Case studies of acute abdominal pain in children and adolescents

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- No discussion of off-label medications

Objectives

- Discuss the clinical features of and differential diagnoses for acute appendicitis in children.
- Describe the evidence-based evaluation of children with acute abdominal pain including laboratory and imaging studies, with a focus on ruling out acute appendicitis.
- Understand the application and limits of scoring systems and algorithms used in the diagnosis of pediatric acute appendicitis.
- Describe the risk factors for as well as clinical and laboratory findings consistent with symptomatic Clotridioides difficile (C.diff) infection.

Background

- Abdominal pain is a very common chief complaint amongst children presenting to the emergency department (ED).
- Etiologies of abdominal pain range from simple problems such as UTI or strep throat to true medical or surgical emergencies.
- The list of differential diagnoses for abdominal pain is extensive and broad
  - Abdominal pain may be due to specifically GI etiologies, e.g. bowel obstruction, cholecystitis, constipation
  - Abdominal pain may be due to GU/GYN conditions, Heme/onc conditions, renal conditions etc.
- Acute appendicitis is the most common surgical cause for pediatric presentation to the ED with abdominal pain.

(Lee et al., 2021; Magnusdottir et al., 2019)

Select Differential Diagnoses

Gastrointestinal Etiologies

- Acute Appendicitis
- Acute Mesenteric Lymphadenitis
- Constipation
- Viral Gastroenteritis (AGE)
- Bacterial Enteritis
- Gastritis/GERD
- Pancreatitis
- Hepatitis
- Inflammatory Bowel Disease (IBD)
- Inflammatory Bowel Syndrome (IBS)
- Functional Abdominal Pain
- Small Bowel Obstruction (SBO)
- Intussusception
- Cholelithiasis/Cholecystitis

GYN/GU Etiologies

- Ovarian Cyst
- Ovarian Torsion
- Mittelschmerz
- Dysmenorrhea
- Pregnancy
- Pelvic Inflammatory Disease (PID)
- Testicular torsion

Heme/Onc Etiologies

- Henoch-Schonlein purpura (HSP)
- Hemolytic-Uremic Syndrome (HUS)
- Sickle cell Disease

(Kay et al., 2018)

Select Differential Diagnoses

Renal Etiologies

- Nephrolithiasis
- Urinary Tract Infection(UTI)/Pyelonephritis

Miscellaneous Etiologies

- Streptococcal pharyngitis
- Pneumonia
- Diabetic Ketoacidosis (DKA)
- Ingestion
- Trauma

(Kay et al., 2018)

Differentials for Acute Appendicitis

- **Acute Mesenteric Lymphadenitis**
- **Viral Gastroenteritis**
- Bacterial Enteritis
- Constipation
- Intussusception
- SBO
- Cholecystitis/Cholelithiasis
- Functional abdominal pain
- Ectopic vs. intrauterine pregnancy
- Ovarian cyst vs. ovarian torsion
- PID
- Pneumonia
- UTI/pyelonephritis
- Testicular torsion
- DKA

(Kay et al., 2018)

Case Studies

Case #1:

HPI:

- 8 yo male, no significant Pmhx, no surgical hx c/o abdominal pain since yesterday. Bib mother from home.
  - Pain is intermittent, 5/10, localized to periumbilical, RLQ and LLQ
  - Pain exacerbated by ambulation and car ride to ED.
  - +diminished appetite, +nausea, -vomiting,
  - -diarrhea, -constipation, -fever, -urinary complaints, -URI symptoms

Case #1:

- Physical Exam
  - Vital signs WNL for age
  - Alert, generally well appearing, in NAD
  - Abdomen flat, soft, non-distended, normoactive bowel sounds, tender to RLQ and LLQ.
    - +rebound, + heel strike, equivocal obturator and psoas signs.
      - Rovsing sign
- Laboratory Results
  - CRP: < 0.3 U/L
  - Lipase: 108 U/L
  - CMP: WNL
  - UA: 1+ Ketones, USG WNL, negative leukocytes, negative nitrites
  - CBC:
    - WBC: **11.9**, Neutrophils: **65.6%,** ANC: **7.78**

Case #1:

- Differential Diagnoses:
  - Acute appendicitis
  - Acute mesenteric lymphadenitis (mesenteric adenitis)
  - Viral gastroenteritis

Classic Signs and Symptoms of Acute Appendicitis

HPI:

- ❑ Fever
- ❑ Anorexia
- ❑ Nausea +/- Vomiting
- ❑ Abdominal pain
  - ❑ Migration of pain from periumbilical area to RLQ

PE:

- ❑ Maximal tenderness at McBurney's point
- ❑ Rebound tenderness
- ❑ Guarding
- ❑ Psoas sign
- ❑ Obturator sign
- ❑ Rovsing sign
- ❑ Heel tap sign/Heel jar test

(Kay et al., 2018; Snyder et al., 2018)

Clinical Decision Rules

Alvarado Score:

- RESULT SUMMARY:
- 7 points
- Probable/likely appendicitis by the Alvarado Score.

- INPUTS:
- Right lower quadrant tenderness —> 2 = Yes
- Elevated temperature (37.3°C or 99.1°F) —> 0 = No
- Rebound tenderness —> 1 = Yes
- Migration of pain to the right lower quadrant —> 0 = No
- Anorexia —> 1 = Yes
- Nausea or vomiting —> 1 = Yes
- Leukocytosis >10,000 —> 2 = Yes
- Leukocyte left shift —> 0 = No

Pediatric Appendicitis Score (PAS):

- RESULT SUMMARY:
- 8 points
- Likely appendicitis. Consider surgical consult.

- INPUTS:
- RLQ tenderness to cough, percussion, or hopping —> 2 = Yes
- Anorexia —> 1 = Yes
- Fever —> 0 = No
- Nausea or vomiting —> 1 = Yes
- Tenderness over right iliac fossa —> 2 = Yes
- Leukocytosis —> 1 = Yes
- Neutrophilia —> 1 = Yes
- Migration of pain to RLQ —> 0 = No

Clinical Decision Rules

Appendicitis Inflammatory Response (AIR):

- RESULT SUMMARY:
- 4 points
- AIR Score

- Low risk
- Outpatient follow-up (if unaltered general condition)

- INPUTS:
- Vomiting —> 0 = No
- RIF pain —> 1 = Yes
- Rebound tenderness —> 2 = Medium
- Temp ≥101.3ºF (38.5ºC) —> 0 = No
- Polymorphonuclear leukocytes —> 0 = <70%
- WBC count, $\times 10^9$/L —> 1 = 10.0–14.9
- CRP level, mg/L —> 0 = <10

Case #1:

Imaging Results

- Ultrasound Appendix:
  - No fixed bowel loop or fluid collection
  - Few non-enlarged lymph nodes
  - Normal appendix not specifically demonstrated

- CT Abdomen/Pelvic w/IV Contrast:
  - Normal appearing appendix visualized
  - No evidence of bowel obstruction
  - Mild to moderate amount fecal material in colon
  - Multiple prominent lymph nodes w/in the RLQ and at the root of the mesentery

ED Treatment:

- Normal Saline bolus
- Zofran IV
- Acetaminophen PO
- PO challenge

Case #1:

Case Summation:

- Impression:
  - Acute Mesenteric Lymphadenitis (Mesenteric Adenitis)

- Disposition
  - Successfully PO challenged w/ginger ale
  - D/Ced home to f/u with PCP
  - Ondansetron (Zofran) ODTs Rxed
  - “Doing better” per mother when called next day by F/U nurse

Mesenteric Adenitis

- One of the most common alternative diagnoses in a child with suspected appendicitis
- ≥ 3 lymph nodes measuring > 5 mm on their short axis
  - One lymph node of ≥ 8 mm
- Primary mesenteric adenitis is self-limiting
  - Resolution expected within 2-3 weeks
- An inflammatory process of the mesenteric lymph nodes
  - Non-specific or Primary (idiopathic) etiology
  - Secondary etiologies
    - Infections
    - Malignancy
    - Inflammatory disorders

(Gross et al., 2017; Helbling et al., 2017)

Mesenteric Adenitis

Clinical Presentation

- Abdominal pain
- Fever
- Nausea and/or vomiting
- Change in stool frequency/consistency
- Preceding or concurrent URI

Diagnostic Findings

- Higher WBC and CRP levels associated with appendicitis compared w/mesenteric adenitis
  - Mild to moderate elevation in mesenteric adenitis
- Lymphocytosis associated with mesenteric adenitis, negative predictor for appendicitis

(Gross et al., 2017; Helbling et al., 2017)

Case #2:

Case #2:

HPI:

- 18 yo male, hx food allergies, no surgical hx, bib EMS with mother from urgent care, c/o periumbilical to R sided abdominal pain since that afternoon, onset while doing yoga
  - Abdominal pain 5/10, sharp. –flank or back pain, +nausea, - vomiting, - diarrhea or constipation, - urinary complaints, - fever, -URI symptoms
  - No aggravating or alleviating factors. No anorexia/changes in PO intake
  - Mother reports family hx of gallstones and kidney stones
  - At urgent care, had episode of pallor and diaphoresis, BP 81/50 mmHg which improved to 124/72 mm Hg after lying down.

Case #2:

Physical Exam:

- Vital signs WNL
- Alert, well appearing, in NAD. Not pale or diaphoretic
- Abdomen flat, soft, no masses, normoactive bowel sounds, + Tenderness to McBurney's point with involuntary guarding, no rebound.
  - Negative Rovsing, Murphy's, psoas, and obturator signs
  - No CVA tenderness

Laboratory Results:

- CRP: 0.6 mg/dL
- Lipase: 55 U/L
- UA: **3+** Ketonuria, Specific Gravity: **1.031**, negative leukocytes, negative nitrites
- CMP: WNL
- CBC: WBC: **13.0**, Neutrophils**: 79.3%,** ANC: **10.26**

Case #2:

Differential Diagnoses:

- Acute Appendicitis
- Acute Mesenteric Lymphadenitis
- Cholelithiasis
- Cholecystitis
- Vasovagal near syncope

Case #2:

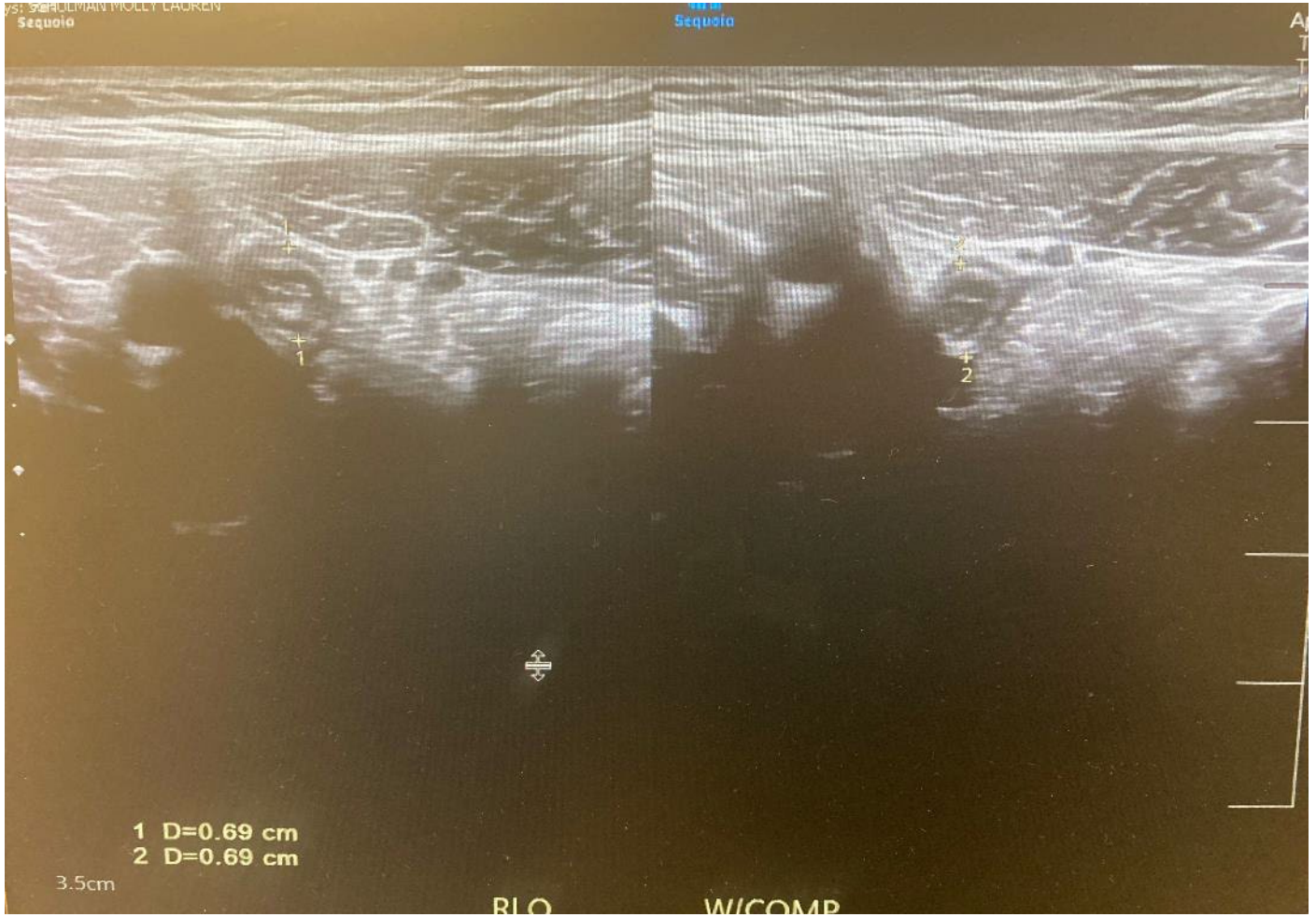
Imaging Results:

- US RUQ:
  - Gallbladder w/no wall thickening, no pericholecystic fluid, common bile duct 0.2 cm, negative sonographic Murphy's sign
- US RLQ:
  - Tubular blind-ending structure, dilated, not compressible, measuring up to 0.8 cm

ED Treatment:

- NPO
- Normal Saline Bolus IV
- Ketorolac (Toradol) IV
- Ondansetron (Zofran) IV
- Ciprofloxacin IV
- Metronidazole (Flagyl) IV

Imaging Results



Case #2:

Impression:

- Acute appendicitis
- Vasovagal near syncope

Case Summation:

- ED consult by general surgery PA
- To OR for laparoscopic appendectomy
  - No intraoperative complications
- D/Ced home on post-op day 1
  - Uneventful post-op course
- F/U general surgery outpatient in two weeks

Appendicitis Treatment

Antibiotics:

- ❑ Pre-operative antibiotic prophylaxis are recommended for simple appendicitis
- ❑ Insufficient evidence to suggest antibiotics alone (non-operative management) as a safe option for children
- ❑ Sample recommended agents:
  - ❑ Simple Appendicitis: Cephalosporin w/anaerobic activity +/- Metronidazole
  - ❑ Complicated Appendicitis: Piperacillin -Tazobactam (Zosyn)

Surgery:

- ❑ Timing of operative management
  - ❑ Adverse outcomes not shown to be in increased > 6 hrs vs < 6 hrs after diagnosis. Delays of > 48 hrs carry increased risk of surgical site infection
- ❑ Laparoscopic appendectomy as standard treatment
  - ❑ Equivalent outcomes in uncomplicated cases
  - ❑ Lower incidents of infection, shorter length of stay, faster return to activities compared with open in complicated cases

(Andersen et al., 2009; Hansen & Dolgin, 2016; Kay et al., 2018; Mandeville et al., 2015; Podany et al., 2017; Snyder et al., 2018)

Case #3:

Case #3:

HPI:

- 7 yo male with no significant Pmhx, no surgical hx, bib both parents with a c/o “weakness” and concern for dehydration. Seen at an urgent care earlier and directed to proceed to the ED.
  - + Chills, - fever. +decreased appetite, +decreased activity level
  - + Periumbilical abdominal pain which parents attributed to constipation, report to have had no stool x 2 days then passed small hard balls yesterday. -nausea, - vomiting, - diarrhea, - urinary complaints
  - Finished a 10 day course of PO Amoxicillin 3-4 days prior, prescribed for treatment of a “upper respiratory infection”, with reported resolution of symptoms

Case #3:

Physical Exam:

- Vital Signs: BP 110/71 mmHg T **100.8 F** orally, P **139** bpm, RR **30** bpm, Sp02 100%
- Looks tired, ill-appearing
  - Tachypneic w/good air entry all lung fields, no retractions, no flaring, no adventitious sounds
  - Abdomen round, mild gassy distension, tympanitic to percussion, no masses,
    - Tenderness to RLQ, LLQ and periumbilical areas, negative appendiceal signs

Laboratory Results:

- UA: **2+** Ketonuria, no leukocytes, no nitrites
- Lipase: WNL
- CRP: **3.2** mg
- CMP: WNL, no electrolyte imbalances, no transaminitis
- EBV Heterophile Antibody (Monospot): Negative
- Rapid Strep: Negative
- COVID-19: Negative
- Influenza A&B: Negative
- CBC w/diff:
  - WBC: **25.5**, Neutrophils **87.8%,** ANC: **22.37**

Case #3:

Differential Diagnoses:

- Viral Syndrome
- Community-acquired pneumonia
- Constipation
- Dehydration
- Acute appendicitis
  - Ruptured appendicitis

Case #3:

Imaging Results:

- CXR: Low lung volumes, no focal consolidation or pneumothorax
- KUB: Abundant stool seen distally, no evidence for obstruction
- US RLQ:
  - Normal appendix not definitively visualized
  - No mass, free fluid or fluid collection
- CT Abdomen/Pelvis w/contrast:
  - Normal caliber appendix in RLQ, no peri-appendiceal fat stranding or collection.
  - Normal caliber small bowel loops. + large amount retained fecal material and gas in colon
  - Liver, gallbladder, pancreas, spleen, adrenal glands, bladder w/no acute findings

Case #3:

ED Treatment:

- NPO
- Tylenol 15mg/kg/dose PO x1
- Zofran 4mg IV x1
- Normal saline bolus 20 ml/kg IV x1
- Ceftriaxone 1V x1
- Metronidazole IV x 1

Case #3:

Case Summation:

- Admitted to pediatric floor
- Onset of loose, foul-smelling, non-bloody diarrhea
  - Stool pathogens by PCR: negative
  - C.difficile GDH Antigen: positive
  - C.difficile Rapid Toxin: positive

  - PO Vancomycin
  - IV Fluids up to 1.5 x maintenance
  - Tachycardia improved and fevers resolved.
    - D/Ced home to continue PO vancomycin
    - F/U with PCP and peds GI

Case #3:

Case Summation:

- Returned to ED x 3 weeks later
  - c/o 5/10 periumbilical pain, NBNB emesis x 4, non-bloody diarrhea x 2
  - + Chills, - Fever, + PO intolerance
  - Afebrile, P 127 bpm
  - Looked tired but nontoxic
  - Abdomen w/mild gassy distension, TTP McBurney's point
  - Labs: CBC: WBC: **19.9**, Neutrophils: **91.8%,** ANC: **18.28**
    - UA**: 3+** Ketonuria
  - US: Appendix not identified, + mildly prominent RLQ lymph node
  - Treated in ED w/Tylenol PO, Zofran IV, NS bolus IV.

- Admitted to pediatric floor for likely recurrent c. difficile colitis
  - Treated with MIVF up to 1.5 x maintenance, PO Vancomycin
  - Pediatric GI consulted, agreed with plan. Recommend fidaxomicin if further recurrence

Clotridioides difficile (C.diff)

Definitions

- Spore-forming, anaerobic, Gram-positive bacillus 
  - Acquired from the environment or via the fecal-oral route
  - Toxins A&B responsible for intestinal disease when there is overgrowth
- C. diff infection: presence of symptoms (usually diarrhea) AND
  - Stool test positive for C. diff toxins OR detection of toxigenic C. diff OR
  - Colonoscopic or histopathologic findings revealing pseudomembranous colitis
- Clinical manifestations range from asymptomatic carriage to mild diarrhea to pseudomembranous colitis to toxic megacolon
- The most common identifiable health care-associated diarrheal illness in North America and the most common health care associated infection in the U.S.

(Adams et al., 2023; American Academy of Pediatrics, 2021; Committee on Infectious Diseases, 2013; McDonald et al, 2018; Sammons & Toltzis, 2015)

Characteristics of C. diff infection by severity

Disease Severity	IDSA Criteria	Signs & Symptoms
Mild to Moderate	**WBC count < 15 and creatinine < 1.5 x baseline**	**Acute-onset, frequent, malodorous diarrhea w/abd pain**
Severe	WBC count ≥ 15 or serum creatinine ≥ x baseline	High diarrheal output, fever. Hypotension/shock in cases of fulminant disease
		IDSA= Infectious Diseases Society of America

(Devine et al., 2022; McDonald et al., 2018)

C.diff Testing

When to test and what test to get?

- Testing for C. diff can be for the presence of organism (glutamate dehydrogenase (GDH), nucleic acid amplification testing (NAAT)) or the presence of toxin (toxin enzyme immunoassay(EIA))
- NAAT alone OR multistep algorithm for testing when there are institutional criteria for stool submission
  - GDH plus toxin or GDH plus toxin arbitrated by NAAT
- Patients with unexplained and new onset diarrhea (≥ 3 unformed stools) in 24 hours
  - Do not submit specimens on patients receiving laxatives
  - Do not submit formed stools
  - Do not routinely test infants ≤ 12 months of age
  - Do not perform testing on children 1-2 years of age unless other causes for diarrhea are excluded
  - In children ≥ 2 years of age, test in the setting or prolonged or worsening diarrhea AND risk factors OR relevant exposures.
- Repeat testing (within 7 days) during the same episode is not indicated
  - Do not test asymptomatic patients (tests of cure are discouraged)
  - Testing for recurrence < 4 weeks after initial test only useful if negative

- (American Academy of Pediatrics, 2021;Committee on Infectious Diseases, 2013; McDonald et al., 2018; Sammons & Toltzis, 2015)

C. diff Risk Factors

- Modifiable risk factors:
  - Antibiotics
    - Highest w/3rd and 4th generation Cephalosporins, Fluoroquinolones and Clindamycin OR
    - Exposed to at least two classes of antibiotics
  - Proton Pump Inhibitors and H2 Blockers
  - Repeated enemas
- Non-modifiable risk factors
  - Comorbid/chronic conditions
    - IBD
    - Solid Organ Transplant
    - Malignancy
    - Cystic Fibrosis
    - Gastrointestinal Feeding Devices (Prolonged NGtube/Gtube/Jtube)

(Adams et al., 2017; Committee on Infectious Diseases, 2013; Devine et al., 2022)

C. diff Treatment

- Discontinue precipitating antimicrobial therapy
- Drugs that decreased intestinal motility should not be administered
- Insufficient data to recommend probiotics for prevention
- Antibiotic Treatment:
  - Severe and complicated: Vancomycin PLUS Metronidazole 30mg/kg/day q5h
  - Severe: Vancomycin 40mgkg/day PO q6h x 10 days
  - Mild to moderate: Metronidazole 30mg/kg/day q6h PO or IV x 10 days OR
    - Vancomycin 40mg/kg/day PO q6h x 10 day
  - First Recurrence: Mild-moderate: As above
  - Severe: Vancomycin as above
  - Subsequent Recurrence: consider fecal microbiota transplant

(American Academy of Pediatrics, 2021; Committee on Infectious Diseases, 2013; McDonald et al., 2018)

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Questions?

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