THE UNIVERSITY OF JORDAN

PRINCIPLES OF PEDIATRIC ANESTHESIA

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Children are not little adults!

Different Anatomy

Different Physiology

Different Pharmacology

Different psychology

Different Approach and preparation

Introduction

- Pediatric anesthesia involves more than simply adjusting drug doses and equipment for smaller patients.
- Neonates (0–1 months), infants (1–12 months), toddlers (12–24 months), and young children (2–12 years of age) have differing anesthetic requirements.

- Safe anesthetic management depends on full appreciation of the physiological, anatomic, and pharmacological characteristics of each group.
- Indeed infants are at much greater risk of anesthetic morbidity and mortality than older children; risk is generally inversely proportional to age.
- In addition, pediatric patients are prone to illnesses that require unique surgical and anesthetic strategies.

DEVELOPMENTAL CONSIDERATIONS:

- A. THE CARDIOVASCULAR SYSTEM:

❖ Anatomic:

- Noncompliant left ventricle
- Residual fetal circulation
- Difficult venous and arterial cannulation

❖ Physiological:

1.Heart-rate-dependent cardiac output(Cardiac stroke volume is relatively fixed)

CO=SV x HR

High Heart Rate to maintain CO

2.Increased heart rate **

3. Parasympathetic(ANS)is more dominant

4.Reduced blood pressure

5. The vascular tree is less able to respond to hypovolemia with compensatory vasoconstriction. Intravascular volume depletion in neonates and infants may be signaled by hypotension without tachycardia.

*Age-related changes in vital signs:

Age	Heart rate	SBP	Resp. rate
Newborn	110-170	> 60	30-50
1 year	100-160	> 80	< 40
5 years	80-130	> 90	< 30
> 10 years	< 90	> 90	< 20

NOTE: Activation of the parasympathetic nervous system by:
anesthetic overdose,
or hypoxia can quickly trigger bradycardia and profound reductions in cardiac output, that can lead to hypotension, asystole, and intraoperative death!!!

Fetal circulation moves to transitional circulation(critical period) then to adult circulation


EPIDURAL

- Blood volume:
- premature : 95ml/kg,
- term : 90ml/kg,
- 6 wks-2 yrs: 85 ml/kg,
- 2yrs –puberty: 80ml/kg.

B. The Respiratory System:

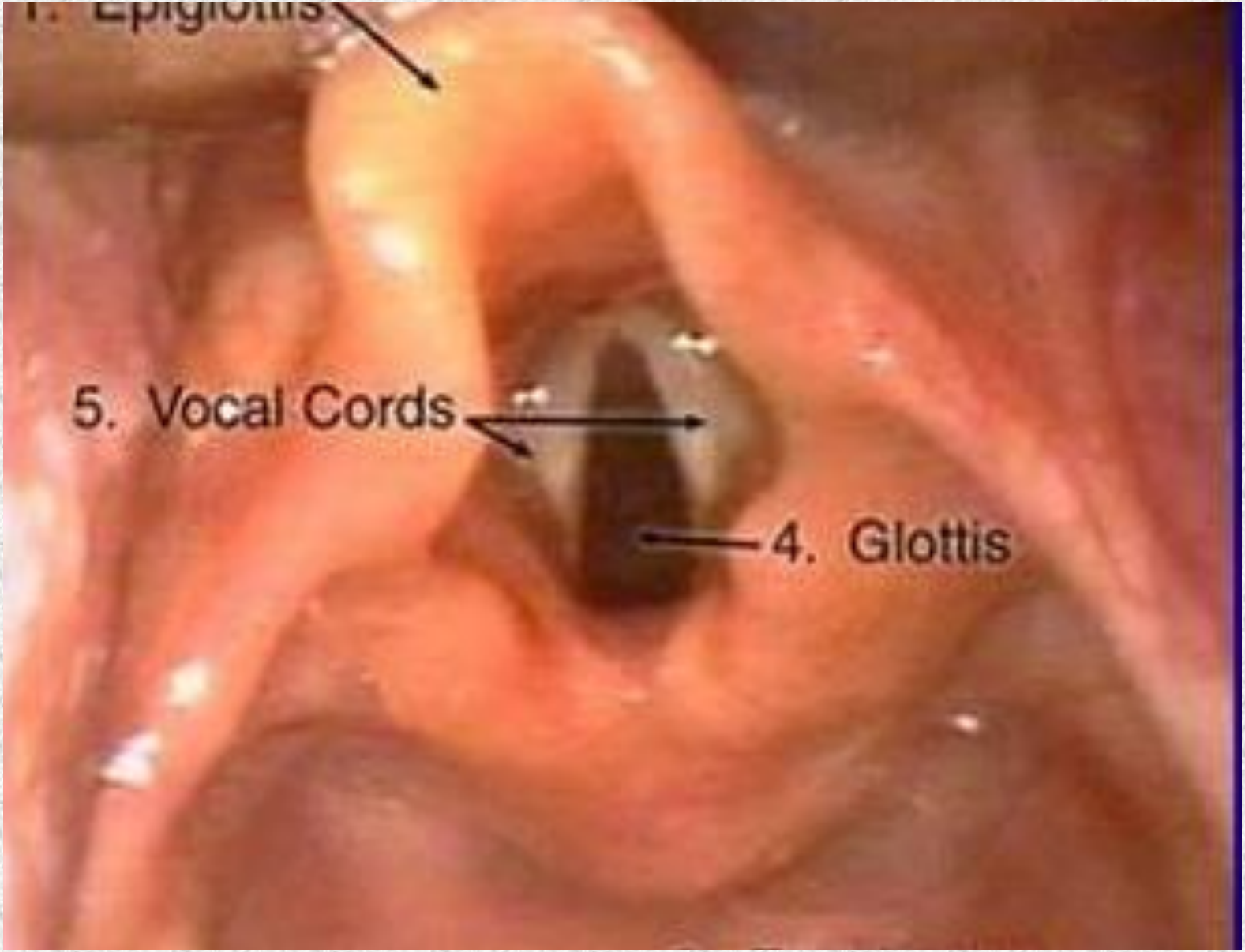
(Almost all cardiac arrest due to respiratory problem!)

The pulmonary system is not capable of sustaining life until both the pulmonary airways and the vascular system have sufficiently matured to allow the exchange of oxygen from air to the bloodstream across the pulmonary alveolar-vascular bed.

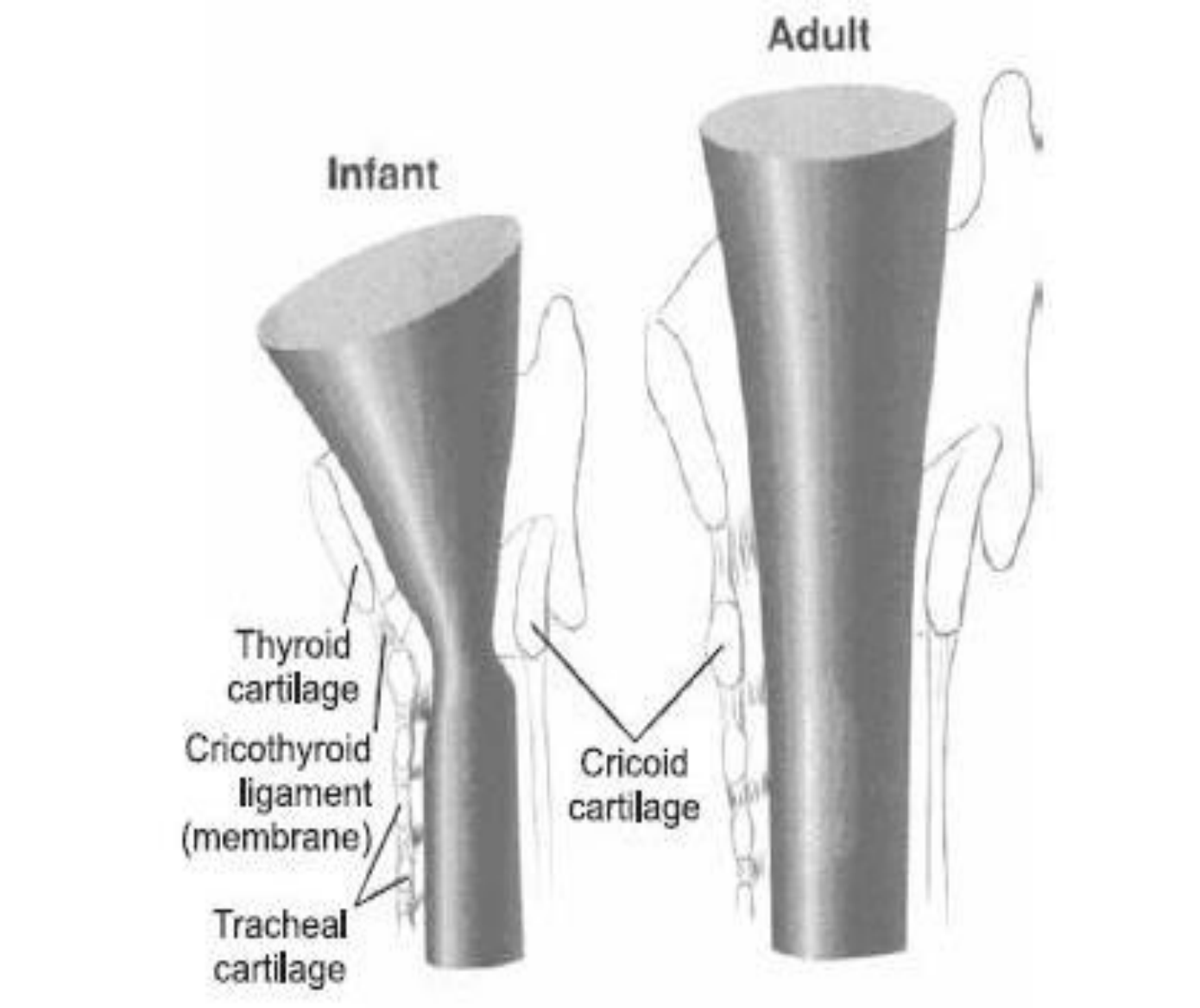
***Independent life is not generally possible until a gestational age of 24 to 26 weeks

At Birth(neonates) the respiratory system differs from adults in:

- Large head and tongue, short neck
- Narrow nasal passages and small diameter of the airways
- More cephalad and anterior larynx,C4.
- The narrowest point of the A/W is the cricoid cartilage till 5 years
- Long and stiff epiglottis, U to Omega shape ,touch the soft palate(easy airway obstruction)
- The vocal cords are angled; consequently, a blindly passed tracheal tube may easily lodge in the anterior commissure rather than slide into the trachea.
- Short trachea, 5 cm in neonates.
- The chest wall is highly compliant, therefore the ribs provide little support for the lungs; that is, negative intrathoracic pressure is poorly maintained.


5. Vocal Cords
4. Glottis

- Obligate nasal breathing until 5 months
- Horizontal ribs so ventilation is mainly diaphragmatic
- Small number of alveoli, low lung compliance,
- **Low FRC and high O2 consumption(oxygen consumption is two to three times higher than adults).**
- Hypoxic and hypercapnic ventilatory drive are not well developed in neonates and infants….


Adult
Infant
Thyroid cartilage
Cricothyroid ligament (membrane)
Tracheal cartilage
Cricoid cartilage

That mean:

1. More likely potential for technical airway difficulties in infants than in teenagers or adults.

   ***Difficult intubation has been estimated to occurs in 0.5- 1% in pediatrics population.

2. Increased work of breathing. Example: In preterm infants, the work of breathing is approximately three times that in adults, and this work can be significantly increased by cold stress (i.e., increased metabolic demand for oxygen) or any degree of airway obstruction.

3. Risk of edema;(small diameter) and airway resistance.

4. The resulting decrease in functional residual capacity (FRC) limits oxygen reserves during periods of apnea (eg,intubation attempts) and readily predisposes neonates and infants to atelectasis and hypoxemia.

Small FRC

Alveoli numbers is 10 % of adults

Higher O2 Consumption 6ml-7ml/kg Adults (3-4ml/kg)

Diaphragm in neonates and infants<2y easy fatigue (lacks the Type I muscle fibers)

Rapid desaturation

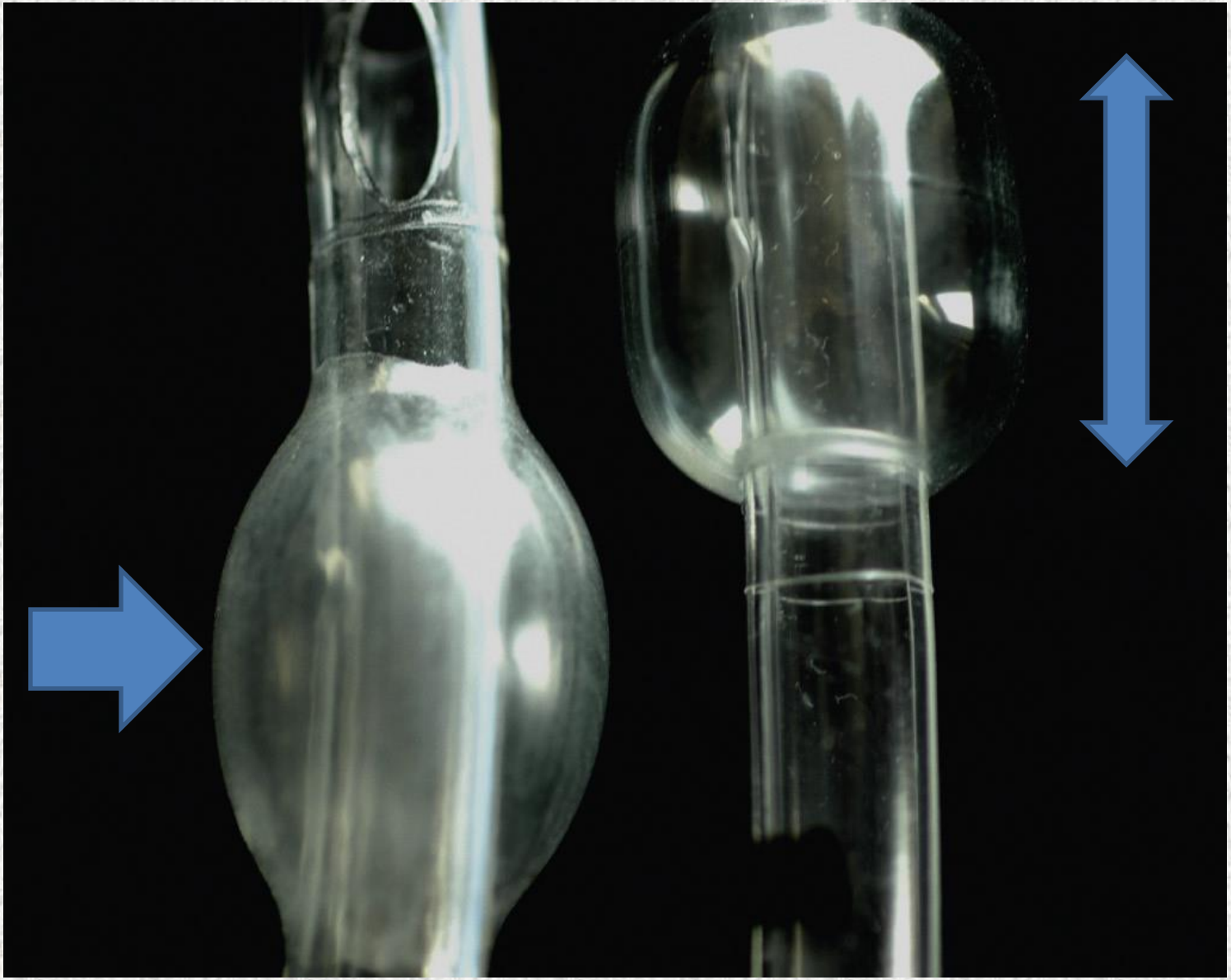
5. Risk of endobronchial Intubation

- **Immature Kidney and liver functions** more free fraction of medication leads to greater effect of the high protein bounded drugs:
  - Barbiturates
  - Bupivacaine
  - Alfentanil
  - Lidocaine
- Water soluble Drugs will distribute more,so a higher loading dose to achieve desired serum levels is required:
  - Muscle relaxants
  - Antibiotics
- Drugs that redistribute to fat have larger initial peak levels (Opioids are more potent)
- Less muscle mass (more sensitive to muscle relaxants)
- **Delayed metabolism and excretion**

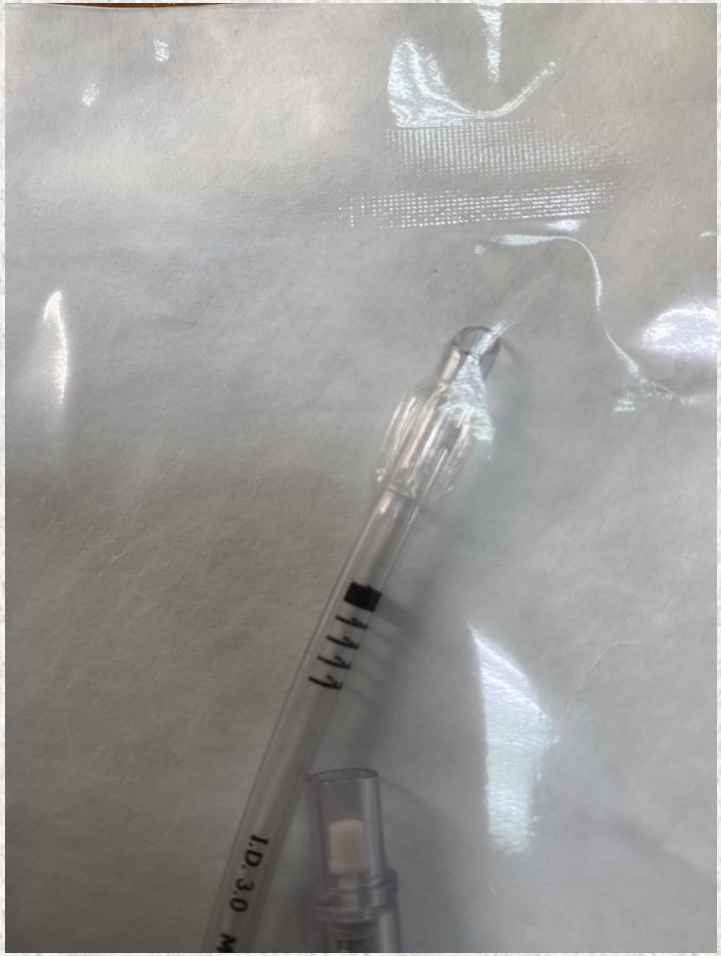
Age	Size—Internal Diameter (mm)
Newborns	3.0–3.5
Newborn–12 months	3.5–4.0
12–18 months	4.0
2 years	4.5
>2 years	ETT size = (16 + age)/4

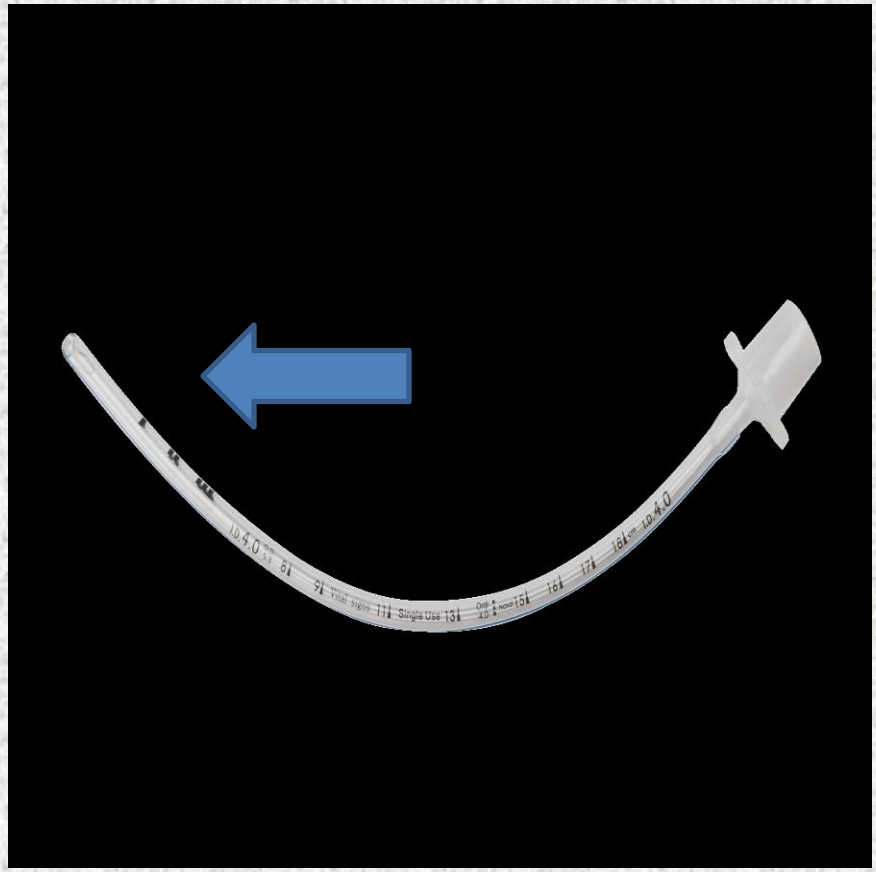
- Depth of ETT:
- Neonates: 8-10 cm
- 1 year: 12 Cm
- After that : 3 X ETT size or

½ age (year) +12 cm.



Cuffed and uncuffed tracheal tubes





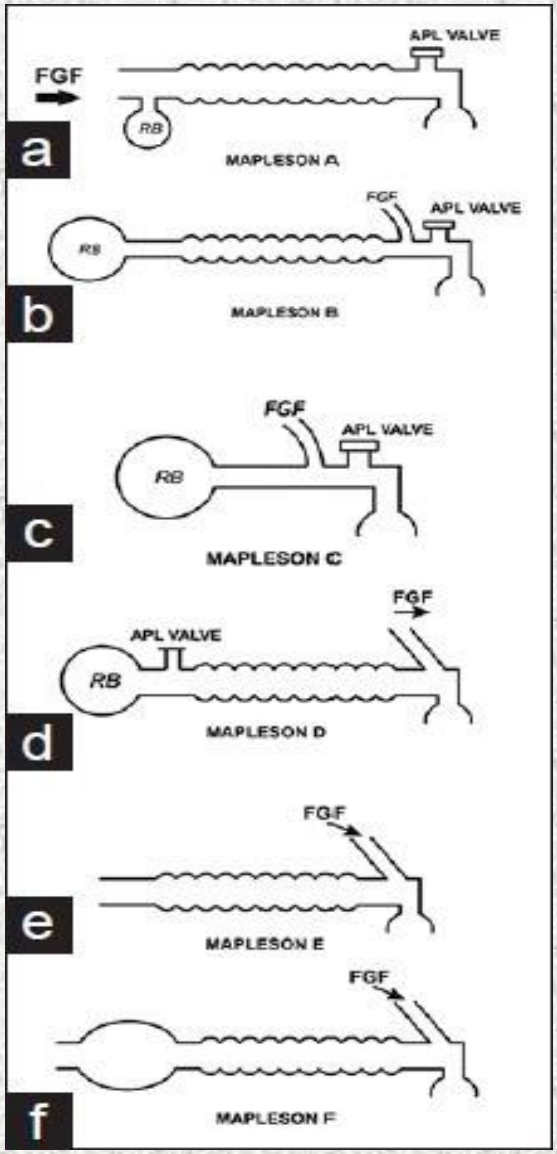

SOLUS
INTERSURGICAL® SOLUS

Breathing system

Jackson-Rees' modification of the Mapleson F system

Advantages of T-piece systems

- Compact
- Inexpensive
- No valves
- Minimal dead space
- Minimal resistance to breathing
- Economical for controlled ventilation



Aspiration Risk

Children < 3 years at greater risk of aspiration

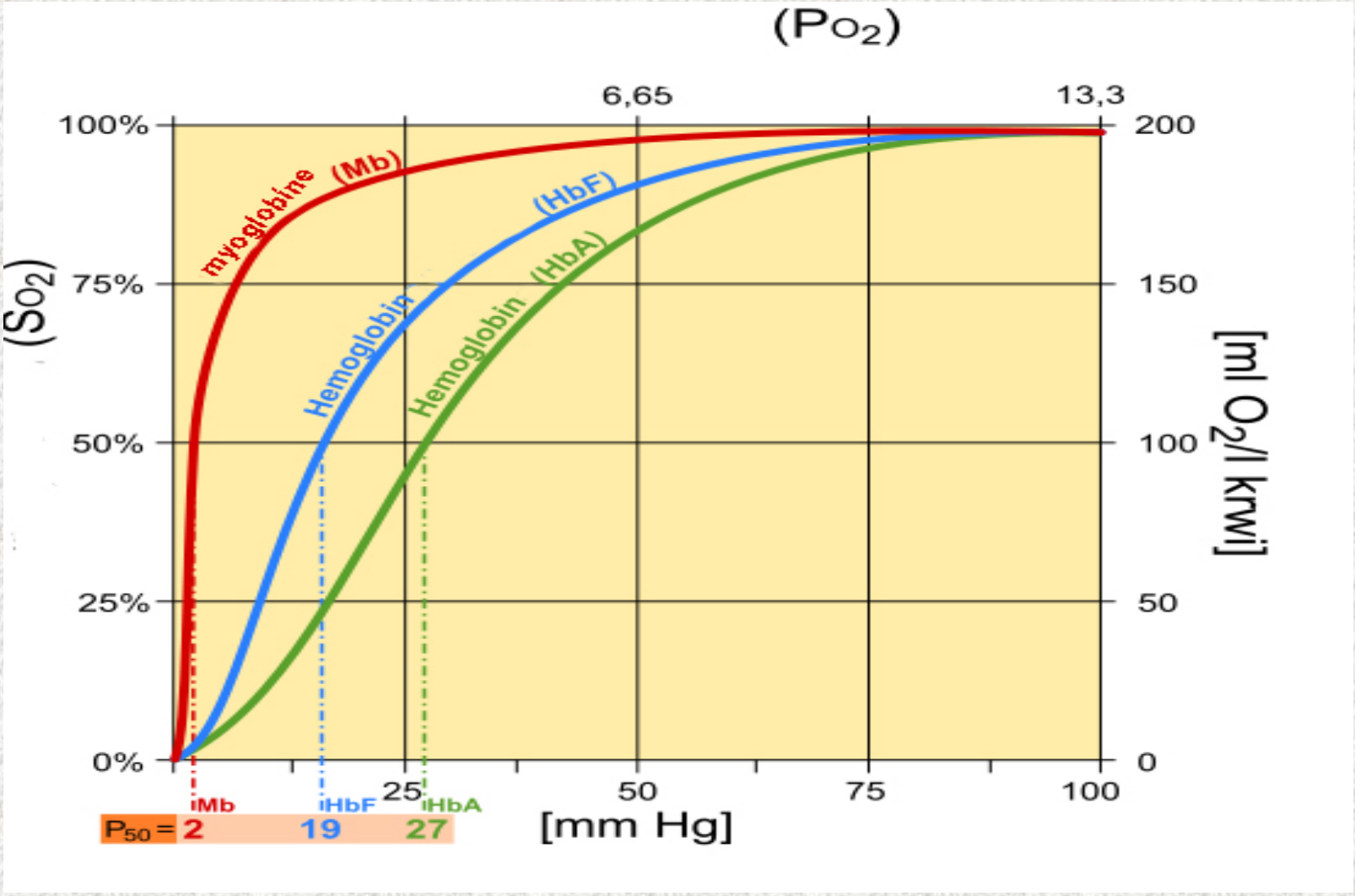
PREOPERATIVE FASTING RECOMMENDATIONS IN INFANTS AND CHILDREN

Type	Fasting Time (hrs)
Clear liquids	2
Breast milk	4
Infant formula	6
Solid (fatty or fried) foods	8

Encourage water intake within two hours

1. Less dehydration
   (better induction hemodynamic profile)
2. Less agitation and crying
   Promotes motility
3. Decrease gastric volume and PH

Neonatal period the HB is HBF .HBF has high affinity to O2 ……P50 is ….. HBF decline with age
HBA peaks at 9 month



Thermoregulation

- Greater heat loss
  - Thin skin
  - Low fat content
  - High surface area/weight ratio
- No shivering until 1 yo
- Thermogenesis by brown fat
- More prone to iatrogenic hypo/hyperthermia


37.0°C

Forced air warming systems always available

Fluid warmer

Room temperature

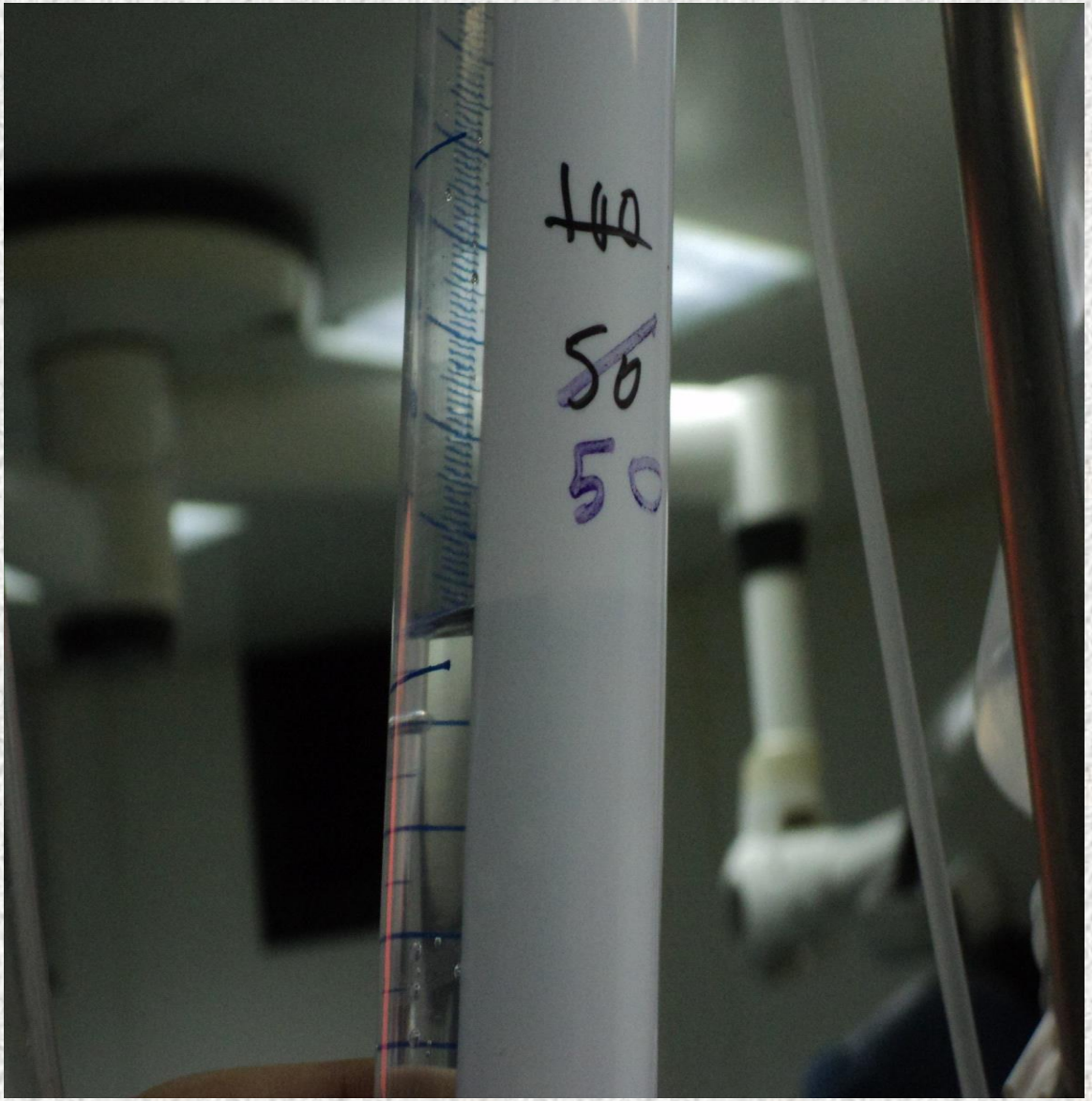
Maintenance Fluid Therapy:

Replace Deficits, losses, and bleeding by isotonic fluid like **Lactated Ringer** (not glucose containing fluid)Risks of Hyperglycemia

Older Child: 4-2-1 rule:

4 ml/kg/hr 1st 10 kg +
2 ml/kg/hr 2nd 10 kg +
1 ml/kg/hr for each kg > 20

Use micropdroppers or infusion pumps.


40
50
50

Include dextrose in the maintenance hydration fluid (Dextrose 1% or Dextrose 2.5%)

*Risk of Hypoglycemia is higher in Premature

**Sick babies(malnutrition , cardiac …)

*****Glucose infusion

Preoperative Psychological Care:

Assessment of current clinical status and alleviate fear and anxiety of the child and family

1.The process of anesthetizing an infant or child and the associated risks must be explained during the preoperative visit since parents often have more anxiety about their child undergoing anesthesia than they do for themselves.

2.An opportunity for the anesthesiologist to evaluate the child psychological status and family interactions.

1.Parental presence induction anesthesia (PPIA)
2. Comfortable separation in the holding area usual(from 1 to 5 years old)
3. >6 years: Child becomes primary focus. Explain exactly what will happen; what you will do then do it that way. (Be trustworthy!)
4. Pharmacologic interventions:
Midazolam is most commonly used as syrup orally(0.5mg/kg)or IV injection
Propofol is a proper option also.

A baby younger than 8 months has no separation anxiety so preparation is often directed toward educating the parents.

Toddlers(1-2) & preschool (3-5) will become upset when separated, and its so difficult to explain for them OR events

Consider your visit as chance to connect with the child by becoming familiar with his/her toys & games to gain trust .

It may be helpful for the child to have their parents accompany them to the OR .

•The goal is to reduce apprehension, produce sedation & amnesia.

• Preferred route is oral (older children) or rectal (preschool) esp. if there is no IV access.

•Avoid IM route.

•

•Smooth induction is less likely to produce long lasting psychological problems.

The most commonly used is oral Midazolam

Dose: 0.5 - 0.75 mg/kg

Cherry flavored with bitter after taste

It produce sedation but not sleep

Onset within 15 minutes.

Can be given intranasally

The second commonly used is ketamine

Route include oral rectal & IM

Given 30 minutes before induction

Dose (5-10 mg/kg)

The disadvantage of ketamine use excessive secretions and hallucinations.

Induction of GA

IV[better] or inhalational?

Monitoring:

-BP

-blood sugar for neonates (Neonates have low glycogen stores ..risk of hypoglycemia)

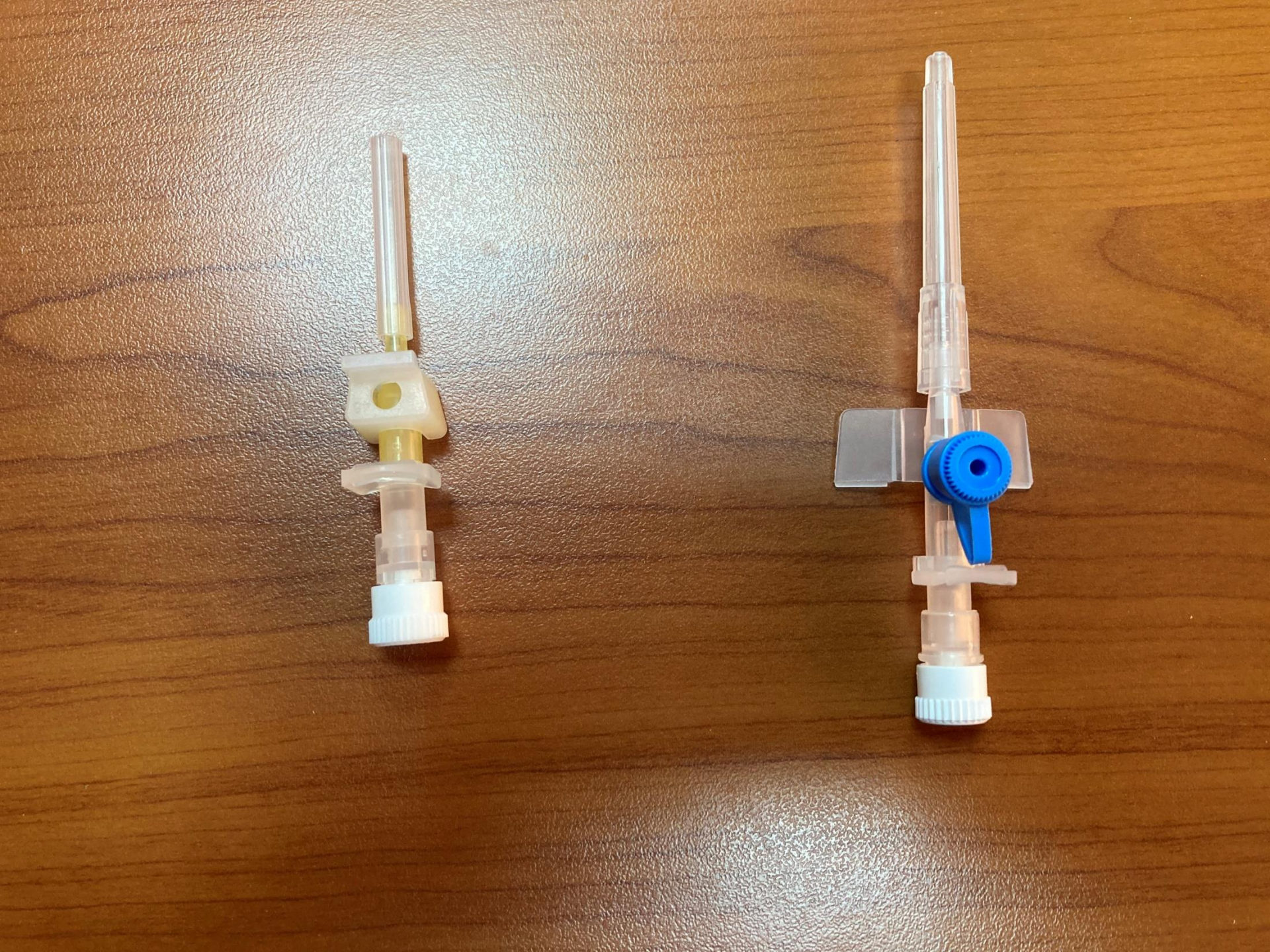
-a precordial stethoscope

-ECG

-pulse oximeter and capnography

-Temperature: rectal, esophageal, nasopharynx.

-A/W pressure monitoring.



MAC

HIGHER MAC

Highest MAC in infants 6 months and 1 year

Fast induction !How?

- Greater Alveolar ventilation to FRC ratio
- High cardiac out put to vessel rich organs(brain)
- Reduced tissue blood solubility

SVOFLURANE: most common and accepted.
HALOTHANE

ISOFLURANE
DESFLURANE

Pediatric psychology

Pediatric Perioperative anxiety

Highest incidence 1-5 years

Anesthesia induction is the most stressful procedure in the perioperative period

URTI

- **Symptoms new or chronic?**

– Infectious vs allergic or vasomotor

- **Viral infection within 2 - 4 weeks of GA with intubation increases perioperative risk**

– Wheezing risk increased 10x

– Laryngospasm risk increased 5x

– Hypoxemia, atelectasis, recovery room stay, admissions and ICU admissions all increased

- **If possible, delay nonemergent surgeries**

Intravenous access may be DIFFICULT!!or even impossible!!!

Keep Intraosseous option in your mind can be used for:

-drug administration

-And fluid replacement

-blood sampling

Laryngospasm

Etiology

- Involuntary spasm of laryngeal musculature
  - Superior laryngeal nerve stimulation
- Risk increased
  - Extubated while lightly anesthetized
  - Recent URI
  - Tobacco exposure

Treatment

- Positive pressure ventilation (PEEP>10cmH2o)
- Laryngospasm notch
- Propofol
  - 0.5–1 mg/kg IV
- Succinylcholine
  - 0.2-0.5 mg/kg IV
  - 2-4 mg/kg IM

And intubation

Perioperative pain control

- Regional (Caudal): extradural block for infraumbilical procedures
- Acetaminophen

– PO 10-15 mg/kg, PR 40 mg/kg, IV 20mg/kg

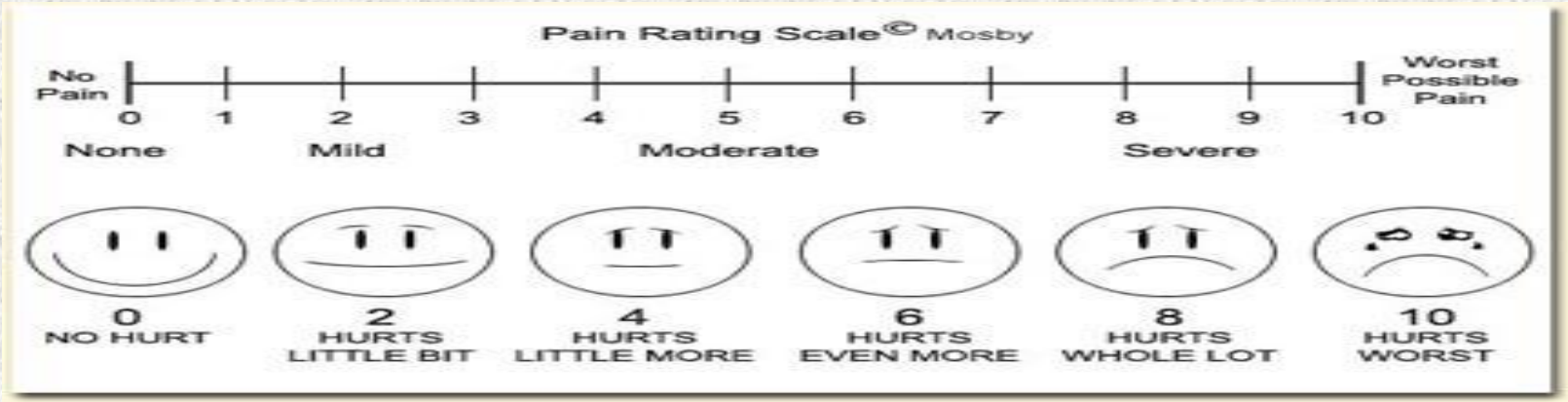
- NSAIDS (diclofenac sodium suppository)
- Ketorolac 0.5-0.75 mg/kg IM/IV
- Opioids

– Morphine 50-100 mcg/kg

-

– Fentanyl 0.5-1 mcg/kg

Pain assesment:



Regional Anesthesia:

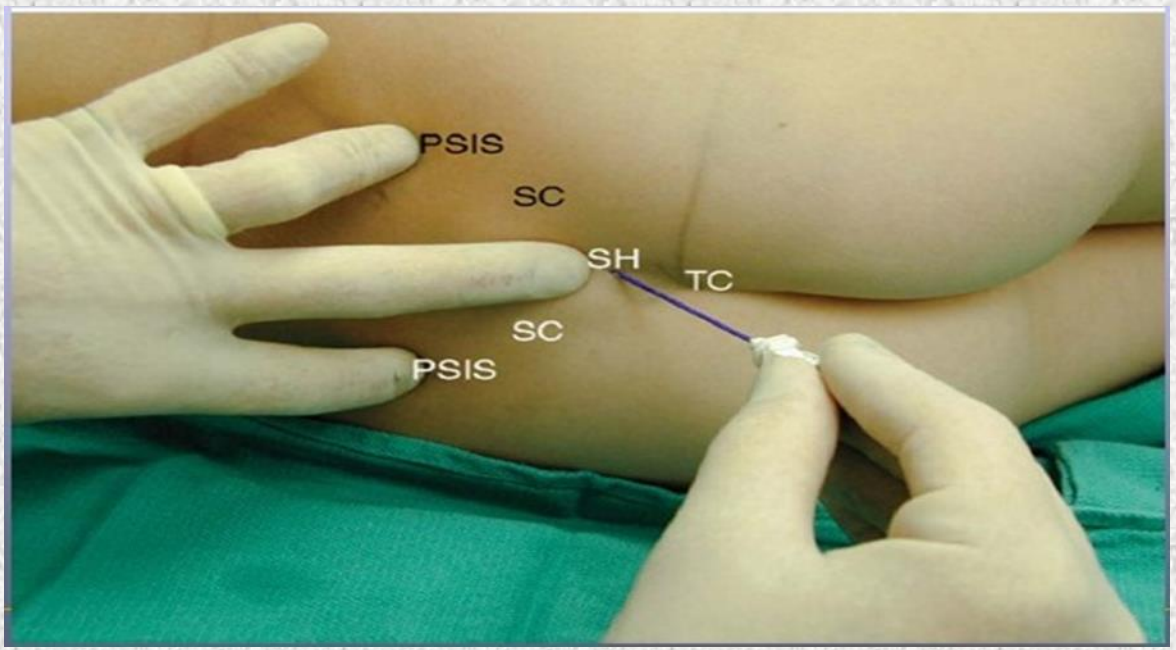
- it decrease anesthetic requirements
- Operative and postoperative utility
- **Caudal block is the most common**
- Options in adults available for children:

– Peripheral blocks and catheters

- Epidural
- Spinal

Caudal

- Perioperative analgesia
  - **Ropivicaine 0.2% 1 cc/kg (up to 2 mg/kg)**
  - **Bupivicaine 0.25% 1 cc/kg (up to 2.5 mg/kg)**
  - Opioids
    - Duramorph 25-50 mcg/kg
    - Hydromorphone 5-10 mcg/kg
  - Clonidine 2 mcg/kg
- Minimal epidural fat
  - May advance catheter to thoracic region



Malignant hyperthermia

- Acute hypermetabolic state in muscle tissue
- Triggering agents
  - Volatile agents
  - SuccinylCholine
- Incidence
  - 1:15,000 peds
  - 1:40,000 adults
- MH may occur at any point during anesthesia or emergence
- Recrudescence despite treatment

MH anesthesia

- Family history

– Muscle bx → caffeine contracture test

– +/- Ryanodine receptor abnormality

- High flow O2 flush circuit x 20 min
- Nontriggering

– TIVA, Nitrous

<u>Increased risk of MH:</u>

- Duchenne's muscular dsytrophy
- Central core disease
- Osteogenesis imperfecta
- King Denborough syndrome

Classic signs of MH

Specific

- Rapid rise in EtCO2 early sign
- Rapid increase in temp late sign
- Muscle rigidity +/-
- Rhabdomyolosis
  - Increase CK
- Myoglobinuria

Nonspecific

- Tachycardia
- Tachypnea
- Acidemia
  - Metabolic
  - Respiratory
- Hyperkalemia
- Dysrhythmias

MH treatment

- Discontinue triggering agents
- Hyperventilate with 100% FiO2
- NaHCO3 1-2 mEq/kg IV
- Dantrolene 2.5 mg/kg IV
- Cool patient
- Support as indicated → intropes, dysrhythmias
- Monitor labs
- Consider invasive monitoring
- 1 800-MH-HYPER

Questions?

THANK YOU ALL