Pediatric Anesthesia

Keywords

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Neonates

• Carbon dioxide curve shifted right → decreased ventilatory response to hypercarbia
• Increased oxygen consumption → up to 3x that of adults
• Stiff ventricles, CO is HR dependent, Frank Starling curve does not apply
• Increased body surface area to mass ratio, thin insulating fat, thin skin, poor central thermoregulation, very susceptible to hypothermia
• Shivering is ineffective because of limited muscle mass
• Nonshivering thermogenesis uses brown fat to produce heat, this increases oxygen consumption significantly
• Cold stressed infants can develop CV depression, acidosis, decreased PaO₂
• Larger VoD, less tissue and protein binding of drugs, immature liver/kidney function
Neonates

• Common neonatal emergencies
  – TEF
  – CDH
  – Omphalocele
  – Gastroschisis
  – PDA
  – Intestinal obstruction/NEC
Congenital Diaphragmatic Hernia

- Abnormal lung development/hypoplasia due to failure of the diaphragm to close
- Most occur through the left-sided foramen of Bochdalek
- CV abnormalities present in 23%
- Low pressures should be used to prevent barotrauma
- Permissive hypercapnia used
- Pneumothorax of contralateral lung may occur when high pressures are used
- Some patients may require HFOV or ECMO
- Pulmonary hypertension can impair oxygenation and decrease CO
Tracheoesophageal Fistula

- Can occur alone or as part of a syndrome – most commonly associated with VACTERL
- VACTERL: Vertebral abnormalities, imperforate anus, cardiac malformations, TEF, Renal/radial abnormalities, limb abnormalities
- Dx’ed by inability to pass NG tube, regurgitation of feedings
- PPV may distend the stomach
- Preductal (right hand) and postductal (left hand/foot) saturations should be measured
Omphalocele vs Gastroschisis

- **Omphalocele**: Hernia within the umbilical cord caused by failure of the gut to migrate into the abdomen from the yolk sac
  - Bowel is completely covered with membranes
  - Frequently have associated cardiac, urologic, and metabolic abnormalities

- **Gastroschisis**: defect in the anterior abdominal wall from which abdominal contents protrude
  - No overlying sac, defect usually <4cm, usually no other associated anomalies
  - Usually occurs to the right of the umbilicus
Omphalocele vs Gastrochisis

- Must prevent evaporative heat loss from exposed viscera
- Require high amount of IVFs intraop to replace evaporative losses
- Watch ventilatory requirements if the bowel is placed back into the abdomen
- The abdominal cavity may not be able to accommodate the viscera
- Venous return from or blood flow to the lower extremity may be compromised – keep pulse ox on the foot to assess
Omphalocele vs Gastrochisis

Gastrochisis:
The intestines are outside of the abdomen through a hole in the abdomen.

Omphalocele:
The intestines, liver, and other organs remain outside of the abdomen in a sac.
Pyloric Stenosis

- Presents at 2-6 weeks of age, usually in first-born males
- Present with persistent nonbloody, nonbilious projectile vomiting
- Dehydration, hypochloremia, and metabolic acidosis can develop from loss of HCl
- Continued vomiting and dehydration can lead to metabolic acidosis
- Olive-like mass in the epigastrium is classic
- Diagnosed by Ultrasound
- Must correct electrolyte and volume deficit prior to OR
- Medical emergency, NOT surgical emergency
- Pts are at risk of aspiration, perform RSI
- Opioids are usually unnecessary and should be avoided intraoperatively
- Always suction the stomach prior to induction
Discharge Criteria

- Discharge criteria in former preterm infants (<37 wks of age at birth)
  - Increased risk for postop apnea even after minor sx
  - Reported in infants up to 60 days PCA
  - 56-60 weeks PCA without anemia after surgery can be discharged, the rest are observed overnight
  - Spinal anesthesia without supplemental sedation is associated with less apnea
  - Addition of sedation increases the risk of postop apnea
Airway

- Obligate nasal breathers
- Large tongue
- Large occiput
- Larynx is more anterior
- Narrowest part of the trachea is at the cricoid
- Glottis is more cephalad –
  - C3 in newborns, C5 in adults
Pulmonary

- Decreased number of alveoli
- Small size of alveoli
- Decreased compliance
- Increased airway resistance
- Horizontal ribs, pliable ribs and cartilage – inefficient chest wall mechanics
- Fewer type 1 highly oxidative fibers – easier to fatigue
- Quicker desaturation from faster metabolic rate, faster RR, decreased TLC, decreased FRC
Tetralogy of Fallot

- RVOT obstruction, overriding aorta, VSD, RVH
- Cyanotic congenital heart lesion
- Many are prone to hypercyanotic spells (Tet spells) – characterized by worsening RVOT obstruction, due to hypovolemia, increased contractility, or tachycardia during times of stimulation or stress
- Pts are frequently tx’ed with beta blockers to prevent tet spells
- Avoid hypovolemia, acidosis, excessive crying or anxiety, increased airway pressures
- SVR should be maintained – use phenylephrine to treat tet spells
Tetralogy of Fallot

Four abnormalities that results in insufficiently oxygenated blood pumped to the body:

1. Narrowing of the pulmonary valve
2. Thickening of wall of right ventricle
3. Displacement of aorta over ventricular septal defect
4. Ventricular septal defect- opening between the left and right ventricles
Estimated Blood Volume

<table>
<thead>
<tr>
<th>AGE</th>
<th>EBV (mL/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premature infant</td>
<td>90–100</td>
</tr>
<tr>
<td>Full-term newborn</td>
<td>80–90</td>
</tr>
<tr>
<td>Infant 3 months to 1 year</td>
<td>70–80</td>
</tr>
<tr>
<td>Child &gt;1 year of age</td>
<td>70</td>
</tr>
</tbody>
</table>

ABL (allowable blood loss) = EBV x (Pt Hct – lowest acceptable Hct)/Pt Hct
## Maintenance Fluid Requirements

### The “4-2-1 Rule”

<table>
<thead>
<tr>
<th>BODYWEIGHT (kg)</th>
<th>MAINTENANCE RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–10</td>
<td>4 mL/kg/h</td>
</tr>
<tr>
<td>11–20</td>
<td>40 mL + 2 mL/kg/h for each kg over 10 kg</td>
</tr>
<tr>
<td>21–70</td>
<td>60 mL + 1 mL/kg/h for each kg over 20 kg</td>
</tr>
</tbody>
</table>
# Endotracheal Tube Sizes

## Approximate Cuffed Endotracheal Tube Sizes for Full-Term Infants and Children

<table>
<thead>
<tr>
<th>Age</th>
<th>Size (Internal Diameter mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–4 months</td>
<td>3.0</td>
</tr>
<tr>
<td>4 months–12 months</td>
<td>3.5–4.0</td>
</tr>
<tr>
<td>10 months–2 years</td>
<td>4.0</td>
</tr>
<tr>
<td>2–3 years</td>
<td>4.5</td>
</tr>
<tr>
<td>3–5 years</td>
<td>5.0</td>
</tr>
<tr>
<td>6–10 years</td>
<td>5.5</td>
</tr>
<tr>
<td>10–14 years</td>
<td>6.0</td>
</tr>
<tr>
<td>15–18 years</td>
<td>6.5–7.0</td>
</tr>
</tbody>
</table>

Age/4 + 4 = uncuffed ETT size, subtract 0.5 for cuffed tube
Postoperative Nausea and Vomiting

- The most common cause of delayed discharge or unplanned admission
- Rare in children <2 years of age
- Increased risk with certain operations: T and A, orchiopexy, penile sx, hernia repair, strabismus repair
- Simplified risk score in children: age >=3, personal or family hx of PONV, surgery time >30 minutes, strabismus sx
- When 0, 1, 2, 3, or 4 of these risk factors were present, the POV risk was 10%, 10%, 30%, 50%, or 70%, respectively
- Synergistic effect with dexamethasone + ondansetron
- Hydration associated with decreased PONV
The URI Dilemma

- Tait et al.
  - Active and recent URI (<4wks): increased respiratory events (breath-holding, coughing, desaturation)
  - Independent risk factors:
    - use of ETT in a child <5 years old
    - prematurity
    - hx of reactive airway disease
    - paternal smoking
    - surgery involving the airway
    - copious secretions
    - nasal congestion
The URI Dilemma

- Cohen and Cameron –
  - longitudinal study; 20,000 children
  - URI: 2-7x more likely to experience respiratory-related complications
    - Risk is increased by 11x if tracheally intubated
- Tait and Knight (1987 – prospective)
  - 489 children receiving halothane for BMT
  - Control, recent URI, active URI
  - No differences among groups with regards to bronchospasm, laryngospasm, or apneas perioperatively
The URI Dilemma

- 6-8 URIs per year
- 95% viral
- Airway hyperreactivity can persist up to 6 wks after URI
- Can affect upper and lower airways
Upper Respiratory Infection

- **Proceed**
  - Uncomplicated URI
  - Clear secretions
  - Afebrile
  - Otherwise healthy
  - Lungs CTA
  - Acting normally

- **Cancel**
  - Febrile >38 C
  - Mucopurulent secretions
  - Productive cough
  - Lethargy
  - Signs of pulmonary involvement
  - Delay 4 wks or more

- For those kids in the middle – decisions should be made on a case by case basis and the comfort level of the anesthesiologist

- Younger anesthesiologists cancel cases due to a URI less frequently than older anesthesiologists
<table>
<thead>
<tr>
<th>Enjoy the following</th>
<th>Up until ___ prior</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear Liquids</td>
<td>2 hours</td>
<td>Any liquid you can see through, such as water, Pedialyte, apple juice, jello, soft drinks and other clear juices</td>
</tr>
<tr>
<td>Breast Milk</td>
<td>4 hours</td>
<td></td>
</tr>
<tr>
<td>Infant Formula and Non-Human Milk</td>
<td>6 hours</td>
<td></td>
</tr>
<tr>
<td>Light Meals</td>
<td>6 hours</td>
<td>Besch, Crackers, Jam, Cereal, Low Fat Yogurt: Any foods with low fat and protein content</td>
</tr>
<tr>
<td>Heavy Meals</td>
<td>8 hours</td>
<td>All fatty or fried foods, meat, cheese, ice cream</td>
</tr>
<tr>
<td>Medications</td>
<td>Usual Time with sip of water</td>
<td>EXCEPTIONS: Hold ACE inhibitors and ARBs on day of surgery; Give white liquid antacids 8 hrs prior</td>
</tr>
</tbody>
</table>

If you have any questions, please call the Anesthesia PASS Clinic at 832-824-5800 or contact your surgeon’s office.