)	17	14



Transition of Circulation



Breathing

- Alveolar minute ventilation is increased
- Increase in respiratory rate
- Less reserve of oxygen
- Control of vent is immature
- Ex-prems are at risk of apnoea
- Diaphragm is responsible for most of the ventilation



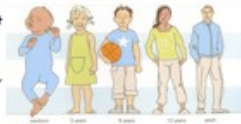
Pharmacology

Children are 'therapeutic orphans'

Extrapolation of adult data problematic

Responses to drugs influenced by growth, development & size.

Considerable pharmacokinetic variability



Developmental pharmacokinetic changes

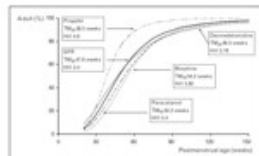
Metabolic processes not linearly related to body mass

Allometry is a term used to describe the non linear relationship between size and function

Other factors:

- organ maturation
- body composition
- ontogeny of drug elimination pathways
- enzyme expression and activity

Figure 1 Clearance maturation, expressed as a percentage of mature clearance, of drugs in which glucuronide conjugation (paracetamol, morphine, dexmedetomidine) plays a major role



These profiles are closely aligned with glomerular filtration rate (GFR). In contrast, epinephrine (P450 2D6) isogenes also contribute to glucuronid metabolism and cause a faster maturation profile than expected from glucuronide conjugation alone. Maturation parameter estimates were taken from [16, 17, 18, 19, 20, 21].

Major PK Covariates

Size
Age
Organ Function
Body Composition
Drug Interactions
Pharmacogenetics
Environmental Factors
Circadian Rhythms

Opioids

- Increased sensitivity to opioids
- Immature hepatic metabolic pathways & ?blood brain barrier
- Unpredictable risk of respiratory depression

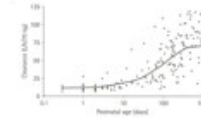
	Morphine half-life
Preterm neonate	9h (+/- 3.4)
Term neonate	6.0h (+/- 2.8)
Infants and children	2h (+/- 1.8)

Kort. Paediatric Anaesthesia 1997

Morphine

Neonatal sensitivity due to:

- Immature BBB
- reduced Vd
- immature elimination pathways
- resulting in higher concentrations



Bouwmeester et al. ESA 2004;92:208

Anaesthesia & neurotoxicity

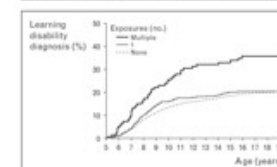
anesthetic drugs cause apoptosis during a critical period of brain development (animals)

vulnerable period during rapid synaptogenesis

this correlates with later behavioral disturbances

evidence in humans that this is of clinical concern is both weak and mixed

Figure 1 Incidence of learning disability by anaesthetic exposure



Cumulative percentage of learning disabilities diagnosis by the age of exposure shown separately for those who have zero, one, or multiple anaesthetic exposures before 4 years of age. Reproduced from Wilder et al.

Volatile Agents

- MAC of inhalational agents greatest in the young
- 30% greater same depth of anaesthesia
- Smaller margin of safety

	MAC (neonate)	MAC (adult)
Isflurane	1.6	1.2
Sevoflurane	3.3	2
Desflurane	9.2	7

Awareness in Children

Study	n	age range	True Cases	Incidence	True & Possible Cases	Incidence (Int:)
Davidson et al A&A	864	5-12y	7	0.8%	12	1.4%
Lopez et al	410	6-16y	5	1.2%	11	2.7%
Blussé et al	928	5-18y	6	0.6%	26	2.8%

Adults: 0.1 to 0.2%

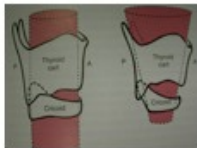
Sevoflurane

- pleasant, non-irritating odour
- induction is both rapid and smooth
- ideal agent for inhalational induction
- eliminate the problem of halothane hepatitis
- BUT more irritability



Paediatric airway

- Large head
- Short neck
- Large tongue
- Nasal breathers
- Narrowest at the cricoid ring



Airway Equipment

- mucosal oedema at cricoid level & airway obstruction if ETT trauma



Airway Management

- larynx is more cephalad

- epiglottis is large, floppy & U shaped

- therefore straight laryngoscope to elevate the epiglottis



Practical Considerations

Preoperative Assessment

Fasting

Premedication

IV Access

Preoperative Assessment

"We are not just anesthetizing the child, we are really anesthetizing the whole family!"

© Stanley J. Cook, MD
Professor of Anesthesiology and Pediatrics
Northwestern University Medical School
Chicago, Illinois, USA



Premedication

- most children do not require pre-medication
- Sedatives for the unduly anxious
- Oral midazolam 30 min prior to induction
- Alternatives: Ketamine, Clonidine
- Beware: the fearful child & the frequent flyer!



IV Access

- Amethocaine gel, a fast acting and potent topical local anaesthetic



Induction of Anaesthesia



Inhalational Induction

- common
- Sevoflurane is ideal agent
- requires some co-operation
- combined with non-pharmacological techniques



Pain Management

"Young people's pain is the same as adults' pain"

But there are some differences.....

- Understanding 'why'
- Needs!
- Pain assessment



Pain in the Newborn

- Nociceptive pathways functional to cortex by 37wks
- CVS response
- Analysis of cry
- Skin conductance
- Biochemical stress response



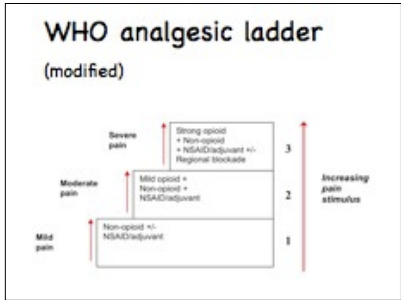
- Consequences of inadequate pain relief?
- Potential altered pain responses
- Delivery of analgesia safely and effectively is now possible with detailed protocols



Pain Management Techniques

- Systemic analgesics
 - opioids, paracetamol, NSAID, (sucrose)
- Local anaesthesia:
 - topical, infiltration, peripheral, central nerve blocks
- 'New' drugs
 - clonidine, ketamine





Neonatal Facial Coding Scale

Action
1. Brow Bulge
2. Eye Squint
3. Naso-labial Furrow
4. Mouth Open
5. Vertical Mouth Stretch
6. Horizontal Mouth
7. Tied Tongue
8. Chin Quiver

Pain rating scales

- Self Report:
 - Faces:
 - Numeric:
- Observational/Behavioural:
- Physiological:

Caudal Epidural Blockade

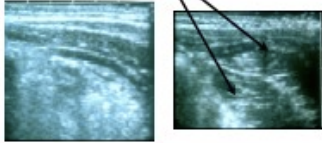
Ilioinguinal Nerve Block

Ilioinguinal Nerve Block

Ultrasound view of fascial planes before injection of local anaesthetic

Ilioinguinal Nerve Block

Distortion of fascial planes after injection of LA



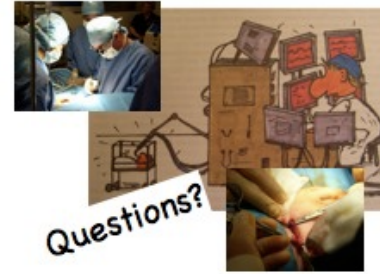
Are Children just small adults?



Is the Anaesthetic Management the same?

Case Outline

Child	Anaesthetic Management	Adult
Parent	Preop Assessment	Patient
Paediatric	Equipment	Adult
Gas	Induction	IV
Gas	Maintenance	Gas
Paediatric	Surgery	Adult
Caudal	Pain Management	Opioid



Temperature regulation

- ✗ large surface area to volume ratio
- ✗ insufficient body fat for insulation
- ✗ do not shiver
- ✗ non-shivering thermogenesis
- ✗ warm environment
- ✗ heating blanket
- ✗ humidification of inspired gases
- ✗ warm iv fluids



Fasting

Age	Formula or breast milk	Clear liquids
<12 months	4 hours	2 hours
>12 months	6 hours	2 hours