

# PEDIATRICS ANESTHESIA : MCQ



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# 1

Correct statement regarding neonatal physiology is

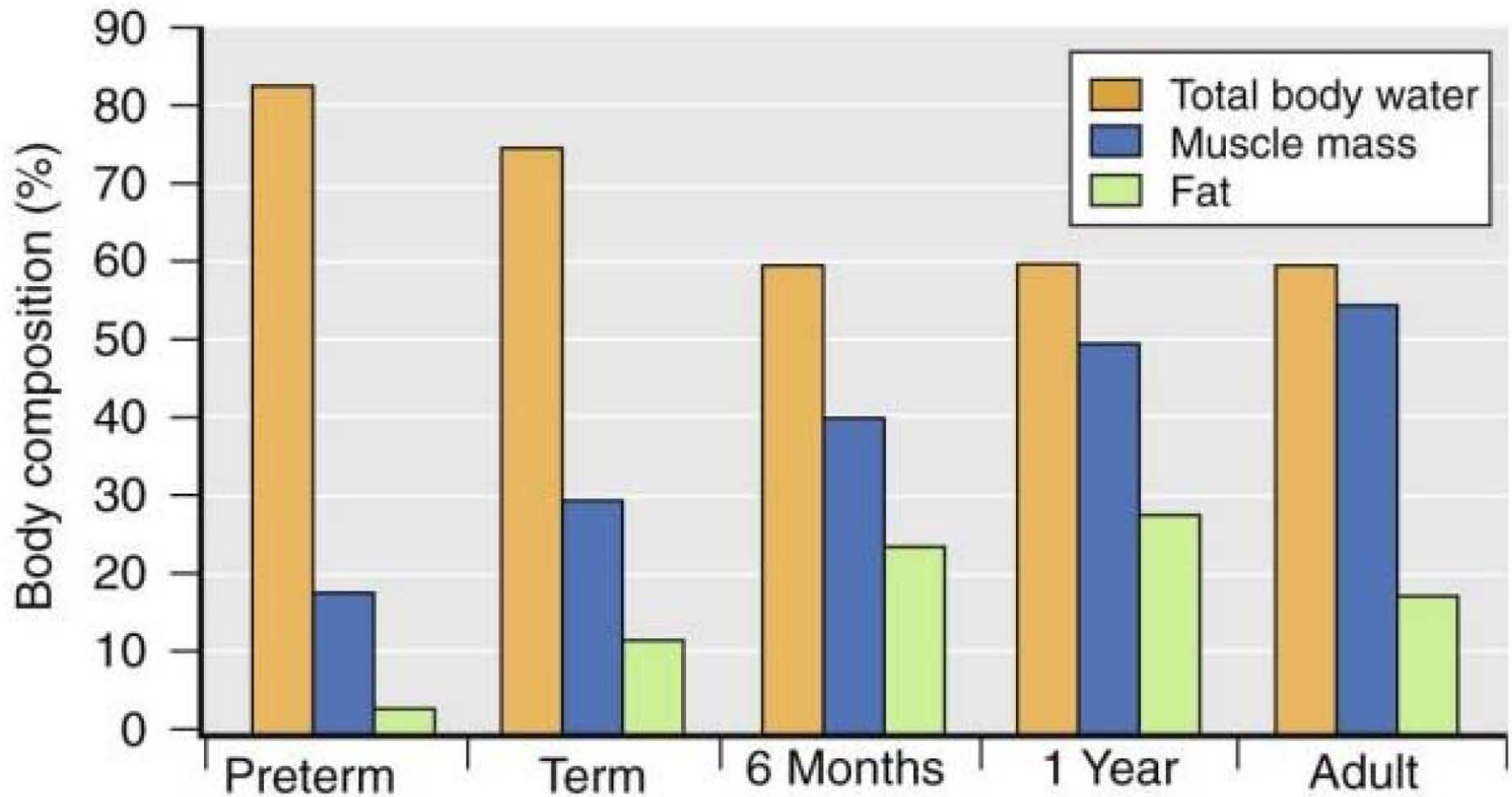


*The "little" patients  
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# Total Body Water (TBW)

Fluid	NB (%BW)	Adult (%BW)
1.ECF	40	20
-Interstitial	35	15
-Plasma	5	5
2. ICF	35	40
TBW รวม	75	60

# Body composition



# Variation of Body Fluid Distribution by Age Group

Distribution of Body Fluids	Preterm Neonates	Full-Term Neonates	Infants	Children	Adults
Total body fluids	80-85%	70-75%	65%	55-60%	50-55%
Intracellular	20-25%	30-35%	35%	35-40%	40-45%
Extracellular	55-60%	45%	30%	20-25%	20%

# Pharmacodynamics

The body compartments (fat, muscle, water) change with age

- ❁ water soluble drug has a larger volume of distribution → larger initial dose (mg/kg) to achieve the desired blood level ; most antibiotics, succinylcholine
- ❁ drug that depends on redistribution into fat for termination of its action ö less fat → longer clinical effect ; thiopental
- ❁ drug that redistributes into muscle may have a longer clinical effect ; fentanyl

# Pharmacodynamics

Factors effect in the neonate's response to medications;

- (1) delayed excretion secondary to the larger volume of distribution,
- (2) immature hepatic and renal function,
- (3) altered drug excretion caused by lower protein binding

## 2

A 4-year-old child weighing 16 kg is scheduled for hernia repair under general anesthesia. Assuming he was NPO for 8 hours, his total fluid deficit will be about \_\_\_\_\_ (mL)



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# Maintenance Fluid

Weight (kg)	Hourly fluid (ml)
<b>&lt; 10</b>	<b>4 ml/kg</b>
<b>11-20</b>	<b>40 ml + 2 ml/kg &gt;10</b>
<b>&gt;20</b>	<b>60 ml + 1 ml/kg &gt;20</b>

# Average fluid need of low-birth-weight infants (mL/kg / 24 hr) during first week of life

Age (days)	Component	Body weight (gm)			
		751 to 1000	1001 to 1250	1251 to 1500	1501 to 2000
1	IVL [†]	65	55	40	30
	Urine [‡]	20	20	30	30
	Stool	0	0	0	0
	Total	85	75	70	60
2 to 3	IVL	65	55	40	30
	Urine	40	40	40	40
	Stool	0	0	0	5
	Total	105	95	80	75
4 to 7	IVL	65	55	40	30
	Urine	60	60	60	60
	Stool	5	5	5	5
	Total	130	120	105	95

10

## Deficit fluid

= maintenance fluid x hr  
of fluid restriction

 50% in the 1st hr

 25% in the 2nd hr

 25% in the 3rd hr

# 🌸 Replacement Fluid

🌸 mild tissue trauma = 2-4

🌸 mod tissue trauma = 4-6

🌸 severe tissue trauma = 6-8

ml/kg/hr

# Method to predict metabolic rates during critical illness

## AVERAGE HOSPITAL ENERGY REQUIREMENTS

<i>Body Weight(kg)</i>	<i>kcal/kg per day</i>	INCREASES IN ENERGY EXPENDITURE WITH STRESS	
0 to 10	100	Fever	12% per°C
10 to 20	1000 + 50/kg	Cardiac failure	>37°C
>20	1500 + 20/kg	Major surgery	15% to 25%
		Burns	20% to 30%
		Severe sepsis	Up to 100%
			40% to 50%

# Clinical & laboratory assessment of severity of dehydration

Signs and Symptoms	Mild Dehydration	Moderate Dehydration	Severe Dehydration
Weight loss (%)	5	10	15
Fluid deficit (mL/kg)	50	100	150
Vital signs			
Pulse	Normal	Increased; weak	Greatly increased; feeble
Blood pressure	Normal	Normal to low	Reduced and orthostatic
Respiration	Normal	Deep	Deep and rapid
General appearance			
Infants	Thirsty, restless, alert	Thirsty, restless, or lethargic, but arousable	Drowsy to comatose; limp, cold, sweaty; gray color
Older children	Thirsty, restless, alert	Thirsty, alert, postural hypotension	Usually comatose; apprehensive, cyanotic, cold
Skin turgor (†)	Normal	Decreased	Greatly decreased
Anterior fontanel	Normal	Sunken	Markedly depressed
Eyes	Normal	Sunken	Markedly sunken
Mucous membranes	Moist	Dry	Very dry
Urine			
Flow (mL/kg per hr)	<2	<1	<0.5
Specific gravity	1.020	1.020–1.030	>1.030

# 3

The total dose of midazolam that may be given orally as premedication is



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# Premedication

- ❁ Chloral hydrate 40 mg/kg + Atropine 0.02 mg/kg → pr
- ❁ Ketamine 4-6 mg/kg + Midazolam 0.5 mg/kg + Atropine 0.02 mg/kg → po
- ❁ Midazolam 0.5-1.0 mg/kg → po, pr
- ❁ Diazepam 0.1-0.3 mg/kg → po
- ❁ Ketamine
- ❁ Thiopentone
- ❁ Dexmedetomidine → Infusions of 2, 4, or 6  $\mu\text{g/kg/hr}$



# 4

A newborn baby of 37 weeks of gestation has a heart rate of 90 bpm, is crying, is pink with blue extremities, and shows some flexion. Her Apgar score would be



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# Apgar Score

Sign	Points		
	0	1	2
Heart rate (bpm)	Absent	<100	>100
Respiratory effort	Absent	Slow, irregular	Good crying
Muscle tone	Flaccid	Some flexion	Active motion
Reflex irritability	No response	Grimace	Crying
Color	Blue or pale	Body pink, blue extremities	All pink

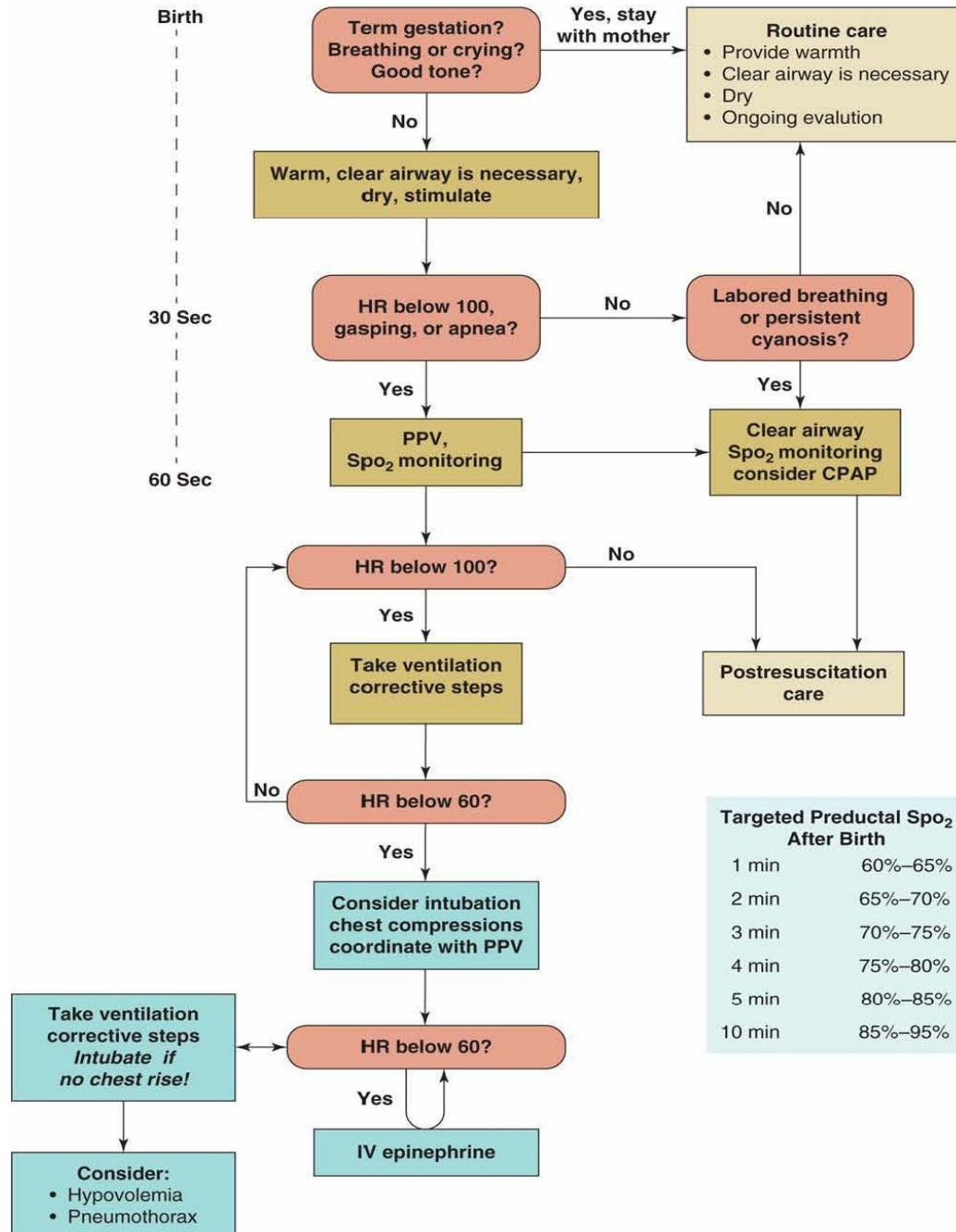
# 5

After initial evaluation of the baby described above, the next step in managing her would be



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## Newborn Resuscitation



# 6

All of the following drugs can be given through endotracheal tube, except



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# Drugs can be given through endotracheal tube

- Lidocaine
- Epinephrine
- Atropine
- Vasopressin
- Surfactant

dose of drugs through ETT= 2 to 2.5 times IV dose

# 7

The disease or syndrome with known association with Malignant hyperthermia is



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## Musculoskeletal diseases associated with a relatively high incidence of malignant hyperthermia

- Duchenne muscular dystrophy
- Myotonia
- King Denborough syndrome (KDS) : young boys who exhibit
  - short stature,
  - mental retardation,
  - cryptorchidism,
  - kyphoscoliosis,
  - pectus deformity,
  - slanted eyes,
  - low-set ears,
  - webbed neck,
  - winged scapulae

# 8

An 8-year-old child is brought to the emergency room with testicular Torsion. The parents tell you he ate a sandwich 6 hours ago. Surgeon wants to operate immediately. Your response should be



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# Fasting Time

Age	Milk and Solids	Clear liquids
< 6 m	4	2
6-36 m	6	3
> 36 m	6-8	3

**Breast milk = 4 hrs**



# 9

Which of the following statements about pediatric airway is true?



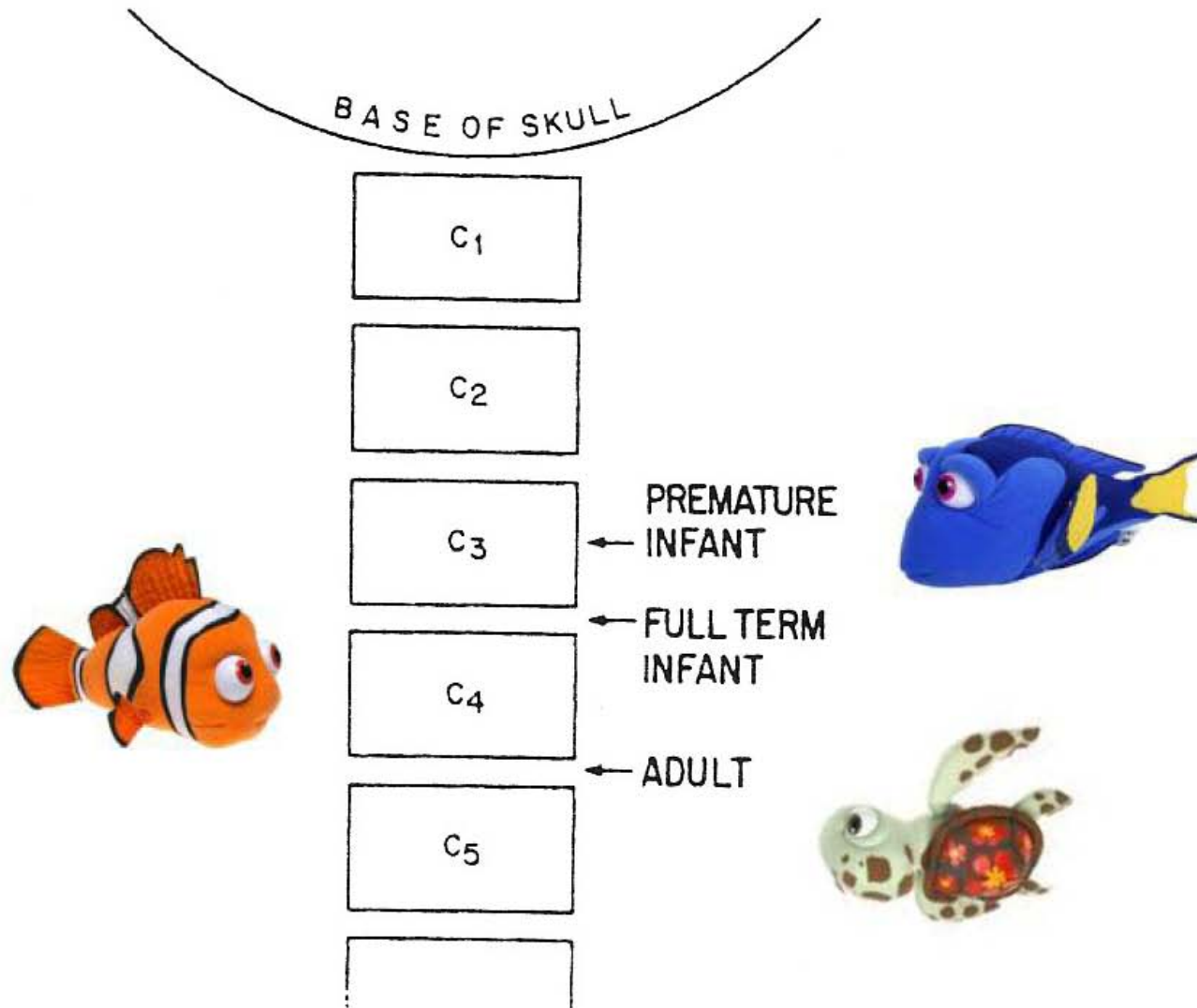
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# Airway of the infant

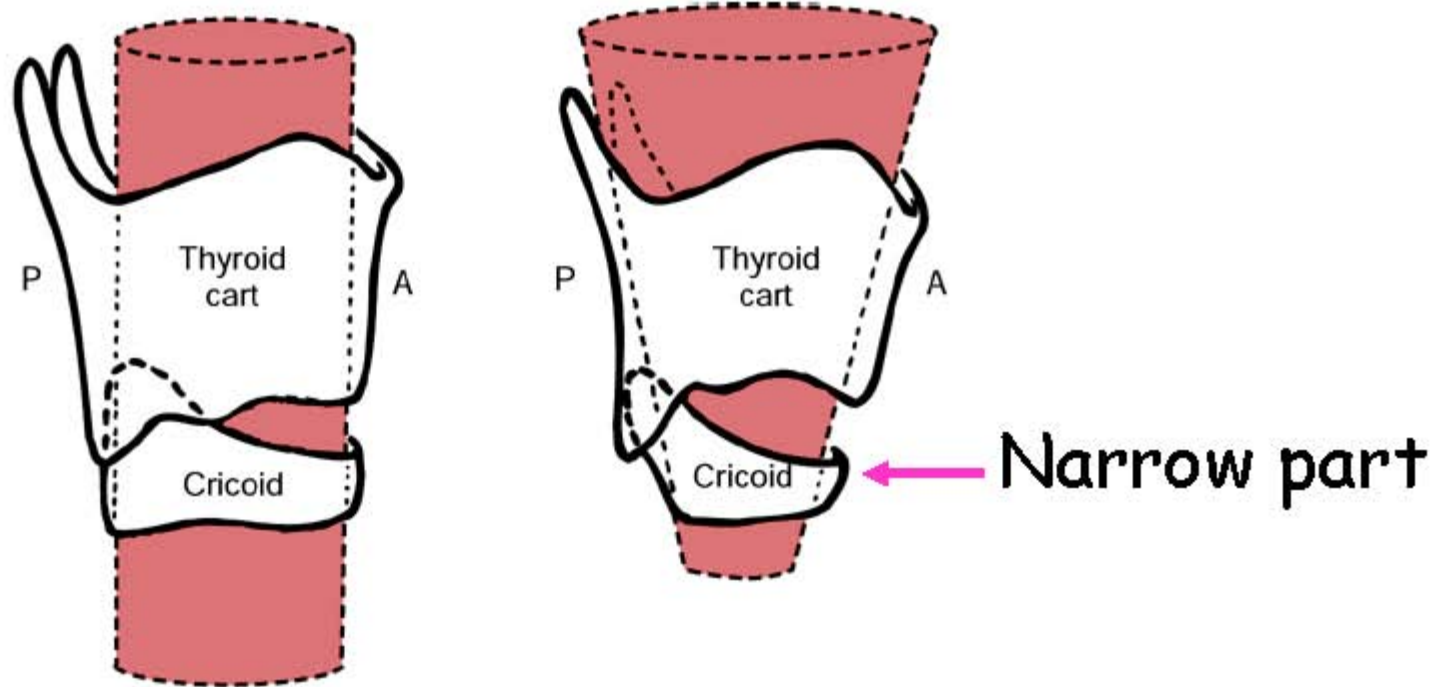
- ❁ Obligate nose breather
- ❁ Large head, short neck, large tongue
- ❁ High and Anterior larynx
- ❁ Short epiglottis & angled over laryngeal inlet
- ❁ Vocal cords are angled
- ❁ Funnel-shaped larynx
- ❁ Narrowest portion = subglottic region at the level of the cricoid cartilage



# Glottic opening relative to cervical vertebra

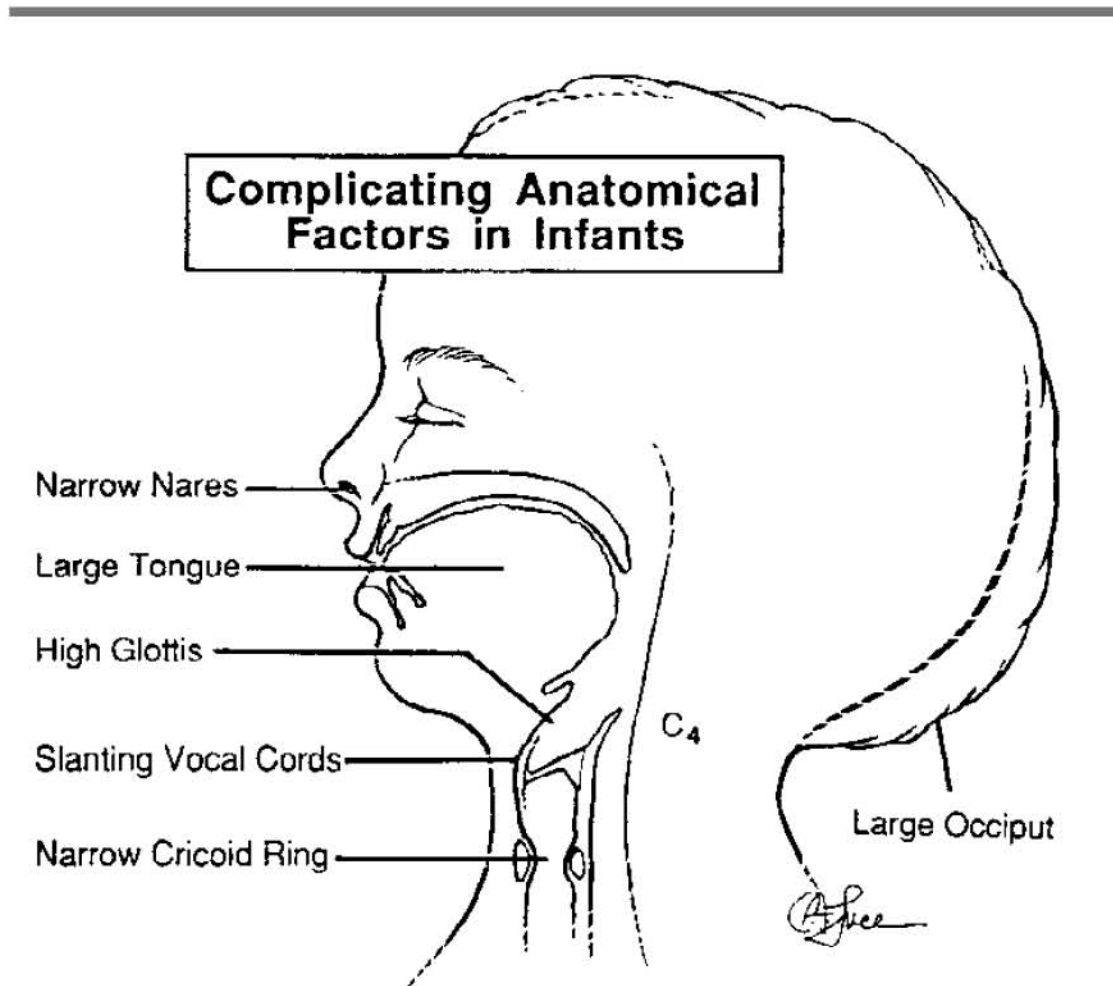


# Adult and Infant Larynx



Narrow part is Glottic opening

# Complicating Anatomical Factors in Infants



# 10

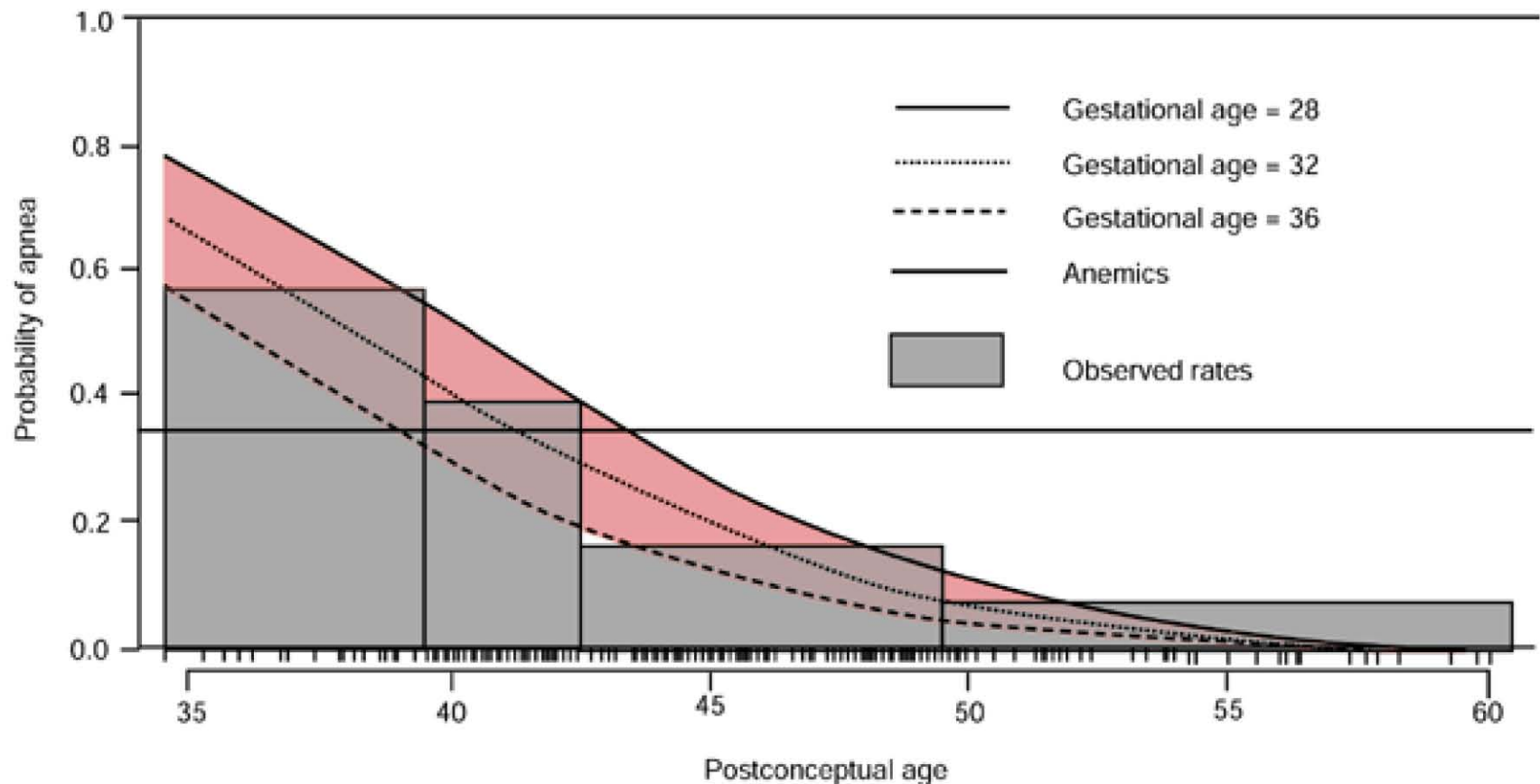
A 10-week-old baby, who was born prematurely at 30 weeks of gestation, undergoes circumcision uneventfully under general anesthesia. After the baby recovers from anesthetics in postanesthesia care unit, he can/should be



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# Predicted probability of Apnea

Nonanemics and anemics separated, various gestational ages



# Risk factors for postanesthetic apnea

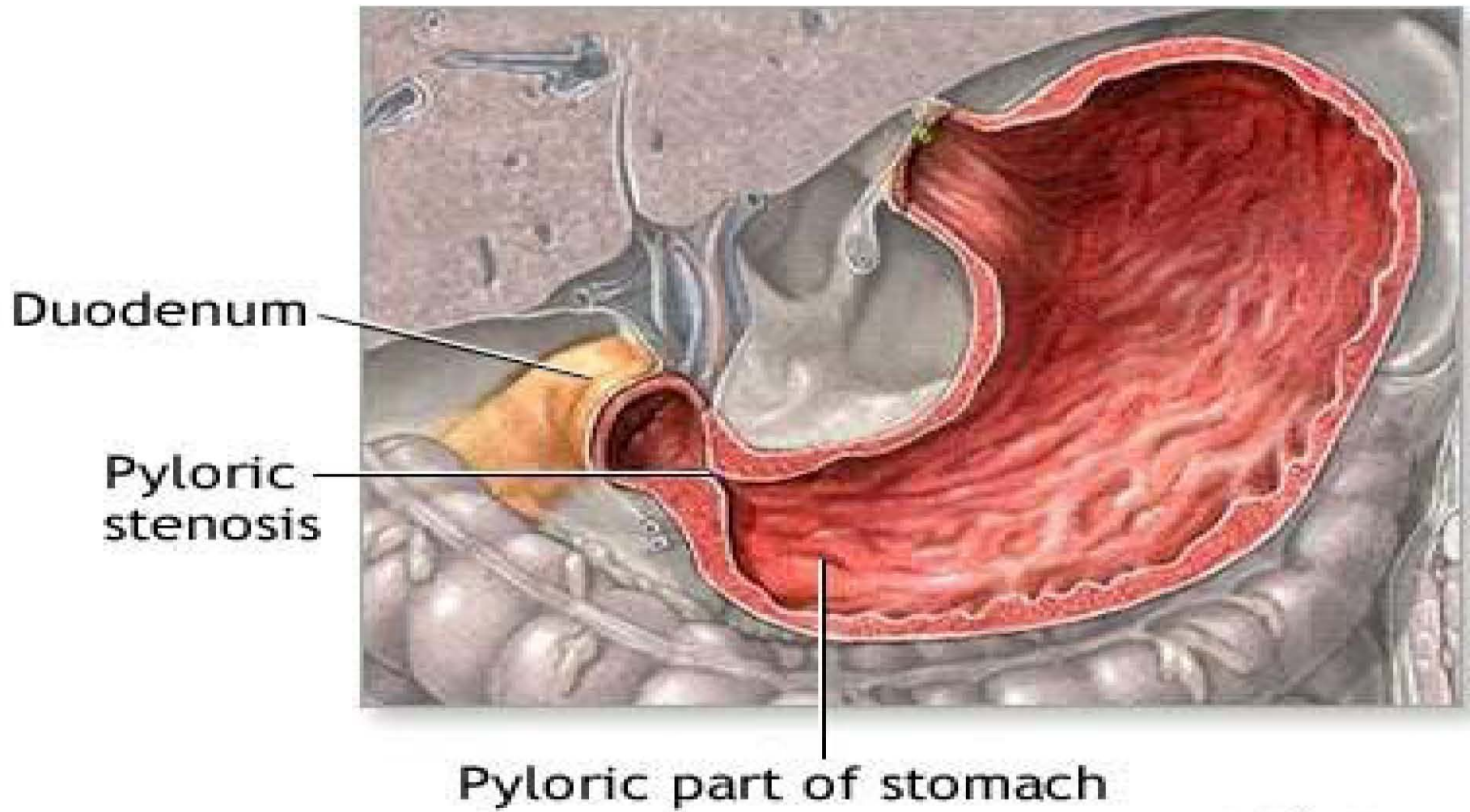
- a low gestational age at birth
- anemia (<30%)
- hypothermia
- sepsis
- neurological abnormalities

# 11

Hypertrophic pyloric stenosis is associated with



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# Pyloric Stenosis

## Problems

- ❁ Hypochloremic -Hypokalemic Metabolic Alkalosis
- ❁ Aspiration (gastric content)
- ❁ Hypotension (Hypovolemia)
- ❁ Dysrhythmia
- ❁ Inadequate respiration
- ❁ manifested in the first 3 to 6 weeks of life

# 12

A child with which of the following diseases/syndromes should be evaluated for heart disease?



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# Omphalocele



# Gastroschisis



# Omphalocele & Gastroschisis

## Problems

- ✿ Hypovolemia → Severe dehydration
- ✿ Heat loss → Hypothermia
- ✿ Prone to infection
- ✿ Increase intra-abdominal pressure
  - ✿ Cardio-respiratory compromise
  - ✿ Edema of lower extremities
  - ✿ Organ ischemia
- ✿ Prolong bowel dysfunction
- ♥ High association with prematurity and other congenital defects

	<b>Gastroschisis</b>	<b>Omphalocele</b>
Pathophysiology	Occlusion of the omphalomesenteric artery	Failure of gut migration from the yolk sac into the abdomen
Incidence	~1 in 15,000 births	~1 in 6000 births
Incidence of associated anomalies	~10%-15%	~40%-60%
Location of defect	Periumbilical	Within the umbilical cord
Problems associated with the defect	Inflammation of exposed gut Edema Dilated and foreshortened gut (chemical peritonitis)	Congenital heart disease (~20%) Exstrophy of the bladder Beckwith-Wiedemann syndrome (macroglossia, gigantism, hypoglycemia, hyperviscosity)

# 13

The earliest and the most pathognomonic feature of malignant hyperthermia (MH) is



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# MH

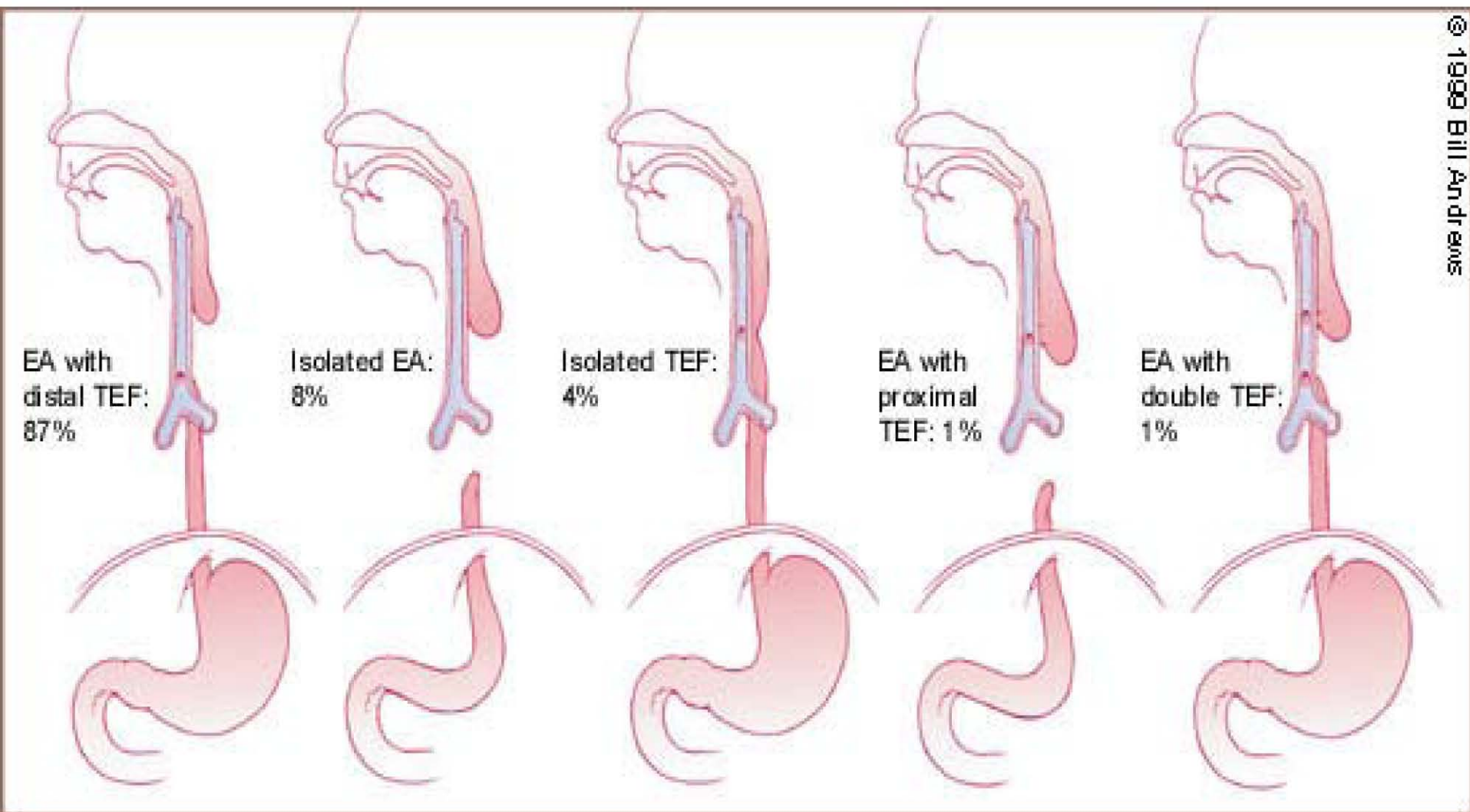
- fatal hypermetabolic disorder triggered by exposure to volatile inhalational anesthetics or succinylcholine
- The incidence of MH is 1:15,000 in pediatric and 1:50,000 in adults
- Signs of MH include
  - masseter muscle rigidity,
  - tachycardia,
  - tachypnea,
  - hypercarbia (increased  $CO_2$  production—earliest sign),
  - hyperthermia (late sign)
  - Hypertension and arrhythmias may be seen (sympathetic overactivity).
  - Generalized muscle rigidity is not consistently present,
  - presence of dark-colored urine indicates myoglobinuria

# 14

The most common type of tracheoesophageal fistula (TEF) is



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# Tracheoesophageal Fistula

## Problems

- ✿ Prematurity & associated congenital anomaly
- ✿ Dehydration
- ✿ Pneumonitis
- ✿ Inadequate ventilation
  - ✿ Gastric distension
  - ✿ Air leak through gastrostomy
- ✿ Problems at ET tube
- ✿ Tracheomalacia

# 42

To protect lungs in a child with tracheoesophageal fistula, all the following should be done, except



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# Interventions to protect the lungs from aspiration in TEF

- Avoidance of feedings
- Upright positioning of the infant to decrease the likelihood of gastroesophageal reflux (30-degree elevation)
- Antibiotic therapy and physiotherapy if pneumonia is diagnosed
- Intermittent suctioning of the upper blind esophageal pouch

# 15

Down syndrome is associated with all of the following, except



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# Down syndrome

- trisomy 21 is most common congenital syndromes
- Anesthetic considerations include
  - presence of short neck & large tongue (difficult airway),
  - irregular dentition,
  - mental retardation,
  - hypotonia,
  - congenital heart disease in 30% to 40% of patients (particularly endocardial cushion defects & ventricular septal defect),
  - subglottic stenosis,
  - tracheoesophageal fistula,
  - chronic pulmonary infections,
  - seizures,
  - duodenal stenosis,
  - delayed gastric emptying.

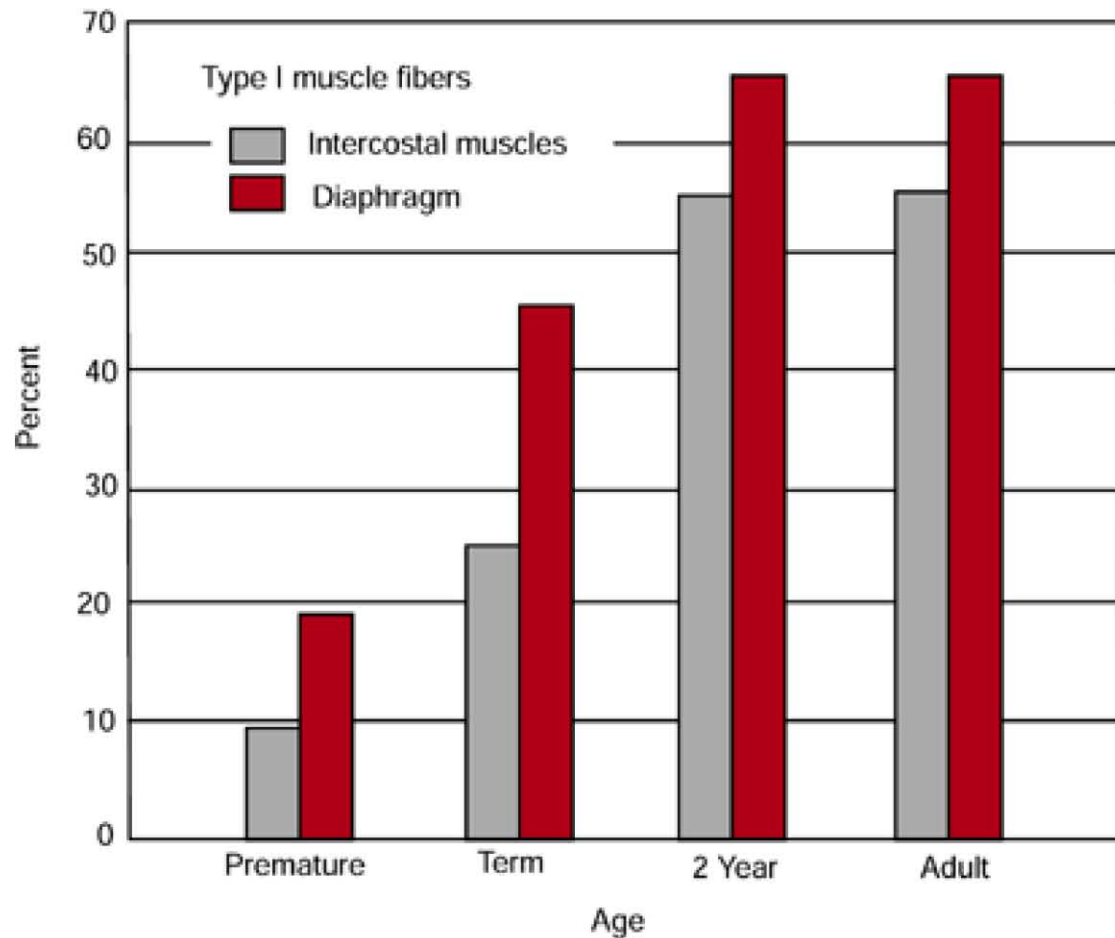
# 16

The first sign of intrathecal injection following the placement of caudal epidural with 0.25% bupivacaine in a 1-year-old child would be



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# Diaphragm & Intercostal muscles changes during the first 2 yrs of life



# 17

A 2-year-old child weighing 13 kg is scheduled for inguinal hernia repair. The calculated dose of 0.25% bupivacaine for a caudal epidural would be approximately \_\_\_\_\_ (mL)



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# Armitage formula

for calculation of caudal bupivacaine in a child with appropriate weight for his age.

- 0.5 mL/kg for a lumbosacral block
- 1 mL/kg for a thoracolumbar block
- 1.25 mL/kg for a midthoracic block

0.25% Bupivacaine up to a maximum of 20 mL

# Regional anesthesia in Pediatrics

## Peripheral nerve block

-  Ilioinguinal NB

-  Iliohypogastric NB

-  Penile NB

## Caudal block (Epidural block)

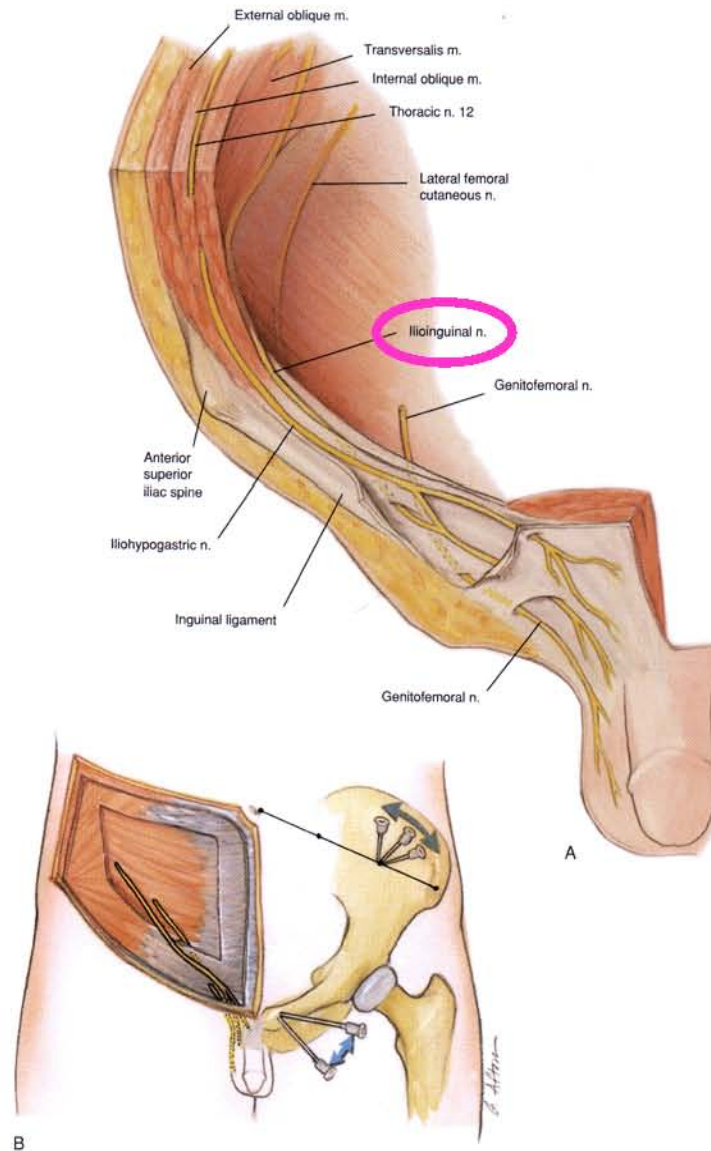
### Dosage prescription scheme of Armitage

-  0.5 mL/kg, all sacral dermatomes are blocked

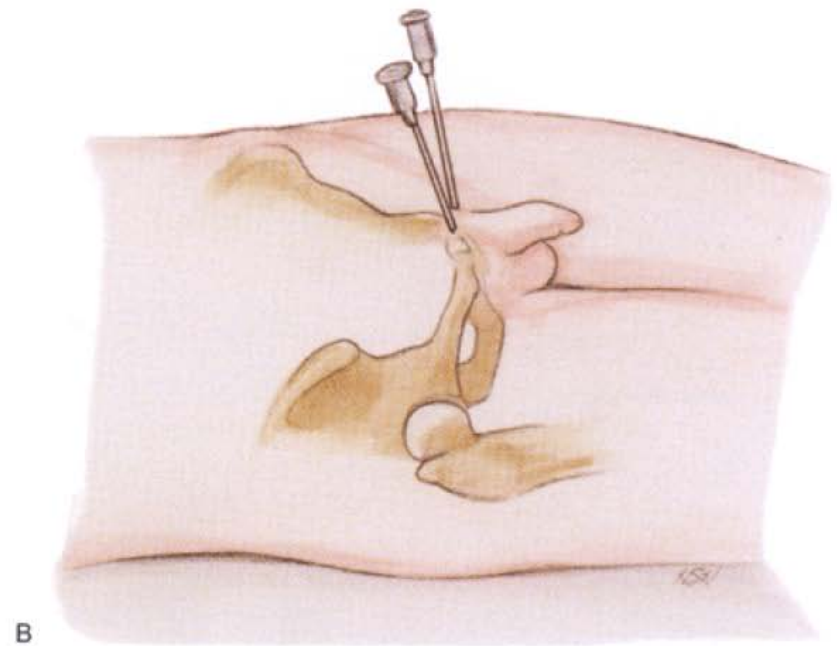
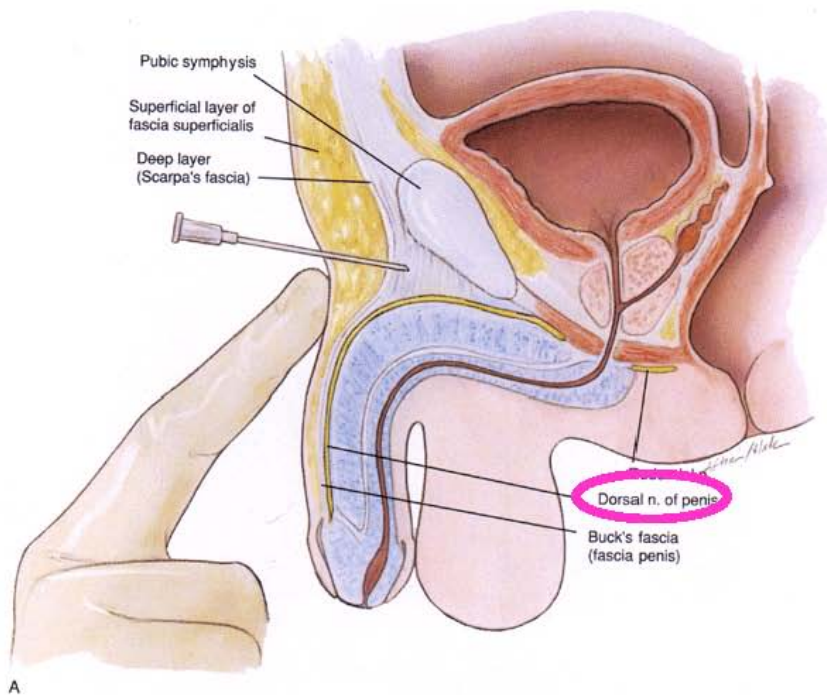
-  1.0 mL/kg, all sacral and lumbar dermatomes are blocked

-  1.25 mL/kg, the upper limit of anesthesia is at least midthoracic

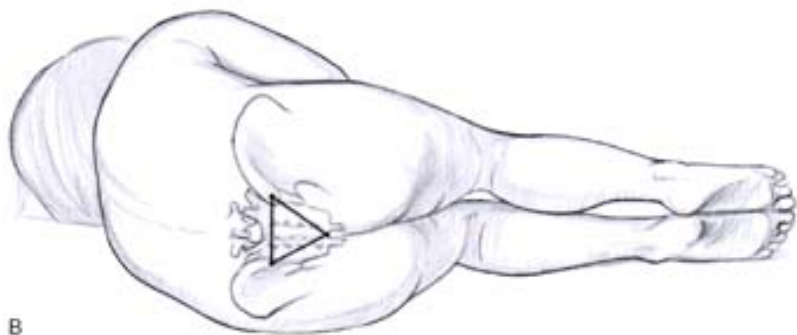
# Ilioinguinal NB



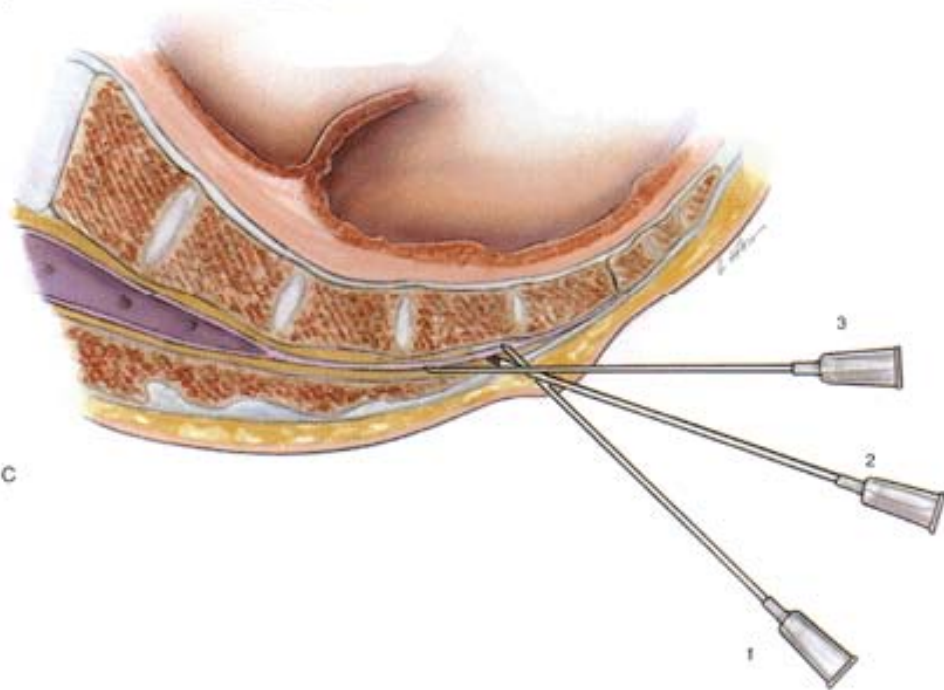
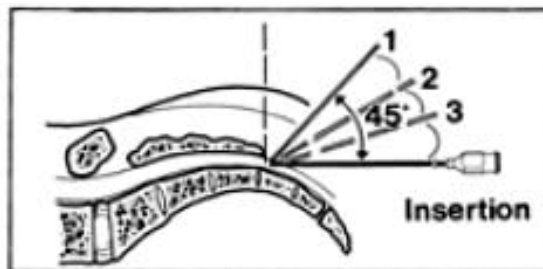
# Penile NB



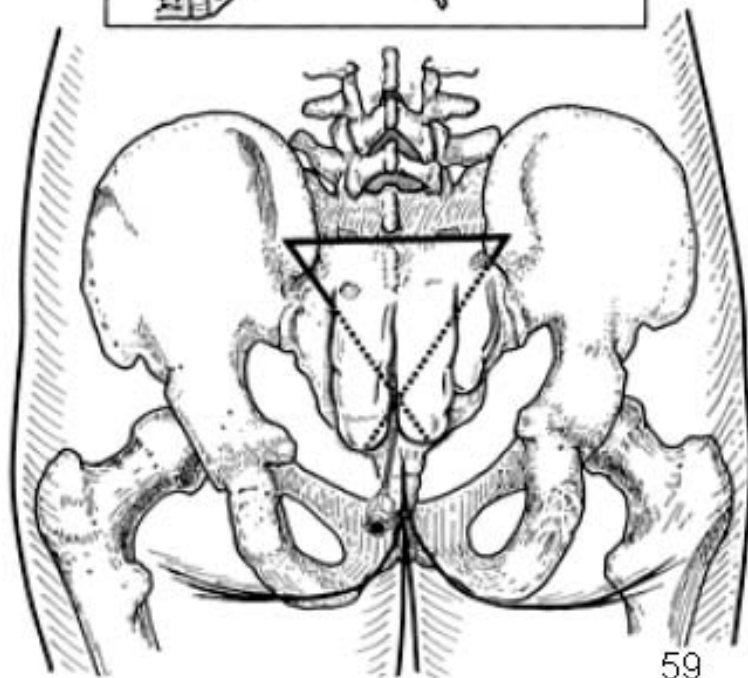
# Caudal block



B



C



# Commonly Used Additives and Recommended Doses in Pediatric Regional Anesthesia

Additive	Recommended Doses	Maximum Doses
Morphine		
Epidural	30 µg/kg	50 µg/kg
Intrathecal	10 µg/kg	20 µg/kg
Fentanyl (epidural)	1-1.5 µg/kg	2.5 µg/kg

# Usual and Maximum Recommended Doses of Local Anesthetic

Local Anesthetics	Usual Concentrations	Maximum Dose of Plain Solutions (mg/kg)	Maximum Doses with Epinephrine (mg/kg)
<b>Aminoesters</b>			
Procaine	1-2	7	10
Chloroprocaine	2-3	7	10
<b>Aminoamides</b>			
Lidocaine	0.25-2	5 (or 400 mg)	10 (or 700 mg)
Mepivacaine	0.25-2	5-7 (or 400 mg)	Not available
Bupivacaine	0.125-0.5	2 (or 150 mg)	3 (or 200 mg)
Levobupivacaine	0.125-0.5	3 (or 200 mg)	4 (or 250 mg)
Ropivacaine	0.1-10	3 (or 300 mg)	Not available (and not recommended)

# Test Dose of local anesthetic

- test dose of LA containing  $5 \mu\text{g}$  per mL of epinephrine ( $0.1 \text{ mL/kg}$ , maximum of  $3 \text{ mL}$ ) to detect inadvertent intravascular injections
- awake patient  $\rightarrow \text{HR} \geq 10 \text{ bpm}$  = positive sign
- $\frac{1}{4}$  of anesthetized children  $\rightarrow \text{HR}$  not increase
- more sensitive indicator  $\rightarrow \uparrow$  T-wave amplitude on ECG
- T-wave height will increase within 20 secs. and disappear within 60 secs.

# Local Anesthetic Toxicity Rx

- 20% intravenous lipid emulsion
- By lipid scavenges, extracts, & binds lipophilic local anesthetics from tissue and plasma
- recommended dose = 1 mL/kg over 3 mins
  - repeated up to 3 mL/kg
  - followed by infusion of 0.25 mL/kg/min until hemodynamic recovery is achieved
  - rate  $\geq 8$  mL/kg is not likely to be effective

# 18

All the following are physiologic changes that occur at birth, except



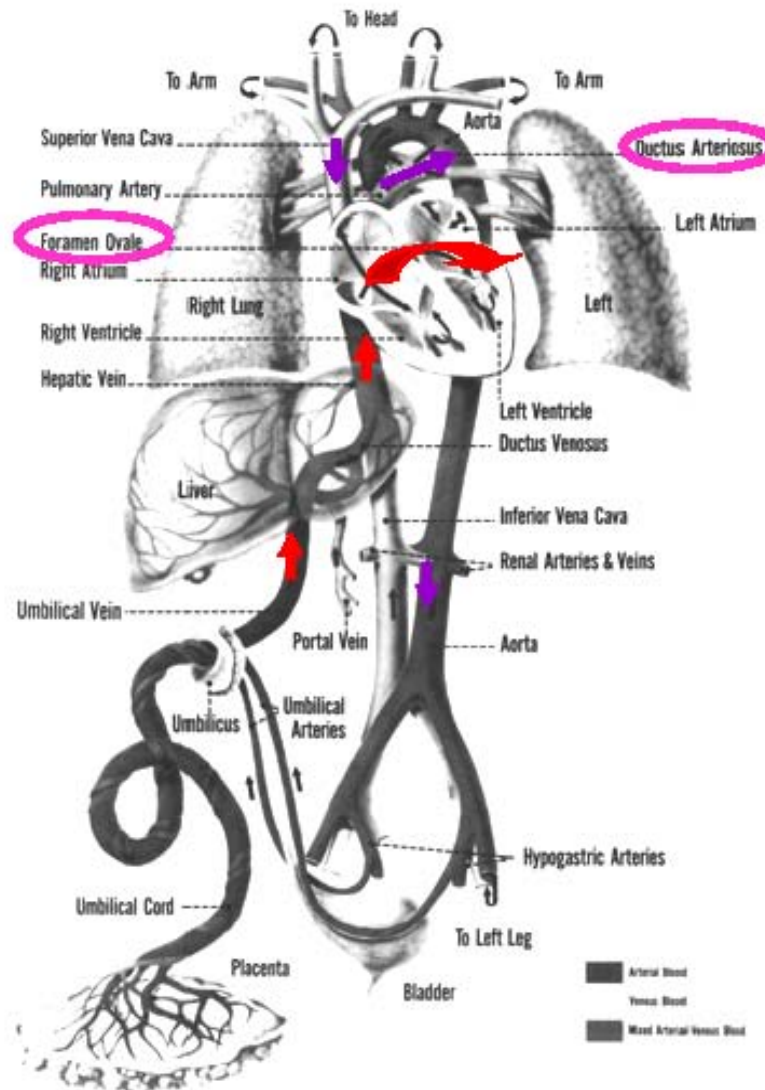
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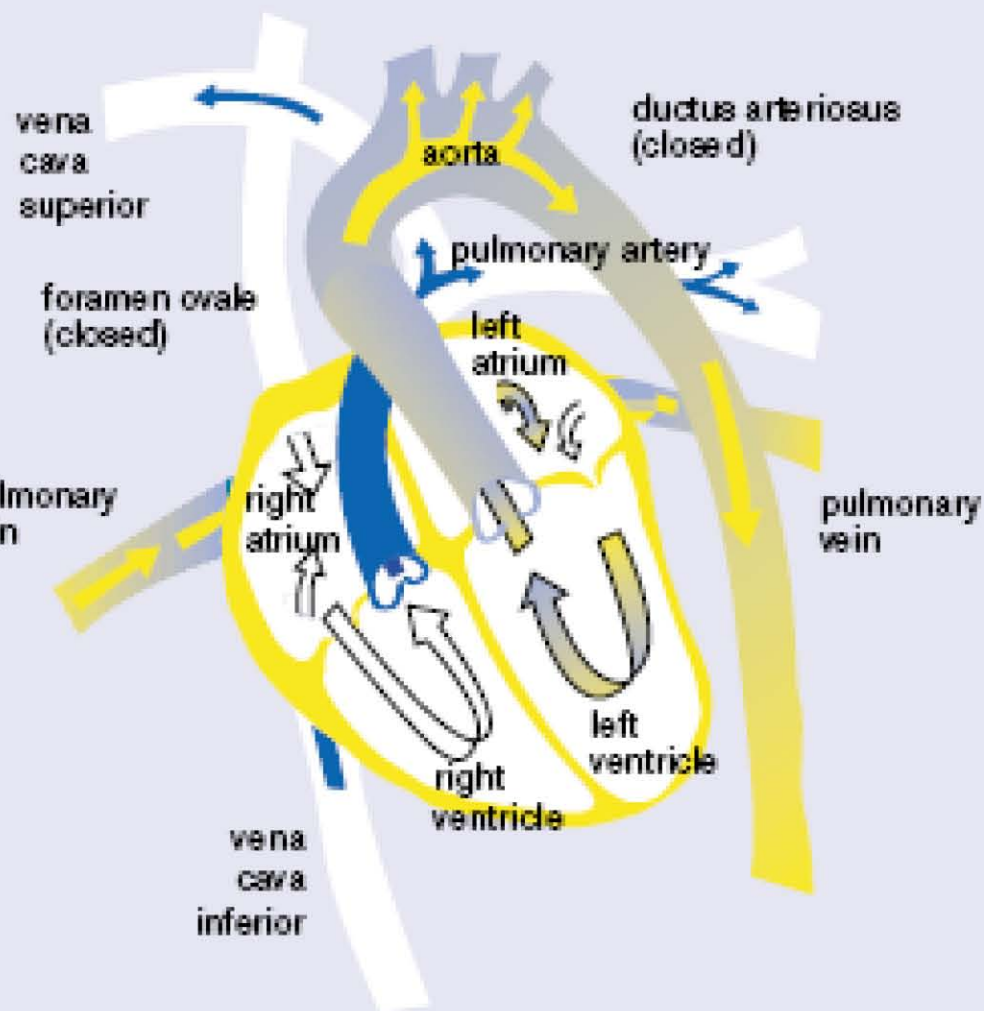
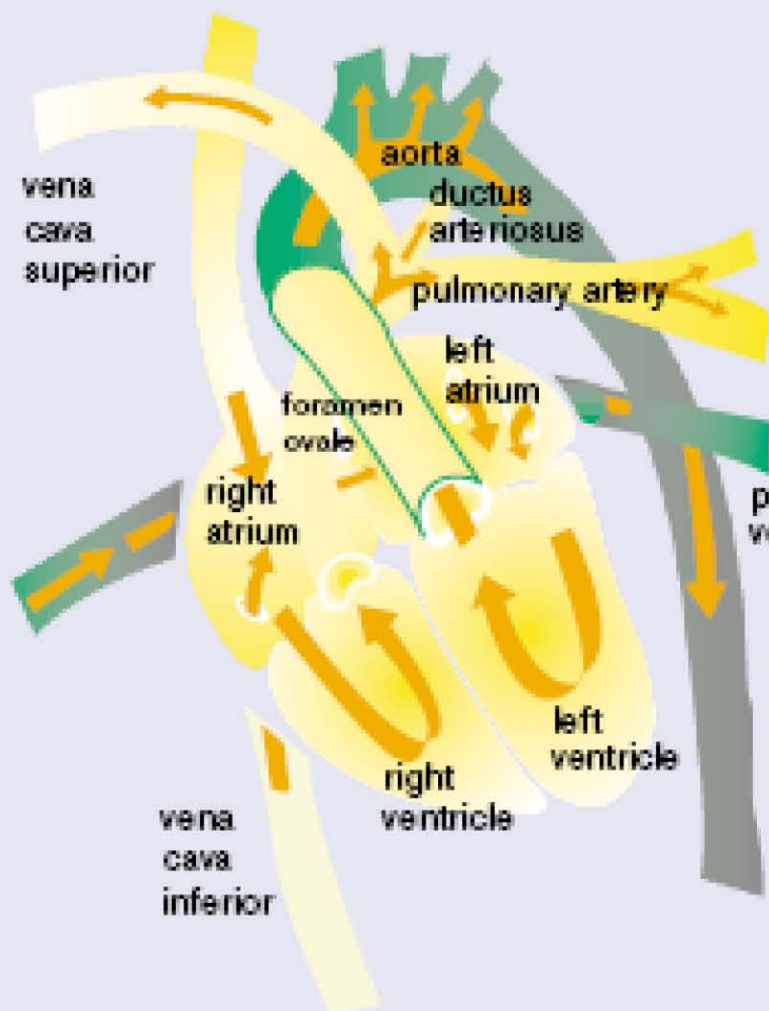
# Cardiovascular System

- ❁ Fetal circulation to adult circulation
- ❁ Immature myocardium
  - ❁ sensitive to volume loading
  - ❁ poor tolerance to increased afterload
  - ❁ heart rate-dependent cardiac output



# Fetal and Adult Circulations





# 19

Neonates lose heat by all the following mechanisms in the operating room, except



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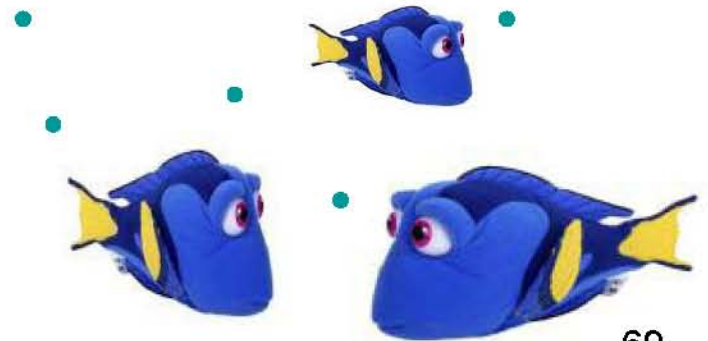
# Thermoregulation

🌸 heat loss

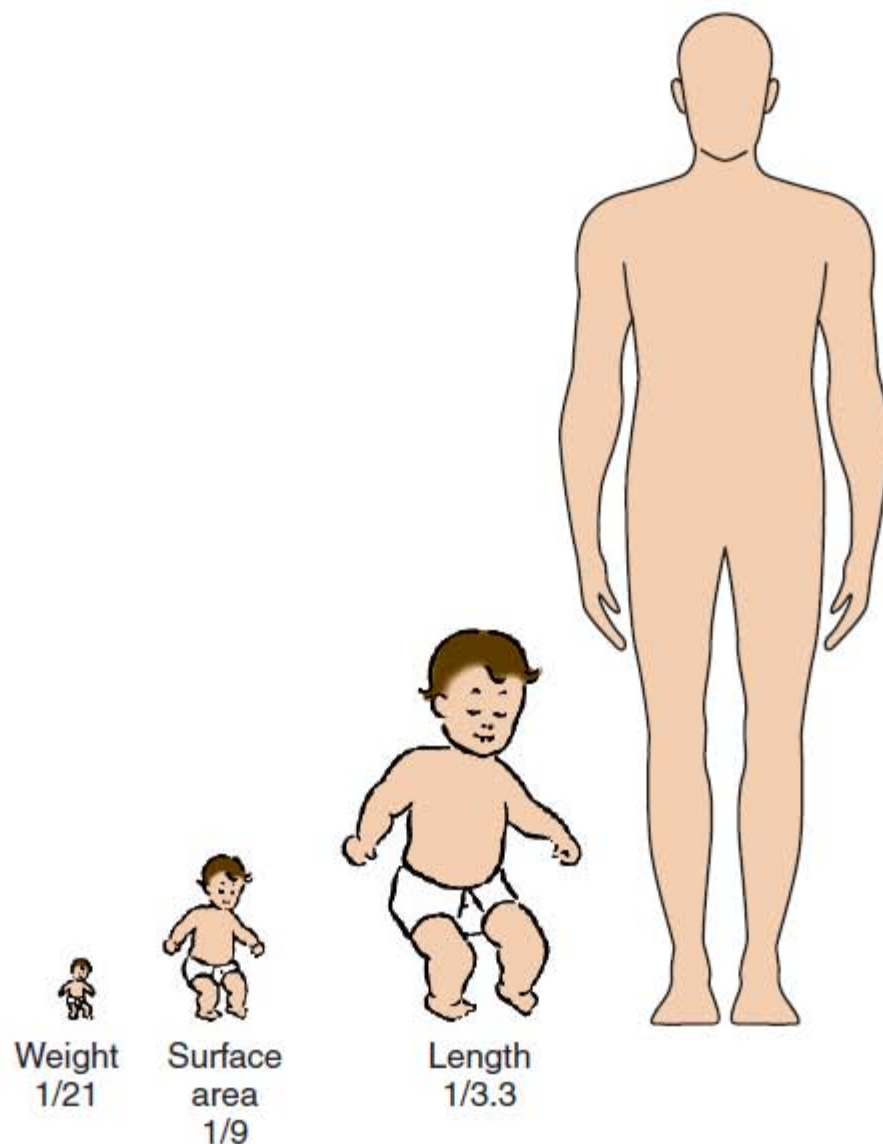
🌸 large body surface-to-weight ratio

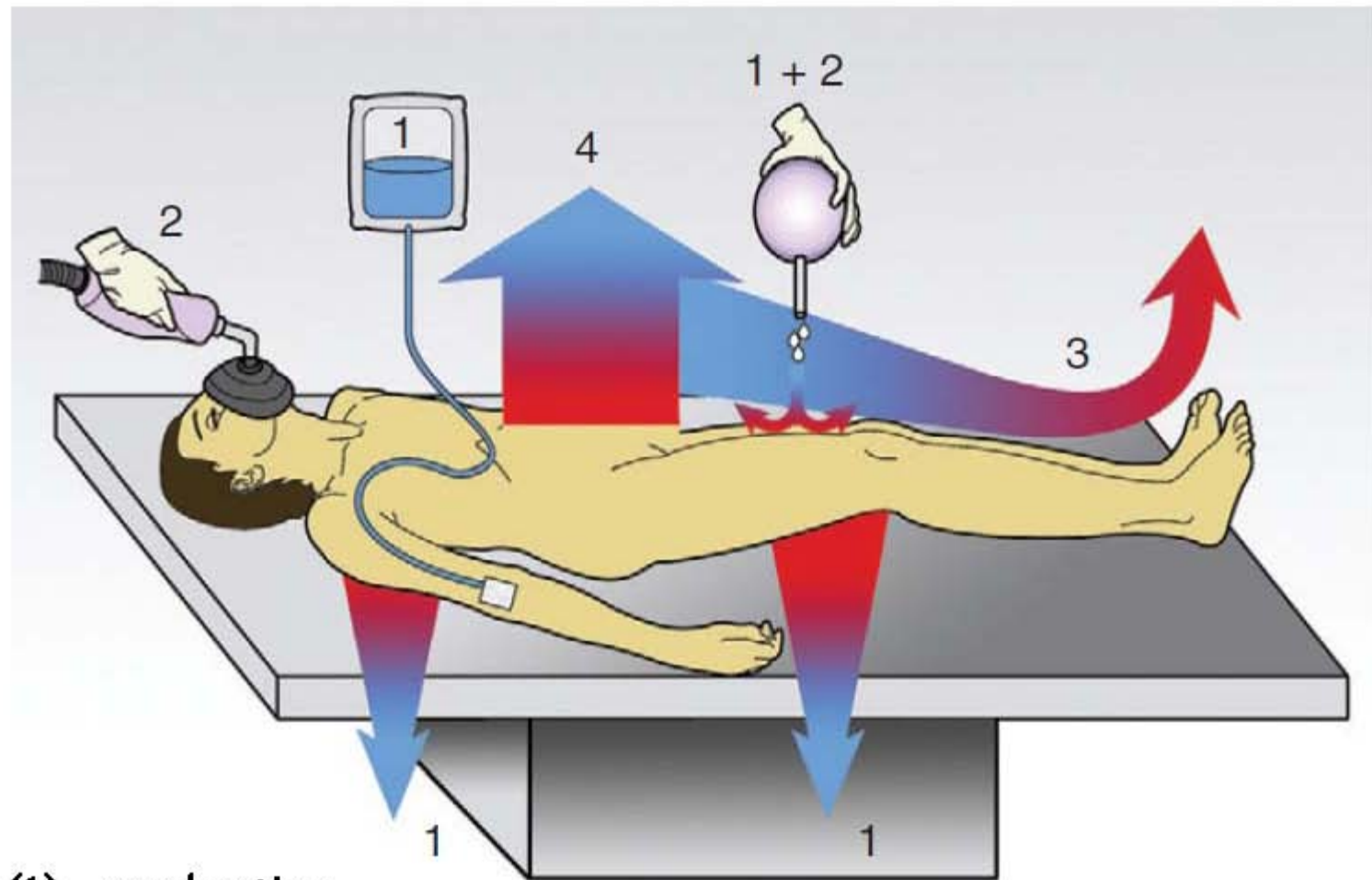
🌸 lack of subcutaneous fat

💀 Vulnerable to hypothermia



# Proportions of newborn to adult





- (1) conduction
- (2) evaporation
- (3) convection
- (4) radiation

# Prevention for hypothermia

reduce heat lost from

- ✿ conduction by placing the baby on a warming mattress and warming the operating room ( $\geq 26.7^{\circ}\text{C}$ )
- ✿ convection by keeping the infant in an incubator, covered with blankets
- ✿ radiation by use of a double-shelled Isolette during transport
- ✿ evaporation by humidification of inspired gases, the use of plastic wrap to decrease water loss through the skin, and warming of skin disinfectant solutions.
- ✿ Hot air blankets are the most effective means of warming children

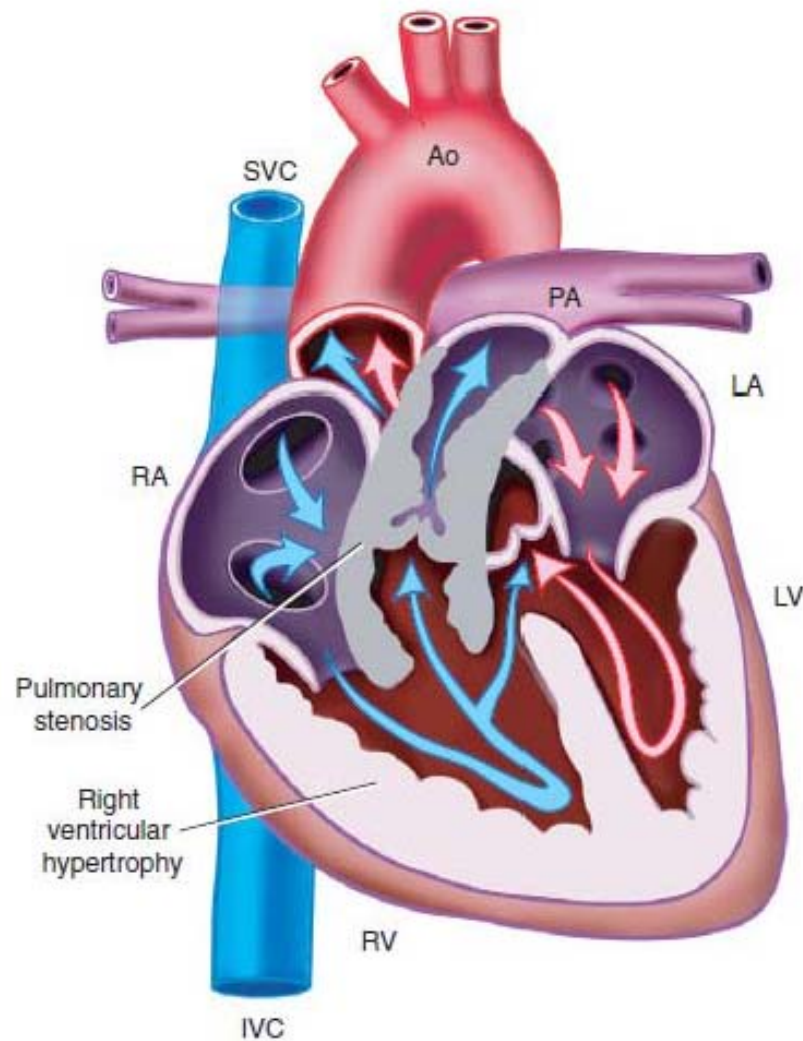
# 20

A 4-year-old child with tetralogy of Fallot is scheduled for incision and drainage of a foot abscess. All the following measures can be used to improve his oxygenation, except



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# TOF



# Tetralogy of Fallot (TOF)

1. Large VSD
  2. Rt. Ventricular Outflow Obstruction
  3. Overriding Aorta
  4. Rt. Ventricular Hypertrophy
- Rt to Lt shunt → Cyanosis
  - Tet Spell; Paroxysmal dyspnea, Hypoxic spell

# Problems of TOF

- Hypoxic spell
- Coagulopathy , Abnormal platelet function
- Rising Hct → Hyperviscosity syndrome
- CVA infarction , Cerebral abscess
- Associated anomaly ;
  - Velocardiofacial syndrome
  - DiGeorge syndrome

# Hypercyanotic spell management

Goal : - Maintain SVR  
- Improve pulmonary blood flow

Treatment :

- Oxygen
- Hyperventilation
- Vasoconstrictor
- Fluid , Blood , Blood component
- Adequate anesthesia
- $\beta$ -adrenergic antagonists (caused by spasm of RVOT)
- $\uparrow$ SVR  $\rightarrow$  Abdominal compression, phenylephrine



# General management

- Adequate hydration
- Avoid hypoglycemia
- Maintain SVR
- Avoid sudden increase O<sub>2</sub> demand
- Optimum Hct ( < 65 %)

# Management of anesthesia

- Induction of anesthesia ; ketamine (3 - 4 mg/kg IM or 1 -2 mg/kg IV)
- Onset of action of IV drugs → more rapid in Rt-Lt shunts because dilutional effect in the lungs ↓
- ventilation with high airway pressures → increase PVR → compromise venous return & exacerbate Rt-Lt shunts

## Prevention & treatment of pulmonary hypertensive crisis

- Hyperventilation (with  $\text{FiO}_2$  100%)
- Correction of acidosis
- Avoidance of sympathetic nervous system stimulation
- Maintenance of normothermia
- Minimization of intrathoracic pressure
- Inotropic support
- Inhaled nitric oxide

# 21

Which of the following heart rates is inappropriate for the age?



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# BP & HR in Children

Age	HR	BP
NB	120	70/45
1 yr	120	80/60
2 yr	110	80/60
4 yr	100	85/60
6 yr	100	90/60
8 yr	90	95/62
10 yr	90	100/65

# Mean SBP

Age > 1 year can be calculated from the formula:

- Upper limit (5th centile) is:

$$\text{SBP} = 90 + (\text{Age in years} \times 2)$$

- Lower limit (5th centile) is:

$$\text{SBP} = 70 + (\text{Age in years} \times 2)$$

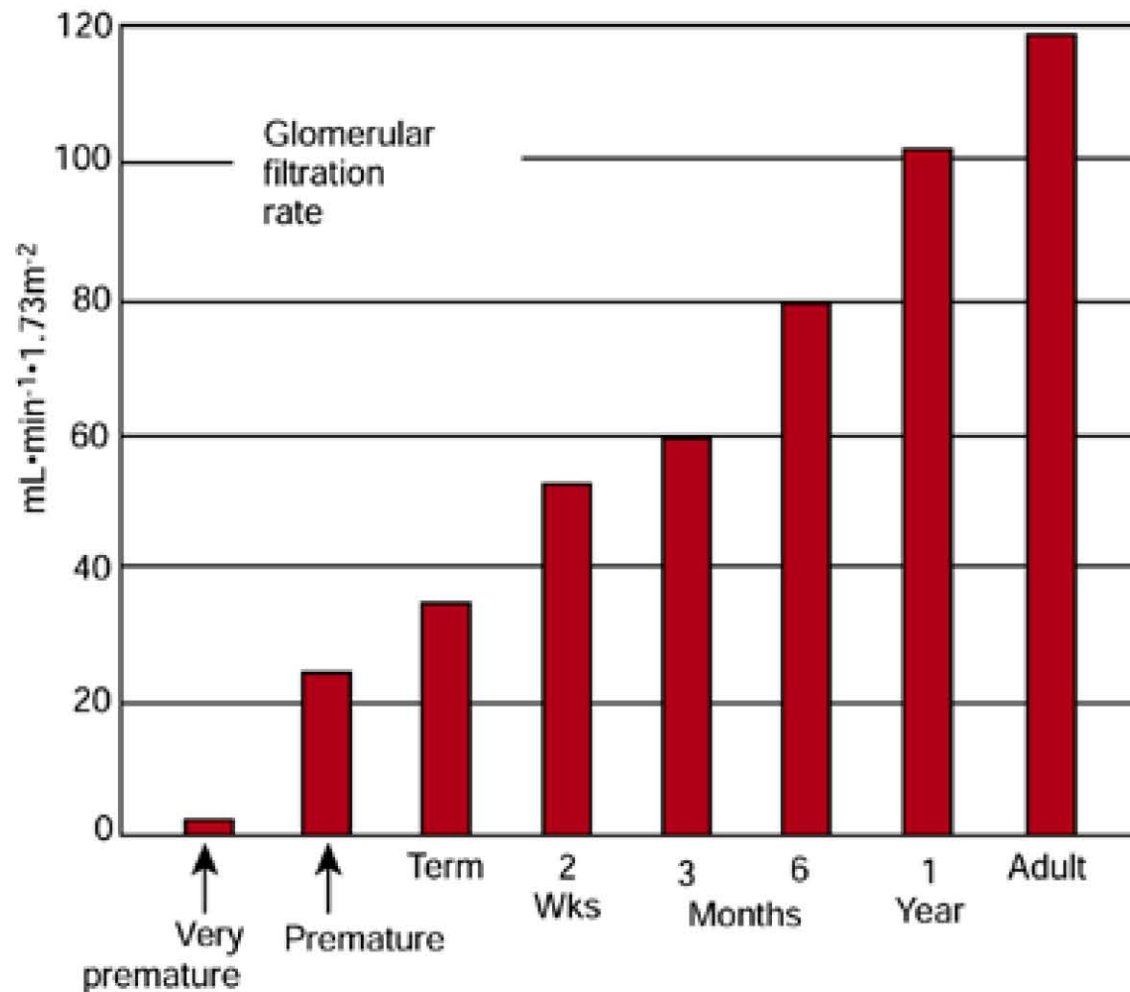
# 22

The age at which the glomerular filtration rate in a child is same as in adults is



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# GFR in all ages



# Kidneys

- ✿ impaired ability of handle  
free water and solute loads
- ✿ prolonged half-life of drugs



# 23

Normal blood glucose level in a neonate is \_\_\_\_\_ (mg/dL)



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# Laboratory value of blood glucose in children

	Newborn	1 Week	1 Month	1 Year
Glucose (mg/dL)	40-60	50-80	60-100	60-100

# 24

The recommended size of an endotracheal tube for a 1-year-old child is



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# Endotracheal Tubes

✿ Internal diameter (I.D.) =  $\frac{\text{age (yr)} + 4}{4}$

✿ Leak at 20-30 cmH<sub>2</sub>O

✿ Uncuffed endotracheal tubes at age < 8 yrs

✿ Length =  $\frac{\text{age (yr)} + 12}{2}$

✿ NG tube size (Fr) =  $\frac{\text{age (yr)} + 16}{2}$

# Recommended Sizes & Distance of ETTubes and Laryngoscope Blades for Use in Pediatric Patients

Age of Patient	Internal Diameter of Endotracheal Tube (mm)	Recommended Size of Laryngoscope Straight Blade	Distance of Insertion* (cm)
Preterm (<1250 g)	2.5 uncuffed	0	6-7
Full term	3.0 uncuffed	0-1	8-10
1 yr	3.5-4.0 cuffed	1	11
2 yr	4.5-5.0 cuffed	1-1.5	12
6 yr	5.0-5.5 cuffed	1.5-2	15
10 yr	6.0-6.5 cuffed	2-3	17
18 yr	7-8 cuffed	3	19

# 25

As compared to a 10-year-old child, a 1-year-old child will have higher



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# Respiratory System

- ✿ increase WOB
  - ✿ compliant chest wall
  - ✿ noncompliant lung
  - ✿ fewer type I diaphragmatic m. fibers
- ✿ prone to hypoxia
  - ✿ high oxygen consumption
  - ✿ high CC/FRC ratio
- ✿ periodic breathing



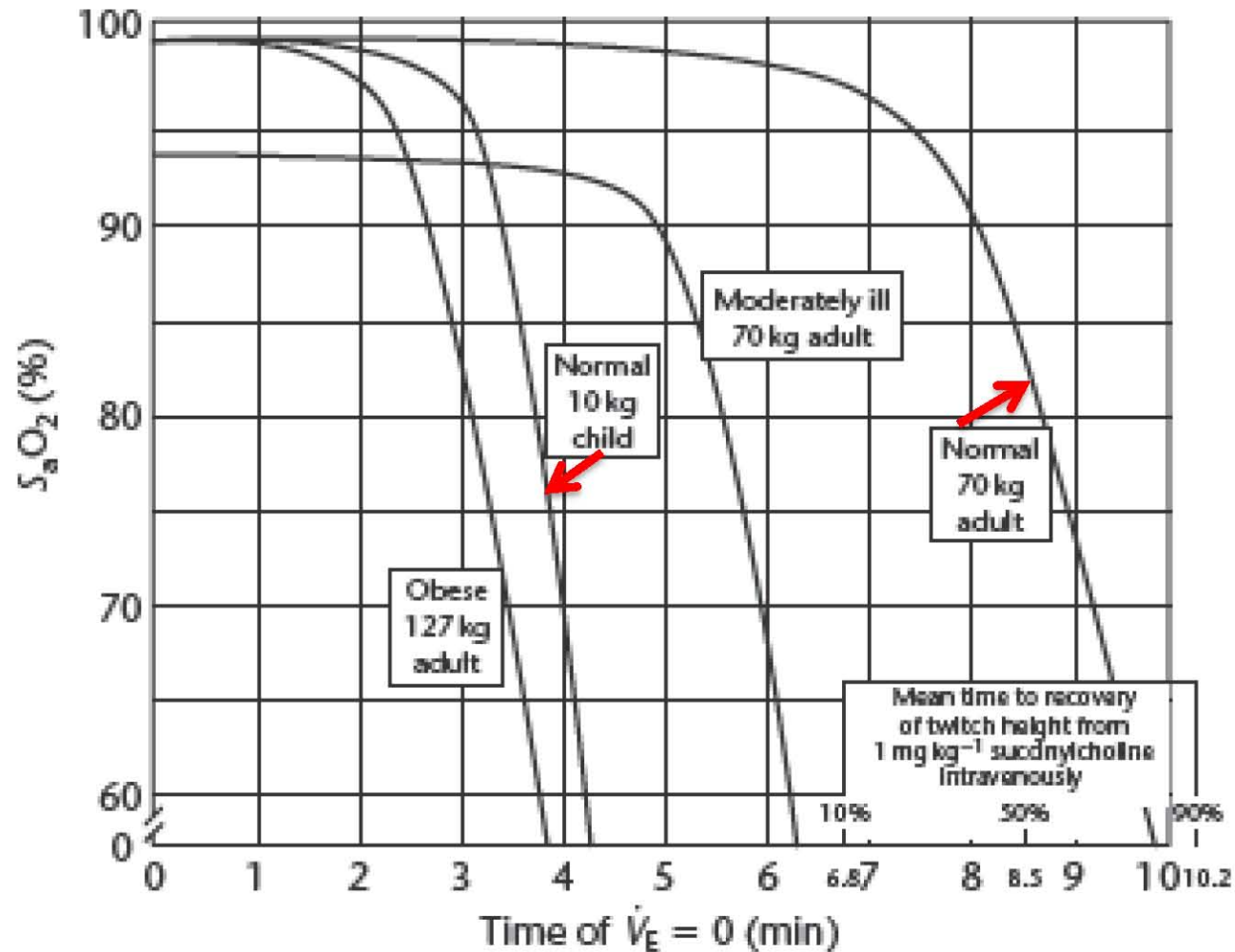
# Normal Respiratory Rates

Age	Respiratory Rate (min <sup>-1</sup> )
Birth-6 weeks	45-60
6 weeks-2 years	40
2-6 years	30
6-10 years	25
> 10 years	20

# Normal Respiratory Values

Parameter	Infant	Adult
RR	30-50	12-16
TV	7	7
Dead space	2-2.5	2.2
Alv vent	100-150	60
VO <sub>2</sub>	7-9	3

# Time to Hb desaturation with initial $FAO_2 0.87$



# 26

The total blood volume in a preterm is \_\_\_\_\_ (mL/kg)



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# Developmental changes in blood volume

Age	Blood Volume (mL/kg)
Preterm	90-105
Term neonate	78-86
1-12 Months	73-78
1-3 Years	74-82
4-6 Years	80-86
7-18 Years	83-90
Adults	68-88

# 27

A 2-year-old is scheduled for elective tonsillectomy and adenoidectomy. His mother tells you he has runny nose. Your decision whether to proceed will be based on all the following, except



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# Factors affecting decision for elective surgery in a child with URI

## Pros

- Presence of runny nose alone
- Active, happy child
- Older child
- Clear lungs

## Cons

- Recent development of symptoms within 1 to 2 days
- Lethargic child
- Purulent nasal discharge
- Wheezing, rales
- Child <1 year, ex-premature
- Major surgery

## The Child with an Upper Respiratory Tract Infection

- ✿ If the child is acutely ill and obviously getting worse → cancel for 6 wks
- ✿ If the child has rhonchi and a productive cough → cancel for 6 wks
- ✿ If the child is stable and afebrile and has had the URI for several days → proceed, avoid ET intubation, not prolong procedure
- ✿ The best way of avoiding last-minute cancellations is a phone call by nursing staff the day before to inquire about the child's health

# 28

Urine output in a 6-year-old child undergoing surgery under general anesthesia should be \_\_\_\_\_ (mL/kg/h)



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# 29

Perioperative management of a child with a femur fracture and sickle cell disease includes all of the following, except



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# patients with sickle cell anemia

Optimal preoperative preparation ;

- adequate hydration,
- treatment of infections,
- acceptable hemoglobin concentration

The goal of transfusion therapy = hematocrit of 35% - 40%

Hemoglobin desaturation or low-flow states (stasis) should be avoided in sickle cell patients.(tourniquet use)

Conditions that could cause hemoglobin desaturation or stasis include hypothermia or hyperthermia, acidosis, hypoxemia, hypotension, or hypovolemia

# 30

Anesthetic management of a 12-year-old with Down syndrome includes all of the following, except



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# Down syndrome

- trisomy 21 is most common congenital syndromes
- Anesthetic considerations include
  - presence of short neck & large tongue (difficult airway),
  - irregular dentition,
  - mental retardation,
  - hypotonia,
  - congenital heart disease in 30% to 40% of patients (particularly endocardial cushion defects & ventricular septal defect),
  - subglottic stenosis,
  - tracheoesophageal fistula,
  - chronic pulmonary infections,
  - seizures,
  - duodenal stenosis,
  - delayed gastric emptying.

# 31

An 8-year-old boy, weighing 30 kg, is undergoing resection of a Wilms tumor in the operating room. His starting hemoglobin is 12 g/dL. If the threshold for transfusion is 8 g/dL, the allowable blood loss is \_\_\_\_\_ (mL)







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# Maximal allowable blood loss

$$\text{MABL} = \text{EBV} \times \frac{(\text{starting Hct} - \text{target Hct})}{\text{average Hct}}$$

Normal EBV in (ml/Kg)

-  Preterm = 100 - 120
-  Full Term = 90
-  Age 3-12 mths = 80
-  Age > 1 yr = 70



# Blood Transfusion

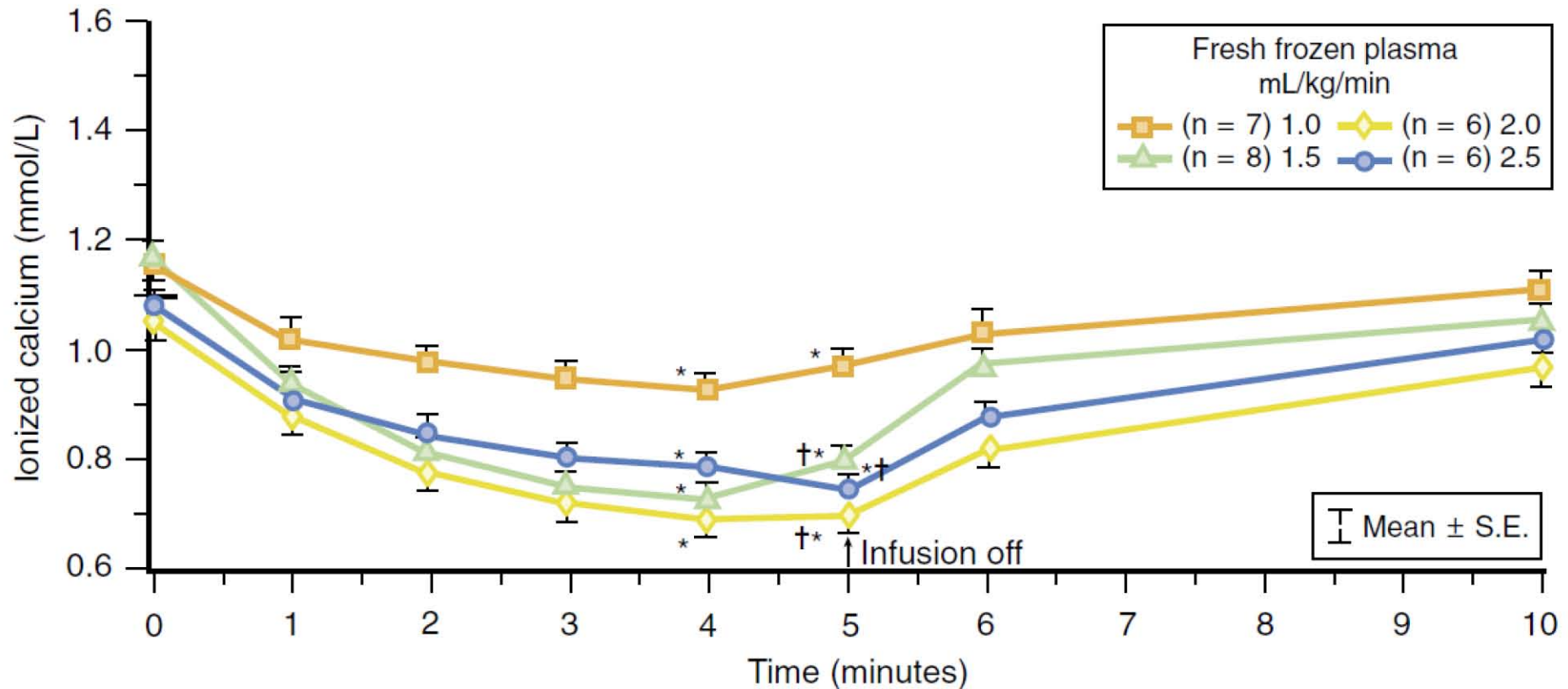
ตัวอย่างการคำนวณ ในเด็กหนัก 15 Kgs และ Hct 20 %

Volume of PRBCs to be transfused =

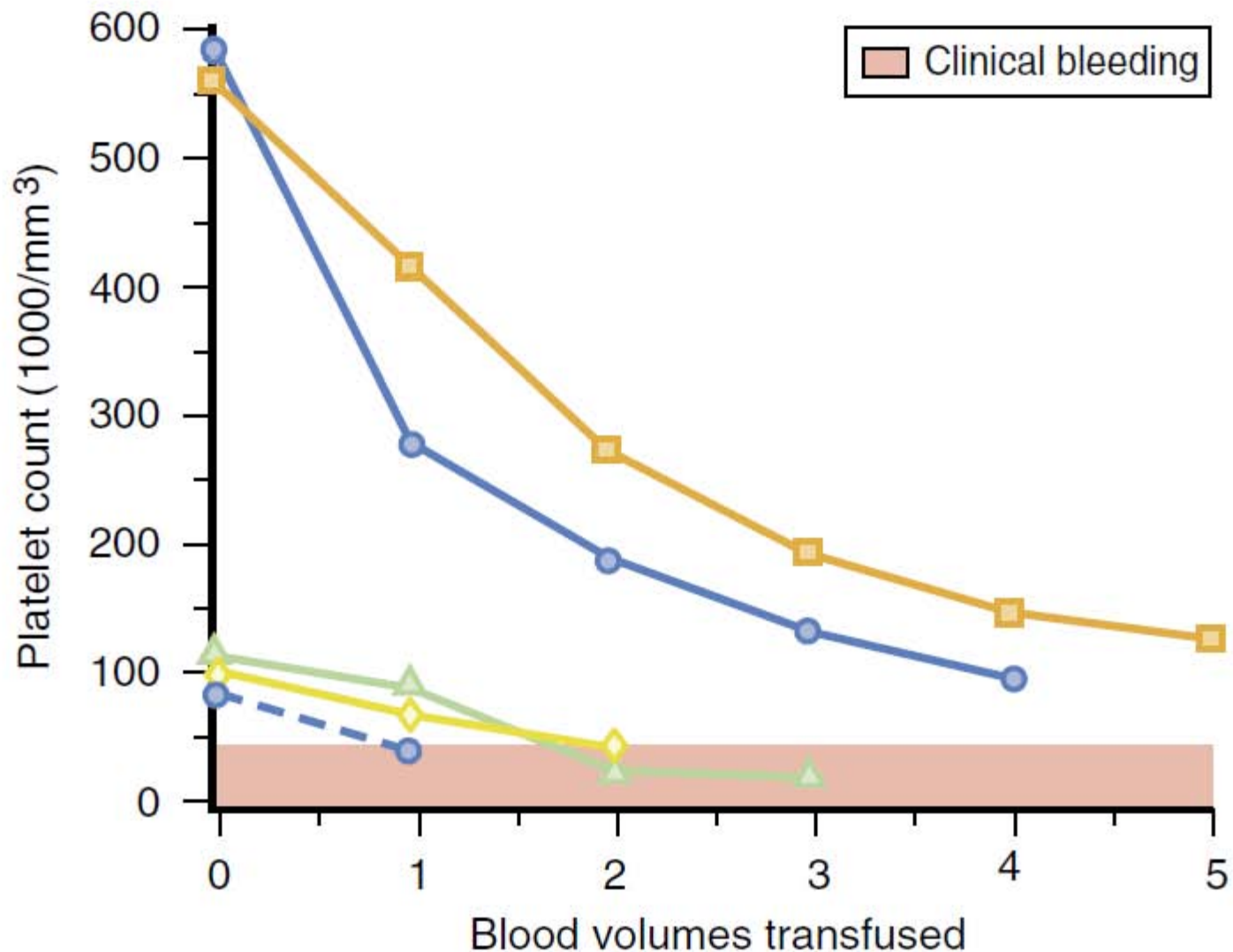
$$\frac{[\text{Desired Hct (35)} - \text{Present Hct (20)}] \times \text{EBV (70 mL/kg} \times 15 \text{ kg)}}{\text{Hematocrit of PRBCs (~60\%)}}$$

# Blood component → Hypocalcemia

FFP



# Dilutional Thrombocytopenia



# 32

A 5-year-old otherwise-healthy child is undergoing strabismus surgery with a laryngeal mask airway (LMA) in place. Thirty minutes into the procedure, his heart rate is 60 bpm, blood pressure is 90/60 mm Hg, and the pulse oximeter reads 98%. The next step in management should be



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# oculocardiac reflex

consists of a trigeminal afferent and a vagal efferent pathway.

The reflex can occur in patients undergoing ocular procedures such as

- cataract extraction,
- enucleation,
- retinal detachment repair.

Management of the oculocardiac reflex consists of

- (1) immediate notification to the surgeon and temporary cessation of surgical stimulation,
- (2) confirmation of adequate ventilation, oxygenation, and depth of anesthesia,
- (3) administration of intravenous atropine (10 µg/kg) if the conduction disturbance persists,
- (4) infiltration of the rectus muscles with local anesthetic.

# 33

The afferent limb for oculocardiac reflex is



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# 34

Positive-pressure ventilation with a face mask is contraindicated in which of the following condition?



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# 41

All of the following are true for children with congenital diaphragmatic hernia (CDH), except



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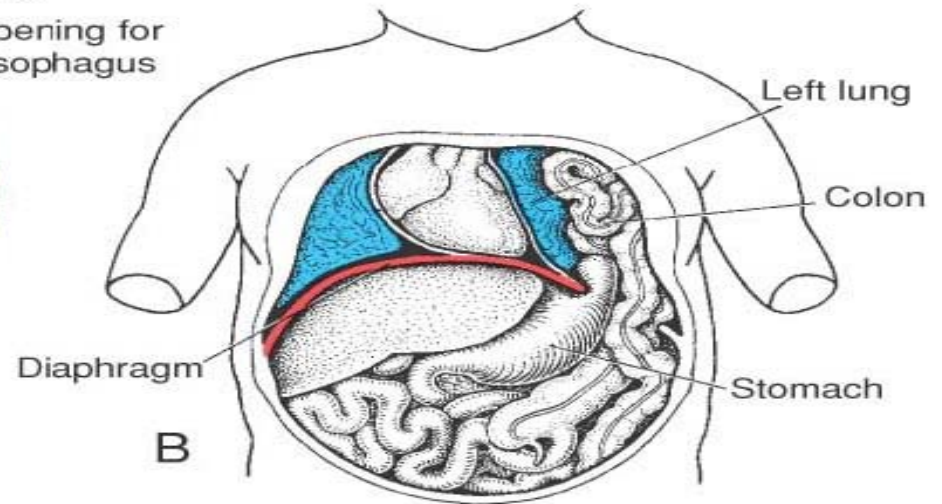
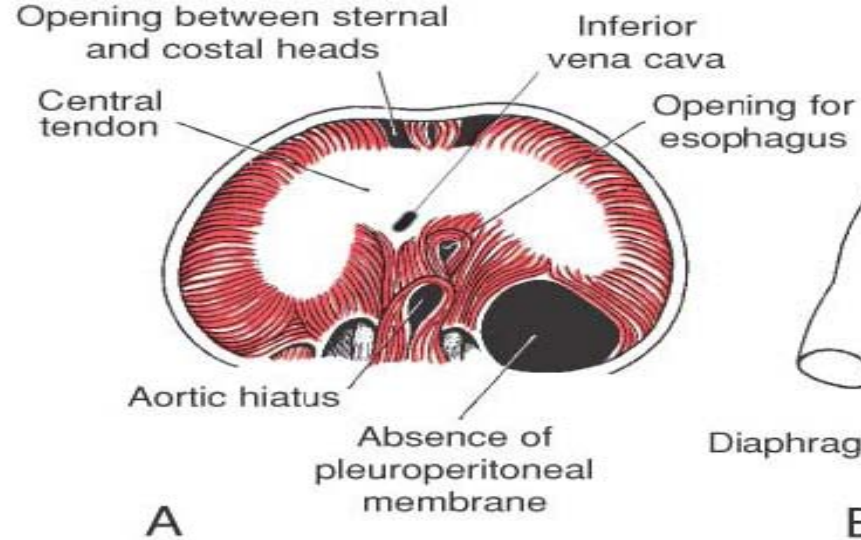
# Diaphragmatic Hernia

- incidence = 1 in 3000-5000 live births
- most common type (90%)= Left Sided
- Hallmarks of diaphragmatic herniation include
  - hypoxia
  - a scaphoid abdomen
  - evidence of bowel in the thorax by auscultation or radiography

# Diaphragmatic Hernia

## Problems

- ✿ Hypoplastic lung
- ✿ Gastric distension
- ✿ Acidosis
- ✿ Pneumothorax
- ✿ Mediastinum shift
- Pulmonary hypertension (associated with 40-50% mortality)



# Anesthetic management

- ✿ Awake intubation without bag-and-mask ventilation prevents overdistention of the stomach and herniation across the midline
- ✿ insertion of ABP for monitoring and close observation of the surgical field are most helpful in diagnosing impairment of venous return or cardiac output
- ✿ blunting of the stress response is accomplished by providing analgesia with narcotics (usually high-dose fentanyl,  $\geq 25 \mu\text{g/kg}$ ) and by controlling respirations with a muscle relaxant (usually pancuronium)
- ✿ careful control of ventilation and oxygenation prevents sudden increases in pulmonary artery pressure ( $\text{PaCO}_2 < 40 \text{ mm Hg}$  and  $\text{PaO}_2 > 100 \text{ mm Hg}$ ); pulse oximetry is helpful in diagnosing subclinical episodes of hypoxemia

- ❁ avoided hypothermia → decrease the oxygen consumption needed for thermogenesis
- ❁ avoided anesthetic agents (depress the myocardium) until the chest is decompressed
- ❁ to prevent bowel distention, nitrous oxide is not given
- ❁ awareness for the development of barotrauma-induced pneumothorax on the ipsilateral or contralateral side
- ❁ adequate intravenous access for maintenance of a constant circulating blood volume should be ensured
- ❁ postoperative intensive care is necessary

A sudden fall in lung compliance, blood pressure, or oxygenation may signal a contralateral (usually right-sided) pneumothorax → placement of a chest tube

# 35

Treatment of postintubation croup in a child who underwent adenoidectomy is



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# 36

The most important measure to avoid subglottic edema in children is



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# 37

Important difference between epiglottitis and laryngotracheobronchitis (croup) is



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# Croup

Croup is upper airway obstruction characterized by a barking cough.

Cause; postintubation croup or a result of viral infection.

Incidence of infectious croup is increased in children aged 3 months to 3 years.

Infectious croup progresses slowly, and patients rarely require intubation.

It is treated with nebulized racemic epinephrine and dexamethasone

# Acute epiglottitis

bacterial infection = *Haemophilus influenzae* type B.

It affects children of 2 to 6 years old.

Acute epiglottitis can rapidly progress from a sore throat to complete airway obstruction.

Endotracheal intubation (spontaneous breathing inhalational induction in sitting position) and antibiotic therapy can be lifesaving

# 38

Anesthesia in a patient with Pierre Robin syndrome can be complicated by



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# 39

Basic metabolic rate in children is



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# 40

The percentage of patients developing malignant hyperthermia (MH) after masseter spasm is



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# 43

The main factor responsible for physiologic closure of a patent ductus arteriosus is



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# 44

The most effective method for maintaining normothermia in an operating room is



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# Prevent hypothermia

- **phase I** (initial rapid decline in body temperature) →  
Prewarming for half an hour with convective **forced-air warming blankets** effectively prevents hypothermia by eliminating the central-peripheral temperature gradient.
- Methods to minimize **phase II** hypothermia (slower decrease in body temperature) from heat loss include
  - use of **forced-air warming blankets** and warm-water blankets,
  - heated humidification of inspired gases,
  - warming of intravenous fluids,
  - raising ambient operating room temperature.

# 45

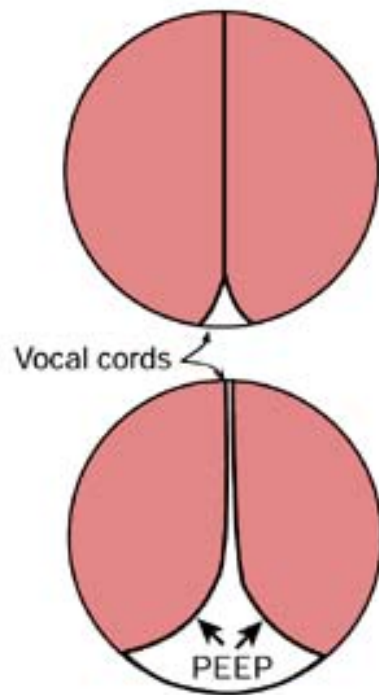
A 2-year-old child undergoing myringotomy develops laryngospasm in the operating room. The patient is breathing spontaneously with face mask at an  $FIO_2$  of 0.6. Next step in the management would be



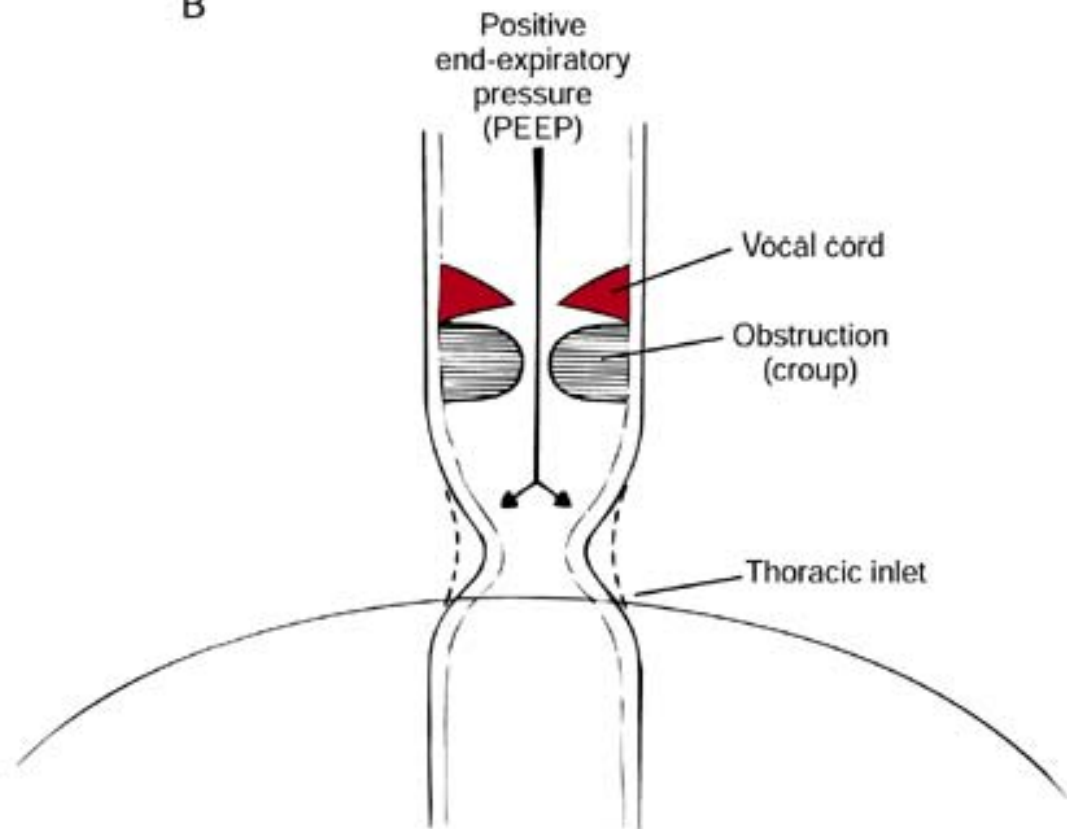
*The "little" patients  
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# Rx Laryngospasm with PEEP

A



B



# 46

Normal pulmonary dead space in a neonate is \_\_\_\_\_ (mL/kg)



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# 47

Which of the following statements regarding fetal hemoglobin is true?



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Approximately 70% to 80% of the hemoglobin at birth is fetal hemoglobin (HbF).

The concentration of HbF decreases significantly by 3 to 6 months of age.

HbF has a high affinity for oxygen, which shifts the oxyhemoglobin saturation curve to left

# 48

Compared to adults, oxygen desaturation is more frequent in pediatric population because of



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# 49

The most consistent sign of intravascular injection following caudal epidural with 0.25% bupivacaine with 1:200,000 epinephrine is



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# 50

The dose of nondepolarizing muscle relaxants in a neonate is



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# Recommended Guidelines for Doses of NDMR

MAINTENANCE DOSE (ED<sub>95</sub>) (mg/kg) DURING ANESTHESIA

Muscle relaxant	N2O/O2	Halothane	Intubation dose(mg/Kg) (2xED95)
Pancuronium	0.08	0.06	0.1-0.15
Atracurium	0.3	0.2	0.5-0.6
Cisatracurium	0.1	0.08	0.1
Vecuronium	0.08	0.06	0.1-0.15
Rocuronium	0.1	0.1	0.3-1.2

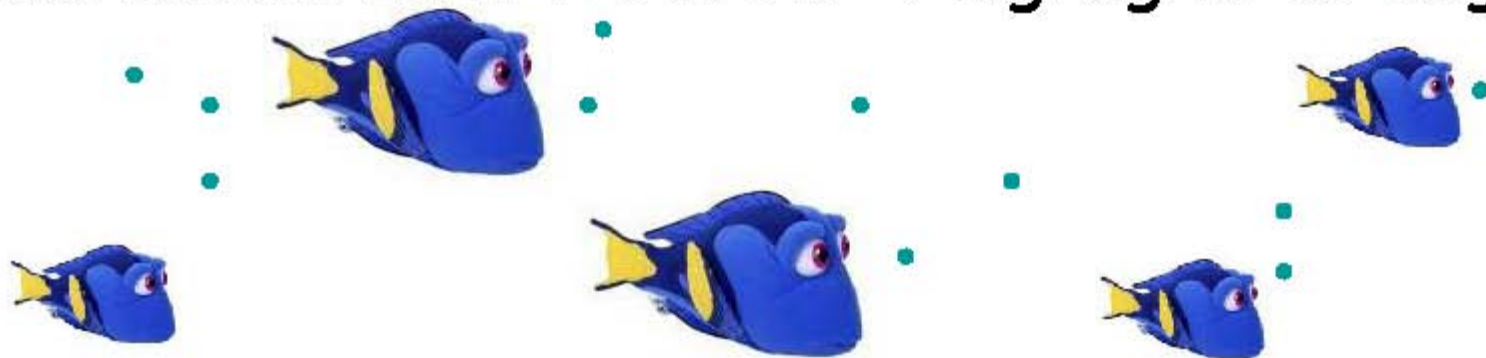
# Reversed by

Atropine 0.02 mg/kg

Prostigmine 0.02 -0.06mg/kg

Sugammadex (antagonize the effects of rocuronium)

increasing a dose from 0.5-4 mg/kg to 16 mg/kg

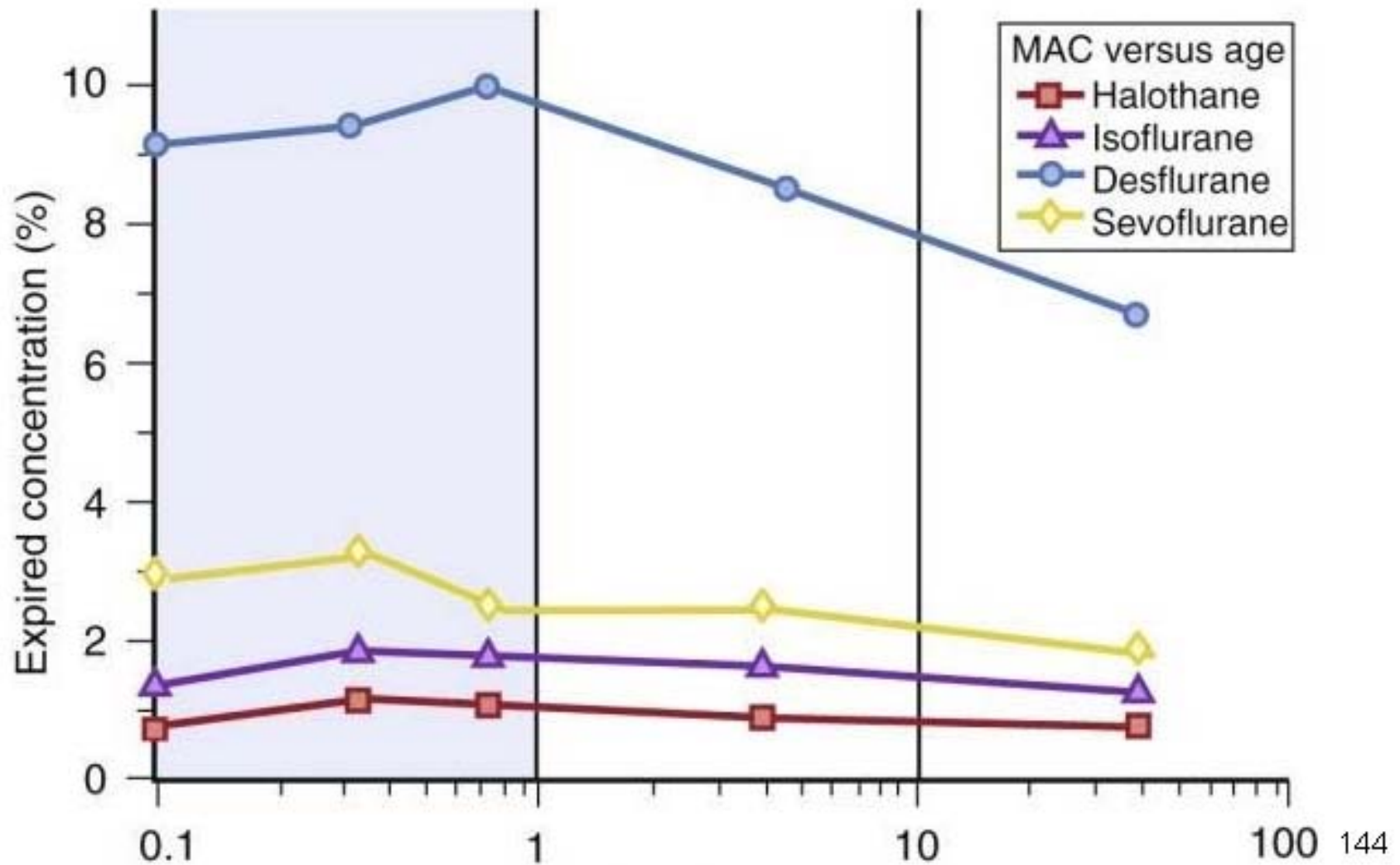


# Extubation

- ✿ Awake
- ✿ Moving actively
- ✿ Good Respiratory efforts
  - ✿ Maintaining adequate, nonparadoxical breathing
  - ✿ Generating a negative inspiratory pressure greater than 30 cm H<sub>2</sub>O
- ✿ Flexing limbs [Sustaining hip flexion with leg elevation for 10 seconds]
- ✿ Lifting the head and/or coughing forcefully

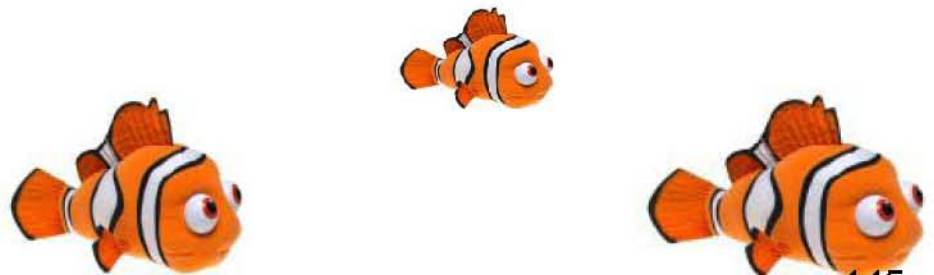


# MAC of Inhalation Agents

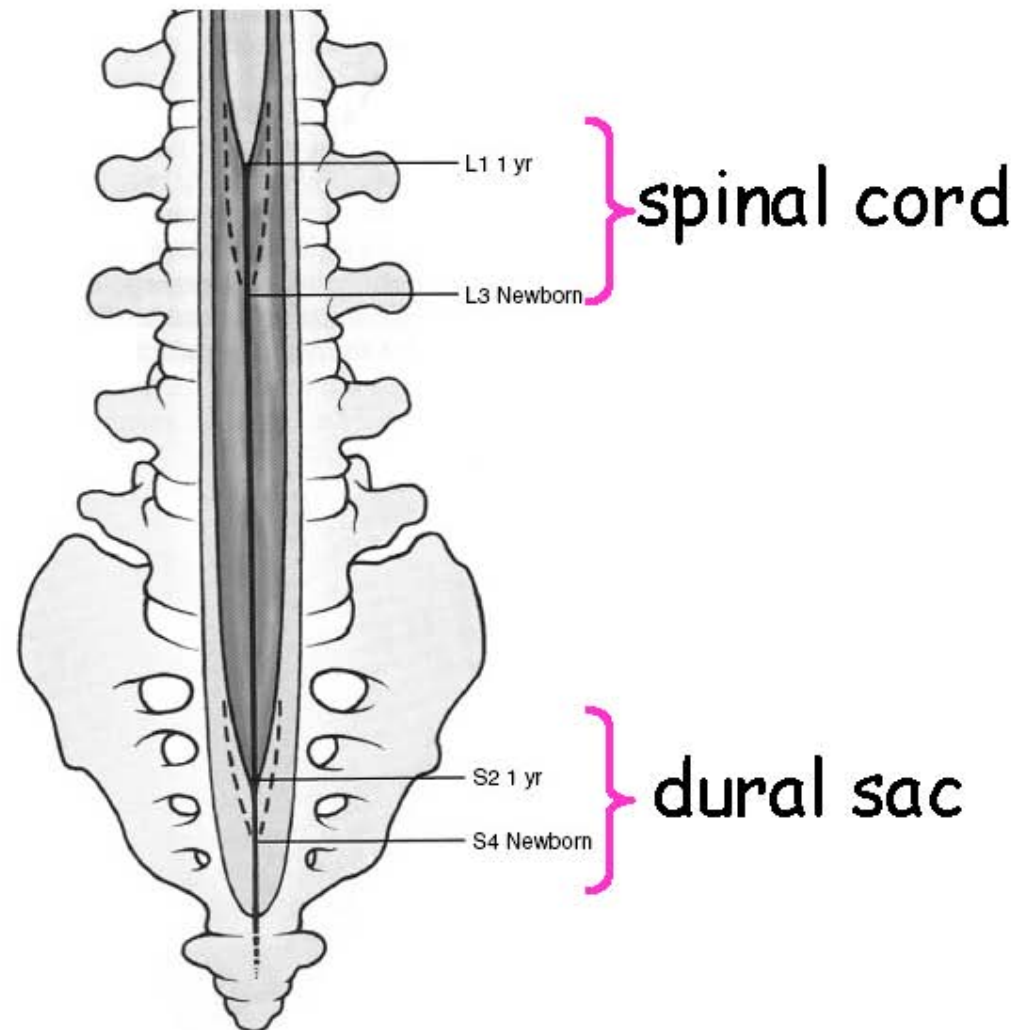


# Central nervous System

- Spinal cord
  - At birth = L3 vertebra
  - 1 year = L1 vertebra
- ANS
  - parasympathetic fully functional at birth
  - sympathetic fully developed until 4 - 6 mths



# Termination of the dural sac & spinal cord



# Liver

- ❁ Impaired drug metabolism
- ❁ Minimal glycogen store and unable to handle large protein loads, tendency to hypoglycemia and acidemia
- ❁ Coagulopathy



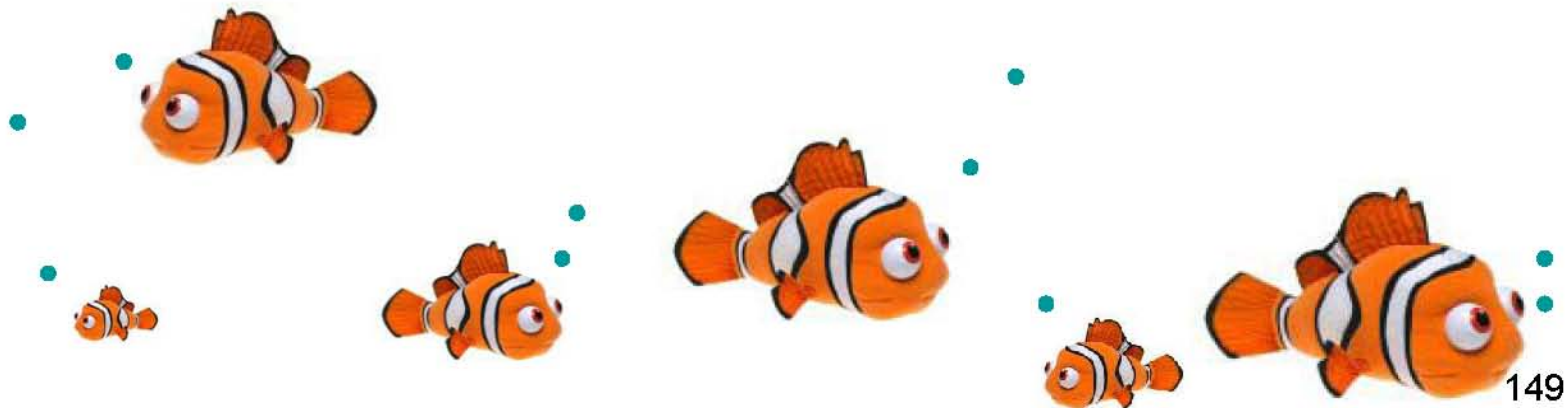
# Gastrointestinal system

- ✿ At birth, gastric pH is alkalotic; by the second day of life, pH is in the normal physiologic range
- ✿ The ability to coordinate swallowing with respiration does not fully mature until infants are 4-5 mths → gastroesophageal reflux
- ✿ developmental problem occurs within the GI system → symptoms within 24-36 hours of life;
  - ✿ upper intestinal abnormalities → vomiting and regurgitation
  - ✿ lower intestinal abnormalities → abdominal distention and failure to pass meconium

# Anesthetic Equipment

Appropriate for ages & sizes

- ✿ Face Masks
- ✿ Breathing Circuits
- ✿ Endotracheal tubes
- ✿ Laryngeal Mask Airway





*A suitable choice of anesthetic agents  
is adapted especially for little patients.*

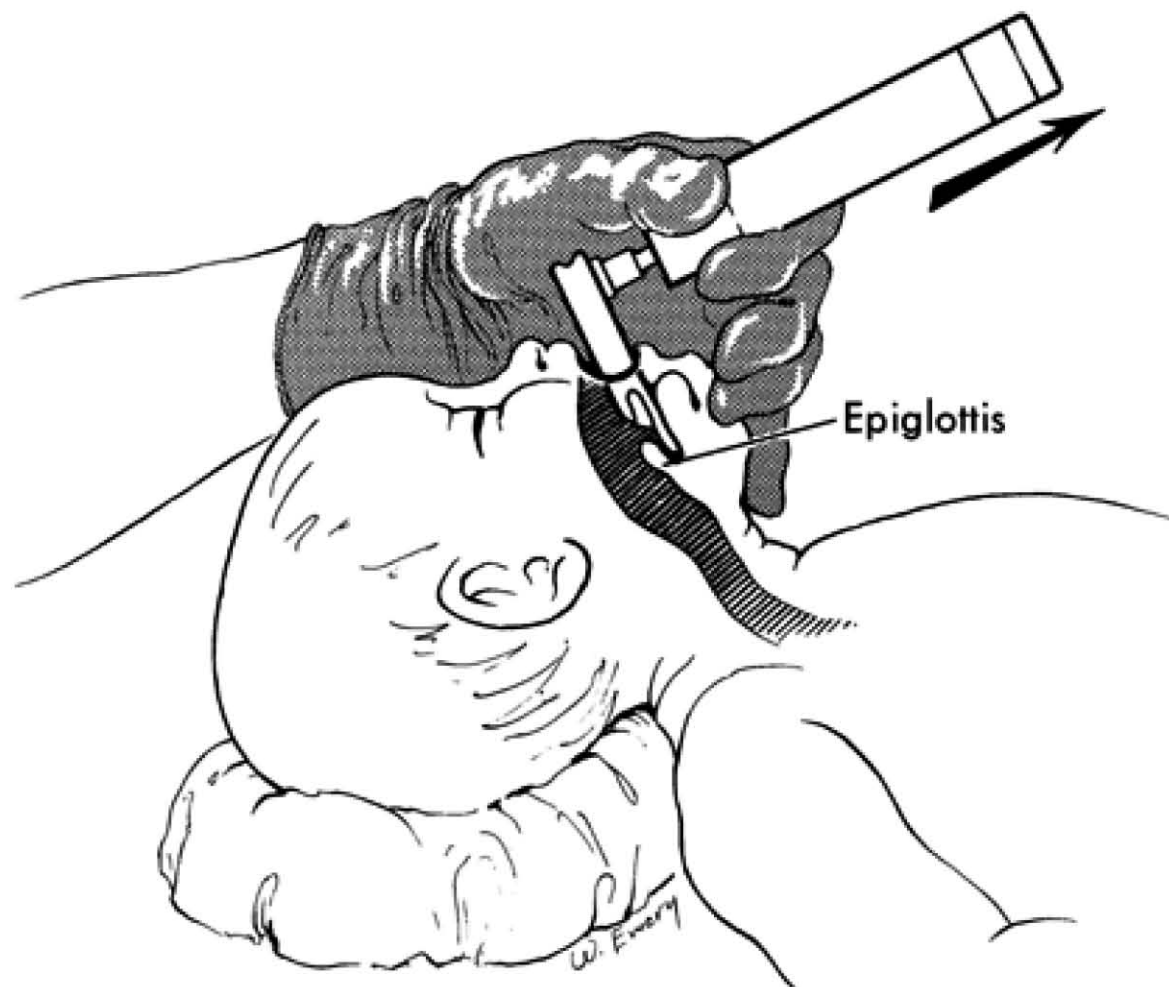
# Face Masks



# Oxyscope



# Intubation

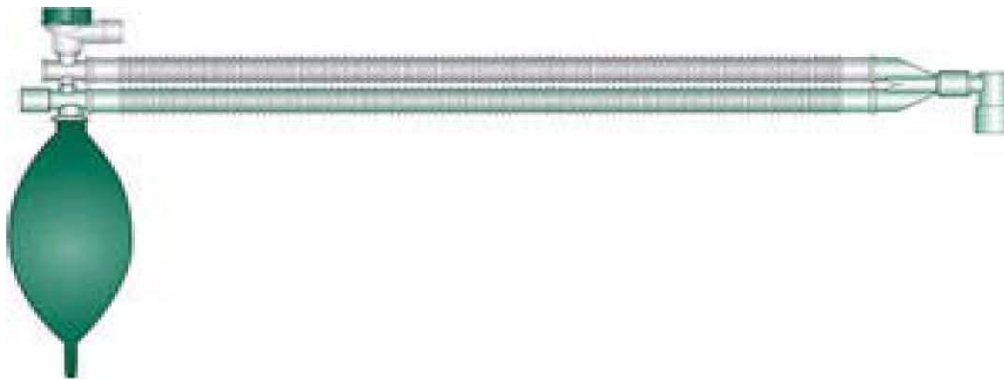
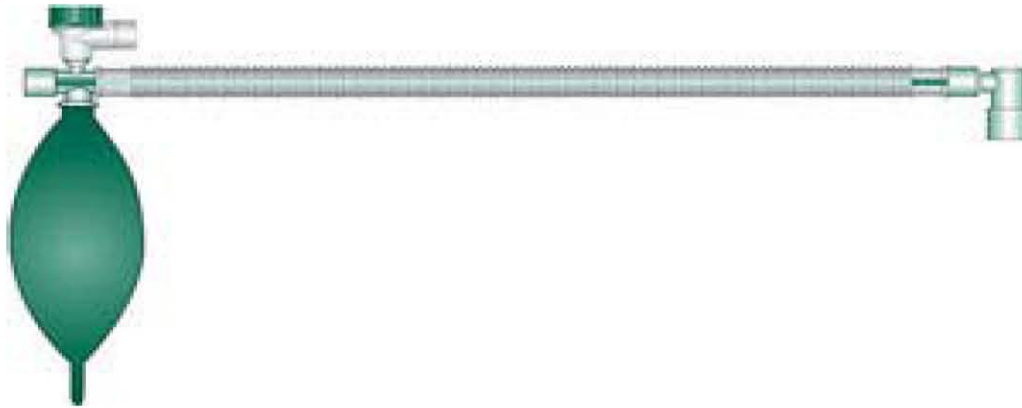


# Breathing Circuits



- ✿ Jackson Rees modified T- piece
- ✿ Bain circuit
- ✿ Pediatric circle system

# Bain circuit



## Weiss and colleagues (2009)

A multicenter, randomized prospective study of 2246 children (birth to 5 years) undergoing general anesthesia

- cuffed ETTs VS uncuffed ETTs did not increase the risk of postextubation stridor (4.4% vs. 4.7%)
- reduce the need for ETT exchanges (2.1% vs. 30.8%)
- No role of cuffed ETTs in neonates & infants who require prolonged ventilation

# Recommended Length of Central Venous Catheter (CVC) Insertion

Patient Weight (kg)	Length of CVC Insertion (cm)
2–2.9	4
3–4.9	5
5–6.9	6
7–9.9	7
10–12.9	8
13–19.9	9
20–29.9	10
30–39.9	11
40–49.9	12
50–59.9	13
60–69.9	14
70–79.9	15
≥80	16

# Laryngeal Mask Airway

Laryngeal Mask Size	Patient Weight
1	≤5 kg
1.5	5-10 kg
2	10-20 kg
2.5	20-30 kg
3	30-50 kg
4	50-70 kg
5	70-100 kg
6	>100 kg

# Preoperation & Premedication

- ✿ routine hemoglobin measurement in
  - ✿ infants younger than 6 months to assess the severity of the physiologic hemoglobin nadir (especially former preterm infants with a potential risk for apnea)
  - ✿ older children expected to significant blood loss
- ✿ preoperative echocardiogram in
  - ✿ chemotherapy with anthracyclines
  - ✿ children with congenital heart disease
  - ✿ neonates at risk for associated cardiac anomalies
- ✿ antiseizure medications will generally benefit from preoperative assessment to ensure therapeutic levels.

# Management of Anesthesia

- ❁ Induction of Anesthesia
- ❁ Types of General Anesthesia
- ❁ Monitoring
- ❁ Maintenance
- ❁ Regional anesthesia
- ❁ Reversed & Extubation

# Induction of Anesthesia

Parental presence during induction of anesthesia

- ✿ Mask → infants < 10-12 months
- ✿ Intravenous
- ✿ Intramuscular
- ✿ Rectal





# Intravenous induction

## Propofol IV

- higher in younger (2.9 mg/kg for infants < 2 years) than in older children (2.2 mg/kg for children 6 - 12 yrs)

## Thiopental IV

- 5 - 6 mg/kg in healthy
- 2 - 4 mg/kg in low fat stores children ; neonates, malnourished infants

## Ketamine

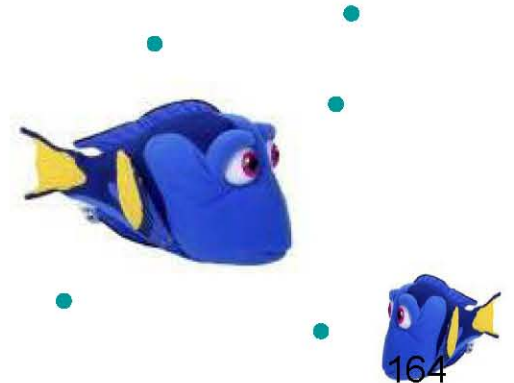
- rectally (10 mg/kg)
- orally (6 - 10 mg/kg)
- intranasally (3 - 6 mg/kg)
- intravenous (1 - 2 mg/kg)

## Etomidate IV







- 0.2 to 0.3 mg/kg good for head injury, unstable cardiovascular status; cardiomyopathy

# Types of General Anesthesia

- 🌸 GA with mask
- 🌸 GA with LMA
- 🌸 GA with endotracheal tube

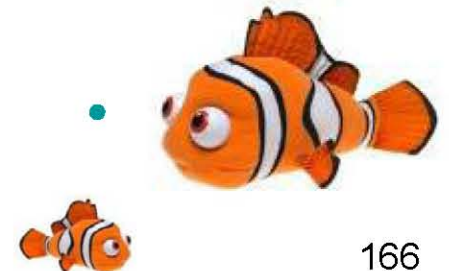


# Monitoring

-  Precordial or Esophageal stethoscope
-  Electrocardiography
-  NIBP
-  Pulse oximetry
-  Temperature
-  Capnography

# Maintenance

- ✿  $\text{N}_2\text{O} : \text{O}_2$  or  $\text{O}_2 : \text{Air}$
- ✿ Inhalation
  - ✿ isoflurane
  - ✿ sevoflurane
  - ✿ desflurane
- ✿ Muscle relaxants ; Sch •
- ✿ Narcotics ; Fentanyl



# Common Problems in the PACU

- ✿ Apnea of Prematurity
- ✿ Airway Obstruction
- ✿ Obstructive Sleep Apnea
- ✿ Postobstructive Pulmonary Edema
- ✿ Postintubation Croup
- ✿ Cardiovascular Instability
- ✿ Nausea and Vomiting
- ✿ Temperature Instability
- ✿ Emergence Delirium
- ✿ Pain and Discomfort



# Postoperative Care

- ❁ Correct abnormal finding
  - ❁ Anemia
  - ❁ Hypothermia
- ❁ Monitoring
- ❁ Oxygen therapy
- ❁ Analgesia
- ❁ Subglottic edema  
(postintubation croup)



# Postoperative Analgesia

- ❁ acetaminophen 60 mg/kg/day
- ❁ codeine + acetaminophen
- ❁ narcotics
  - ❁ fentanyl 1-2 mcg/kg, iv, q 1 hr
  - ❁ pethidine 0.5-1 mg/kg, im, q 4 hr
  - ❁ morphine 0.02-0.05 mg/kg, im, q 4 hr
  - ❁ codeine 1-1.5 mg/kg, im, q 4 hr

# Postoperative Analgesia

- ✿ continuous narcotic infusion

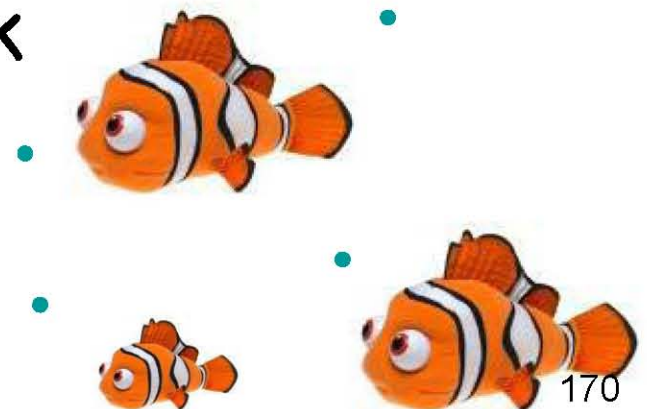
- ✿ PCA

- ✿ regional anesthesia

  - ✿ caudal block, epidural block

  - ✿ peripheral nerve block

  - ✿ local infiltration



# References

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