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PEMplaybook.org
General advice

Listen to Parents

Green Vomit = Surgical
Vomiting + Distention = Surgical
Vomiting + Shock = Surgical

Watch Out for Dangerous Mimics!
Inborn Errors of Metabolism
Sepsis
Non-accidental Trauma
CNS Space-Occupying Lesions

Neonate (birth to one month)

Necrotizing Enterocolitis

Essentials:
- Typically presents in 1st week of life (case reports to 6 months in chronically ill children)
- Extend suspicion longer in NICU graduates
- Up to 10% of all cases of necrotizing enterocolitis are in full-term children
- Pathophysiology is unknown, but likely a translocation of bacteria

Diagnosis:
- Feeding intolerance, abdominal distention
- Abdominal XR: pneumatosis intestinalis

Management:
- IV access, NG tube, broad-spectrum antibiotics, surgery consult, ICU admission

Other Surgical Causes of Vomiting in the Neonate

Gastric Outlet obstruction: “single bubble”; gas-filled stomach on AXR
Duodenal Atresia: “double bubble”; an air-filled stomach and dilated duodenal bulb
Proximal Jejunal Atresia: “triple bubble”; air in stomach, duodenum, jejunum
Distal Ileal Atresia: Multiple air-filled loops of bowel; no air in the rectum

Pneumatosis Intestinalis.
Intestinal Malrotation with Volvulus

**Essentials:**

- **Bilious vomiting** (80-100%) in the 1st month; especially in the 1st week
- May look well initially, then rapidly present in shock
- **Ladd’s bands**: abnormally high tethering of cecum to abdominal wall; peristalsis, volvulus, ischemia

**Diagnosis:**

- History of **bilious emesis is sufficient** to involve surgeons
- **Upper GI series**: corkscrew appearance
- US (if ordered) may show abnormal orientation of and/or flow to superior mesenteric artery and vein

**Management:**

- Stat surgical consult
- IV access, resuscitation, NG tube to decompress (bowel wall perfusion at risk, distention worsens)

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**Myth:** Vomiting with diarrhea = AGE

**Fact:** Diarrhea can be present with malrotation

**Myth:** Normal plain films exclude the diagnosis

**Fact:** Contrast films are necessary to evaluate for malrotation

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**Risk Factors for Malrotation**

- Congenital diaphragmatic hernia
- Congenital heart disease, especially heterotaxy syndrome
- Omphalocele and Gastroschisis
- Prune belly syndrome
- Cornelia de Lange syndrome

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**Corkscrew Sign** in Malrotation.
Hirschsprung Disease

Essentials:

- Problem in migration of neural crest cells
- Aganglionic colon (80% rectosigmoid; 15-20% proximal to sigmoid; 5% total colonic aganglionosis) colon (known as short-segment disease)
- Poor to no peristalsis: constipation, perforation, and/or sepsis

Diagnosis:

- May be diagnosed early as “failure to pass meconium in 1st 48 hours”
- In ED, presents as either bowel obstruction or enterocolitis
- Contrast enema
- Beware of the toxic megacolon (vomiting, distention, sepsis)

Management:

- Resuscitation, antibiotics, NG tube decompression, surgical consultation; stable patients may need rectal biopsy for confirmation
- Staged surgery (abdominoperineal pull-through with diverting colostomy, subsequent anastomosis) versus one-stage repair.

Risk Factors For Hirschprung Disease

Trisomy 21

Bardet-Biedl syndrome – obesity, polydactyly, hypogonadism, renal failure

Multiple endocrine neoplasia type 2

Mowat-Wilson syndrome – facies, GU and cardiac anomalies

Smith-Lemli-Opitz syndrome – facies, cholesterol, syndactyly

Waardenburg syndrome – wide-set eyes, deafness, white skin/hair
Infant and Toddler (1 month to 2 years)

Pyloric Stenosis

**Essentials:**

- **Hypertrophy** of pyloric sphincter; genetic, environmental, exposure factors

**Diagnosis:**

- *Hungry, hungry, not-so-hippos*; they **want to eat** all of the time, but cannot keep things down
- Poor weight gain (less than 20-30 g/day)
- **US:** “π-loric stenosis” (3.14); pylorus dimensions > 3 mm x 14 mm
- **UGI:** “string sign”

**Management:**

- Trial of medical treatment with oral atropine via NGT (muscarinic effects decrease pyloric tone)
- Ramstedt pyloromyotomy (definitive)

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**Pyloric Stenosis Foils**

**Gastroesophageal reflux** is not associated with poor weight gain or electrolyte abnormalities.

**Cow milk protein intolerance** may cause a slow GI bleed and a pale infant, but he appears well and hydrated.

**Adrenal crisis** overlaps in presentation: vomiting, dehydration, electrolyte abnormalities. Adrenal crisis presents in shock, not malnutrition/dehydration. 

Adrenal crisis – **hyperkalemic acidosis**; 
Pyloric stenosis – **hypokalemic hypocloremic alkalosis**.

**Liver disease** overlaps with pyloric stenosis: vomiting, poor weight gain, hyperbilirubinemia (seen in both). Look for pale acholic stools, conjugated hyperbilirubinemia.

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**Ultrasound with Hypertrophic Pylorus.**

(> 3 mm x 14 mm)
Intussusception

**Essentials:**
- Majority (90%) ileocolic; no pathological lead point
- Small minority (4%) ileoileoocolic due to lead point: Meckel’s diverticulum, polyp, Peyer’s patches, Henoch-Schönlein purpura (intestinal hematoma)

**Diagnosis:**
- **Ultrasound** sensitivity and specificity near 100% in experienced hands
- Abdominal XR may show non-specific signs; used mainly to screen for perforation before reduction

**Management:**
- **Hydrostatic** enema: contrast (barium or water-soluble contrast with fluoroscopy) or saline (with ultrasound)
- **Air-contrast** enema: air or carbon dioxide (with either fluoroscopy or ultrasound); higher risk for perforation than hydrostatic (1% risk), but generally safer than perforation from contrast
- Consider **involving surgical service early** (precaution before reduction)
- Traditional disposition is admission; controversial: home discharge from ED

Intussusception Fake-Outs

**Presentation A: Vomiting**

**Ddx:** viral gastroenteritis, malrotation, food intolerance, gastroesophageal reflux

*Seasonal viral acute gastroenteritis (AGE)* is a double jeopardy here: intussusception may present like AGE. Viral infections can stimulate Peyer’s patches, causing a lead point. In other words, even clear-cut AGE may be a prelude to intussusception. Vigilance and good precautionary advice are in order.

Adenovirus and bacterial enteritis have the highest association with intussusception. Earlier forms of the rotavirus vaccine (Rotashield) conveyed higher risk in the few weeks immediately after vaccination. The current iterations (RV5, RV1) do not convey the same association.

**Presentation B: Lethargy**

**Ddx:** Trauma, sepsis, metabolic derangements, toxicologic

**Take home points:**
- Vomiting and irritability (especially without diarrhea) is not clear-cut AGE.
- Lethargy may be the only presenting sign of intussusception.
Appendicitis

**Essentials:**

- Appendicitis **occurs in all ages**, but rarer in infants. Infants do not have fecalith; rather they have some other anatomic or congenital condition.
- More common in school-aged children (5-12 years) and adolescents.
- Younger children present atypically, more likely to have perforated when diagnosed.

### Perforation Rates by Age

- **Neonates**: 80%
- **Young children** (<5 years): 50%
- **School-age** (5 to 12 years): 30%
- **Adolescents** (>12 years): 20%

**Take Home:** Younger children more likely to have perforated at time of diagnosis.

### Accuracy of Signs in Appendicitis in Children

<table>
<thead>
<tr>
<th>Sign</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>LR +</th>
<th>95% CI</th>
<th>LR -</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>RLQ tenderness to palpation</td>
<td>1.0</td>
<td>0.1</td>
<td>1.3</td>
<td>(1.1-1.4)</td>
<td>0.45</td>
<td>(0.35-0.59)</td>
</tr>
<tr>
<td>Rebound tenderness</td>
<td>0.5</td>
<td>0.8</td>
<td>2.6</td>
<td>(2.0-3.6)</td>
<td>0.59</td>
<td>(0.50-0.71)</td>
</tr>
<tr>
<td>Psoas sign</td>
<td>0.4</td>
<td>0.9</td>
<td>2.5</td>
<td>(1.7-3.7)</td>
<td>0.75</td>
<td>(0.66-0.86)</td>
</tr>
<tr>
<td>Pain with percussion, hopping, cough</td>
<td>0.8</td>
<td>0.6</td>
<td>2.0</td>
<td>(1.7-2.4)</td>
<td>0.36</td>
<td>(0.26-0.50)</td>
</tr>
<tr>
<td>Abdominal distention</td>
<td>0.2</td>
<td>1.0</td>
<td>6.5</td>
<td>(0.93-45.5)</td>
<td>0.8</td>
<td>(0.71-0.89)</td>
</tr>
<tr>
<td>Diffuse peritonitis</td>
<td>0.2</td>
<td>1.0</td>
<td>25.0</td>
<td>(1.5-414.1)</td>
<td>0.76</td>
<td>(0.63-0.90)</td>
</tr>
<tr>
<td>Guarding</td>
<td>0.6</td>
<td>0.6</td>
<td>1.6</td>
<td>(1.4-2.0)</td>
<td>0.61</td>
<td>(0.49-0.76)</td>
</tr>
<tr>
<td>Obturator sign</td>
<td>0.3</td>
<td>0.9</td>
<td>2.2</td>
<td>(1.4-3.4)</td>
<td>0.82</td>
<td>(0.73-0.93)</td>
</tr>
<tr>
<td>Rovsing sign</td>
<td>0.3</td>
<td>0.8</td>
<td>1.9</td>
<td>(1.3-2.8)</td>
<td>0.83</td>
<td>(0.74-0.93)</td>
</tr>
</tbody>
</table>


### Diagnosis:

- Non-specific signs and symptoms
- Often have abdominal pain first; vomiting comes later
- Location/orientation of appendix varies
- Appendicitis scores vary in their performance
- Respect fever and abdominal pain

#### Fever in Appendicitis

_Fever is the single most useful sign associated with appendicitis._

**Presence** of fever **triples** the likelihood of appendicitis: LR + 3.4 (2.4-3.8)

**Absence** of fever **markedly decreases** its likelihood: LR - 0.3 (0.16-0.64)
Management:

- Traditional: surgical
- On the horizon: identification of low-risk children who may benefit from trial of antibiotics
- If perforated, interval appendectomy (IV antibiotics via PICC for 4-6 weeks, then surgery)
Obstruction

Essentials:

- Same pathophysiology and epidemiology as adults: “ABC” – adhesions, “bulges” (hernias), and cancer.

Diagnosis:

- Obstruction is a sign of another condition. Look for cause of obstruction: surgical versus medical
- Abdominal XR in low pre-test probability
- CT abdomen/pelvis for moderate-to-high risk; confirmation and/or surgical planning

Management:

- Treat underlying cause
- NG tube to low intermittent wall suction
- Admission, fluid management, serial examinations

Abdominal XR. Small bowel obstruction. (Incarcerated inguinal hernia)

Nasogastric Tube (NGT) Advice, Tips, and Tricks

NGT insertion is ranked at one of the most painful procedures in acute care. In awake, non-intubated patients, there is usually time to plan.

- Nebulize 4 mg/kg 4% lidocaine by facemask to pre-treat the nasal, oral, and pharyngeal mucosa
- Use lidocaine jelly as a lubricant
- Have all supplies ready, including hydrocolloid dressing (e.g. Duoderm), transparent film dressing (e.g. Tegaderm), tube, tape, syringe, oral sucrose solution
- Wrap child and gently restrain; anxiolysis as appropriate
- Place Duoderm on cheek near nostril.
- Measure the insertion depth (tip past xiphoid, run along midline and loop around nasopharynx. Mark.
- Hold tube by distal end and suspend in air to see natural curve to assist in direction
- Insert gently, in step wise fashion, giving the child “breaks”. Give oral sucrose solution or cold water in between pauses. Forceful insertion causes spasm and poor direction of tube as well as discomfort.
- Watch for cough, difficulty breathing or any discomfort when not manipulating the tube.
- Insert to mark at nostril. Secure the tube over the Duoderm and cover with Tegaderm. Affix with tape.
- Verify placement with air bolus and CXR.
- Set to low intermittent wall suction.
Abdominal Surgical Emergencies in Children: A Relative Timeline

Take these pearls home:

- **Consider** surgical pathology early in encounter
- **Resuscitate** while you investigate
- Have a **low threshold for imaging** and/or consultation, especially in preverbal children
Selected References

**Necrotizing Enterocolitis**


**Malrotation with Midgut Volvulus**


**Hirschsprung Disease**


**Pyloric Stenosis**


**Intussusception**


**Appendicitis**


Cohen B et al. The non-diagnostic ultrasound in appendicitis: is a non-visualized appendix the same as a negative study? J Pediatr Surg. 2015 Jun;50(6):923-7

Herliczek TW et al. Utility of MRI After Inconclusive Ultrasound in Pediatric Patients with Suspected Appendicitis. AJT. 2013; 200:969-973.


Intestinal Obstruction


Pediatric Surgery


