Pediatric Abdominal Pain

Brian Handly, MD
UNC Department of Radiology
3 yo male.
38° C.
BP 95/60
HR 110

Abdominal tenderness
**Acute Abdominal Pain**

---

**Table 2: Differential Diagnosis of Acute Abdominal Pain by Predominant Age**

<table>
<thead>
<tr>
<th>Birth to one year</th>
<th>Two to five years</th>
<th>Six to 11 years</th>
<th>12 to 18 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gastroenteritis</td>
<td>Appendicitis</td>
<td>Gastroenteritis</td>
<td>Appendicitis</td>
</tr>
<tr>
<td>Appendicitis</td>
<td>Constipation</td>
<td>Appendicitis</td>
<td>Constipation</td>
</tr>
<tr>
<td>Constipation</td>
<td>Urinary tract infection</td>
<td>Constipation</td>
<td>Constipation</td>
</tr>
<tr>
<td>Intussusception</td>
<td>Intussusception</td>
<td>Intussusception</td>
<td>Trauma</td>
</tr>
<tr>
<td>Volvulus</td>
<td>Trauma</td>
<td>Volvulus</td>
<td>Pharyngitis</td>
</tr>
<tr>
<td>Trauma</td>
<td>Pharyngitis</td>
<td>Trauma</td>
<td>Pneumonia</td>
</tr>
<tr>
<td>Sickle cell crisis</td>
<td>Sickle cell crisis</td>
<td>Sickle cell crisis</td>
<td>Sickle cell crisis</td>
</tr>
<tr>
<td>Henoch-Schönlein purpura</td>
<td>Henoch-Schönlein purpura</td>
<td>Henoch-Schönlein purpura</td>
<td>Henoch-Schönlein purpura</td>
</tr>
<tr>
<td>Mesenteric lymphadenitis</td>
<td>Mesenteric lymphadenitis</td>
<td>Mesenteric lymphadenitis</td>
<td>Mesenteric lymphadenitis</td>
</tr>
</tbody>
</table>

*Am Fam Physician. 2003 Jun 1;67(11):2321-2327*
Constipation
Constipation

• Diagnostic Value of Abdominal Radiography in Constipated Children

• “The limited amount of data available shows conflicting evidence for an association between clinical symptoms of constipation and fecal loading on abdominal radiographs in children. The recommendation to perform a plain abdominal radiograph in case of doubt of the presence of constipation in a child cannot be supported.”
2 or more symptoms

• Two or fewer defecations per week
• At least one episode of fecal incontinence per week
• Stool retentive posturing
• Painful or hard bowel movements
• Large diameter stools that could obstruct the toilet
• Presence of a large fecal mass in the abdomen or rectum

* Without objective evidence of an organic disease responsible for the symptoms.

Rome III Criteria, Pediatric Functional Constipation, 2006
Constipation

13 yo male with pedal edema

3 yo male
Henoch Schönlein Purpura

• Small vessel vasculitis
• Immunoglobulin A deposition
• Palpable purpura, arthritis, abdominal pain, renal disease
• Bowel wall thickening, thumbprinting
Intussusception

Get an IV
Get a nurse
Get a surgical consult
9 yo female

- Umbilical pain yesterday
- Nausea, vomiting
- Pain migrated today to RLQ

- 39.0
- 130HR
- BP 90/50
# Alvarado Score

<table>
<thead>
<tr>
<th>Signs</th>
<th></th>
<th>Yes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Right lower quadrant tenderness</td>
<td>No</td>
<td>0</td>
<td>Yes +2</td>
</tr>
<tr>
<td>Elevated temperature (37.3°C or 99.1°F)</td>
<td>No</td>
<td>0</td>
<td>Yes +1</td>
</tr>
<tr>
<td>Rebound tenderness</td>
<td>No</td>
<td>0</td>
<td>Yes +1</td>
</tr>
<tr>
<td>Symptoms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Migration of pain to the right lower quadrant</td>
<td>No</td>
<td>0</td>
<td>Yes +1</td>
</tr>
<tr>
<td>Anorexia</td>
<td>No</td>
<td>0</td>
<td>Yes +1</td>
</tr>
<tr>
<td>Nausea or vomiting</td>
<td>No</td>
<td>0</td>
<td>Yes +1</td>
</tr>
<tr>
<td>Laboratory Values</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leukocytosis &gt; 10,000</td>
<td>No</td>
<td>0</td>
<td>Yes +2</td>
</tr>
<tr>
<td>Leukocyte left shift</td>
<td>No</td>
<td>0</td>
<td>Yes +1</td>
</tr>
</tbody>
</table>

5 points
Possible appendicitis by the Alvarado Score.
With labs

<table>
<thead>
<tr>
<th>Signs</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right lower quadrant tenderness</td>
<td>No</td>
</tr>
<tr>
<td>Elevated temperature (37.3°C or 99.1°F)</td>
<td>No</td>
</tr>
<tr>
<td>Rebound tenderness</td>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Migration of pain to the right lower quadrant</td>
<td>No</td>
</tr>
<tr>
<td>Anorexia</td>
<td>No</td>
</tr>
<tr>
<td>Nausea or vomiting</td>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Laboratory Values</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leukocytosis &gt; 10,000</td>
<td>No</td>
</tr>
<tr>
<td>Leukocyte left shift</td>
<td>No</td>
</tr>
</tbody>
</table>

**8 points**

Probable/likely appendicitis by the Alvarado Score.
In terms of diagnostic accuracy, the cut-point of 5 was good at 'ruling out' admission for appendicitis (sensitivity 99% overall, 96% men, 99% woman, 99% children). At the cut-point of 7, recommended for 'ruling in' appendicitis and progression to surgery, the score performed poorly in each subgroup (specificity overall 81%, men 57%, woman 73%, children 76%).
<table>
<thead>
<tr>
<th></th>
<th>Truth</th>
<th>Test Result</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive (number)</td>
<td>Negative (number)</td>
</tr>
<tr>
<td>True Positive</td>
<td>(A)</td>
<td>(C)</td>
</tr>
<tr>
<td>True Negative</td>
<td>(D)</td>
<td>(B)</td>
</tr>
<tr>
<td>False Positive</td>
<td>(A+B)</td>
<td>(C+D)</td>
</tr>
<tr>
<td>False Negative</td>
<td>(A)</td>
<td>(B+C)</td>
</tr>
<tr>
<td>Total</td>
<td>(A+B+C+D)</td>
<td>(C+D)</td>
</tr>
</tbody>
</table>

Sensitivity is...

$$\text{Sensitivity} = \frac{A}{(A+C)}$$
EITHER WBC or left shift -> sensitivity of 80%

BOTH WBC and left shift -> specificity of 94%
Abdominal pain NOS
Cost

- 30$ - 150$

- 100$ - 800$
Appendicitis
16 yo male
Secondary Signs of Appendicitis (3)

- Periappendiceal fat hyperechogenicity
- Decreased bowel peristalsis
- Adjacent fluid collection suspicious for abscess (not just FF)

12 yo male
Standardized report – Nationwide study

• Positive
  • No appendix visualized, secondary signs present
  • No appendix no secondary signs
• Negative
  • With standardized US report, 92% sensitivity, 98% specificity
  • NPV of no appendix, no secondary signs was 97%
What about MR?

• ~15 min total
• No sedation
• No contrast
14 yo female
10 yo female normal
16 yo female

- Right lower quadrant pain
- Fever 38.5
- Bloody stool
- 20 lb weight loss
Inflammatory Bowel Disease

• Ulcerative colitis and Crohn’s disease
• ~1 case per 10000, CD > UC by about 2.5X
• Average age of onset  = 12

Magnetic Resonance Enterography

- Idea: distend bowel with oral contrast (VoLumen)
- Image with fast sequences + glucagon to freeze the bowel motion
Wall thickening
Wall hyperenhancement
Mural stratification
Mimics
7 yo male

- Generalized abdominal pain x 3 days
- Nausea, vomiting

- 39.0
- 110HR
- BP 100/60
7 yo male
9 yo female

- Generalized abdominal pain x 3 days
- Nausea, vomiting
- Diarrhea

- 39.0
- 110HR
- BP 100/60
Mesenteric Adenitis

- 3 or more nodes, 5 mm each
- Can have associated inflammation of the bowel
- Normal appendix (diagnosis of exclusion)
- Self-limited
RUQ pain

LUQ pain

[Image of two twin girls in blue dresses]
Omental infarction and Epiploic appendagitis
14 yo female

- Abdominal pain and bloating
- No fever
- Mild bradycardia
- Mild hypotension
- LMP: ???
14 yo female
SMA syndrome

- Associated with rapid weight loss, anorexia nervosa
- Post scoliosis surgery
- Neurologically disabled
- SMA-aortic angle <10° suggests diagnosis
1 yo male

Asymptomatic!
The rule of twos does not include:

- Two feet from the ileocecal valve
- Two types of common ectopic mucosa
- Two percent risk of malignant transformation
- Two percent of the population
- Usually presents around two years of age

Meckel Diverticulum

Vitelline duct (omphalomesenteric duct)

- Connects fetal gut to yolk sac (within nascent umbilical cord)
- Should obliterate around 9 weeks gestational age
- Antimesenteric side of ilium
3 cases

18 yo female
17 yo female
16 year old female
Trauma
Trauma

• Less abdominal muscle
• Ribs are more flexible
• Solid organs comparatively larger
Figure 2: Telltale seatbelt sign of bruising across the abdomen
## Trauma

80% blunt trauma in peds

<table>
<thead>
<tr>
<th>Organ</th>
<th>BLUNT</th>
<th>%</th>
<th>PENETRATING</th>
<th>Organ</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spleen</td>
<td>30</td>
<td></td>
<td>Gastrointestinal tract</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Liver</td>
<td>28</td>
<td></td>
<td>Liver</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Kidneys</td>
<td>28</td>
<td></td>
<td>Blood vessels</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Gastrointestinal tract</td>
<td>14</td>
<td></td>
<td>Kidneys</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Bladder/urethra/ureters</td>
<td>4</td>
<td></td>
<td>Spleen</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Pancreas</td>
<td>3</td>
<td></td>
<td>Bladder/urethra/ureters</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Blood vessels</td>
<td>3</td>
<td></td>
<td>Pancreas</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

Solid organ injury
Can labs help?

- **AST/ALT**
  - Likely liver injury if > 450/250, not 100% sensitive

- **Hemoglobin and Hematocrit**
  - Can be misleading if hyperacute bleed

- **Amylase/Lipase**
  - Limited sensitivity, especially early
Good news!

Fewer than 5% of children with solid organ injury require operation!
Spleen

• Most commonly injured organ
• 6-9% of blunt trauma patients
Grade 3 injury
Infectious mononucleosis

Risk of rupture highest in 2\textsuperscript{nd}-3\textsuperscript{rd} week of illness
Liver

• Commonly injured, 6-9% of blunt trauma patients
• Increasing grade of hepatic injury correlates with need for transfusion (not operative hemostasis)
Liver

### Hepatic CT Injury Grading Scale

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Laceration(s) &lt; 1 cm deep Subcapsular hematoma &lt; 1 cm diameter</td>
</tr>
<tr>
<td>II</td>
<td>Laceration(s) 1-3 cm deep Subcapsular or central hematoma 1-3 cm diam</td>
</tr>
<tr>
<td>III</td>
<td>Laceration(s) 3-10 cm deep Subcapsular or central hematoma 3-10 cm diam</td>
</tr>
<tr>
<td>IV</td>
<td>Laceration(s) &gt; 10 cm deep Subcapsular or central hematoma &gt; 10 cm diam Lobar maceration or devascularization</td>
</tr>
<tr>
<td>V</td>
<td>Bilobar tissue maceration or devascularization</td>
</tr>
</tbody>
</table>
Bad
Worse
Despite all this...

Only 20% of children with active hemorrhage with liver or spleen injury require operative hemostasis!!
Kidney

• Injury in 4-14% of blunt abdominal trauma
• Underlying renal anomalies predispose to injury
17 yo female, MVC

Renal Injury Scale

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
</table>
| Grade I| Contusion/Subcapsular hematoma  
No parenchymal laceration |
| Grade II| Laceration < 1 cm depth of renal cortex  
No urinary extravasation |
| Grade III| Laceration > 1 cm depth of renal cortex  
No urinary extravasation |
| Grade IV| Laceration extending through renal cortex,  
medulla and into collecting system  
Minor renal artery or vein injury  
with contained hematoma |
| Grade V | Shattered kidney  
Devascularized kidney, hilar avulsion |
17 yo female, MVC
6 months later
What clinical finding might this patient have?
Summary

• Be smart about imaging children
• Ultrasound is first line when possible
• Common pediatric pathology that presents with abdominal pain
What did I eat?
What did I eat?
What did I eat?