Taking the “itis” out of Appendicitis

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Learning Objectives

• State an understanding of this disease including pertinent anatomy, etiology, and pathophysiology of acute and perforated appendicitis.
• Describe consideration for diagnosing appendicitis including; signs and symptoms, physical exam findings, laboratory results, radiographic findings, and differential diagnoses.
• Describe surgical, non-operative with drain placement for complicated appendicitis, and preliminary findings for a clinical trial for non-operative management of acute appendicitis.

NSQIP®-Peds

• What is ®NSQIP?
  — Started with the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP)® for adults
  • 1980s Congress needed a program to allow for data collection and quality improvement initiatives in the VA system
  • ACS in collaboration with the American Pediatric Surgical Association developed ACS NSQIP Peds for specialties in children’s surgery which began in 2008 with four pilot hospitals
  • Challenging as pediatric occurrence rates are low and the patients are variable
  • Focus on a smaller number of surgeries as for hernias etc. not having large number of complications

• Enrollment open to free standing children’s hospitals, children’s hospitals within larger hospitals, specialty children’s hospitals, general hospitals with a pediatric wing
• Hospitals pay a fee and employee a surgical clinical reviewer to collect reliable date on and compare their outcomes to other participating program
  — Every 8 days a report for ORs based on CPT codes Can this help with standardization and protocolization?
• Provides a national database to measure outcomes
• Allows clinicians to act on data to improve care (e.g., minimize PIC use in the appendicitis population)
• How did I just learn of this?

Disclosures

• Sarah A. Martin
  – Sarah has no disclosures
• Kelly S. Finkbeiner
  – Kelly has no disclosures

***No rates are risk- or demographic-adjusted***
Appendicitis

- Most common emergent surgical condition
- Incidence is increasing, approximately 1 per 1,000
- Increasing in Hispanics, Asians and Native Americans; decreasing in Caucasian and African Americans
- Peak incidence 10 to 19 years of age
- Males > Females

The Appendix

Pathophysiology

- Occurs from occlusion of the appendiceal lumen
- Occlusion blocks mucus and bacterial drainage, raising appendiceal luminal pressure
- Increased pressure impairs perfusion with eventual gangrene and perforation

Diagnosis

- Can this disease be identified in a cost effective and time efficient manner with minimal radiation?
  - Negative appendectomy rates in the U.S. at approximately 5%
- Estimated that a seasoned clinician should be able to diagnose in 90% of the cases clinically
- Clinical “score” + Lab + Radiologic Findings
Physical Exam

- Nearly 1/2 of children have an atypical presentation
- Classic presentation
  - Dull periumbilical pain migrating to the right lower quadrant over 24 hours
  - McBurney’s point: Located 1/3 of the distance along a line from the front of the right pelvic bone and the umbilicus
  - Fever
  - Anorexia

Physical Exam

- Common signs & symptoms
- Other signs
  - Rovsing’s sign-right sided pain with lower left palpation
  - Psoas sign-pain with flexion and internal rotation of the right hip
  - Obturator sign-pain with left side down right hip extension
  - Dunphy-pain with coughing
  - Markle test-pain with heel-drop
- Stethoscope test
- Findings that increase the likelihood
  - Fever, pain migration to the RLQ, and rebound tenderness

Laboratory Tests

- CBC
- CMP
- CRP
- Urinalysis
- Pregnancy test

Which signs & symptoms is/are the most useful in making the diagnosis of appendicitis according to a classic systematic review of the literature (Bundy et al., 2007)?

A. Fever
B. Fever and WBC count > 10,000/µL
C. Rebound tenderness and RLQ pain
D. Fever and rebound tenderness

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Pediatric Appendicitis Risk Scores

- Can help protocolize
  - Pediatric Appendicitis Score (PAS)
    - Children 4 to 15 years old
    - 10-point score
    - Diagnosis unlikely with score < 5
  - Alvarado
    - 10-point score
    - Diagnosis unlikely with score < 5
  - Appendicitis Inflammatory Response Score (AIR)
    - 8 variables on weighted ordered logistic regression analysis
    - Includes CRP
Pediatric Appendicitis Risk Scores

- **Symptoms**
  - Nausea or vomiting: 1
  - Vomiting: —
  - Anorexia: 1
  - Migration of pain to the right lower quadrant: 2

- **Signs**
  - Pain in the right lower quadrant: 2
  - Rebound tenderness: 1
  - Light: —
  - Medium: —
  - Strong: —

- **Body**
  - Temperature >37.5°C: —
  - Temperature >38.5°C: 1

- **Laboratory Tests**
  - Leukocytosis shift: —
  - Polymorphonuclear leukocytes (>75%): 1
     - 70%–84%: —
     - >85%: —
  - WBC >10×10⁹/L: 1
     - 10.0–14.9×10⁹/L: —
     - >15.0×10⁹/L: —
  - CRP Concentration
    - 10–49 g/L: —
    - >50 g/L: —

- **Total Score**
  - PAS score: 1–4
  - AIR score: 0–4
  - Alvarado score: 1–4

<table>
<thead>
<tr>
<th>Risk of appendicitis</th>
<th>PAS score 1–4</th>
<th>PAS score 5–7</th>
<th>PAS score 8–10</th>
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</thead>
<tbody>
<tr>
<td>Low-risk</td>
<td>Alvarado score 1–4</td>
<td>AIR score 0–4</td>
<td>Low-risk</td>
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<tr>
<td>Intermediate risk</td>
<td>Alvarado score 5–6</td>
<td>AIR score 5–8</td>
<td>Intermediate risk</td>
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<tr>
<td>High-risk</td>
<td>Alvarado score 7–10</td>
<td>AIR score 9–10</td>
<td>High-risk</td>
</tr>
</tbody>
</table>

Case of PAS

Clinical Decision Rule to Identify Children at **Low Risk** for Appendicitis

Eight weighted criteria for total of 12 points

1. WBC >10 X 10⁹/L = 1 point
2. Polymorphonuclear leukocytes (>75%) = 1 point
3. Nausea or vomiting = 1 point
4. Anorexia = 1 point
5. Rebound pain = 1 point
6. History of migration of pain to RLQ = 2 points
7. Focal RLQ pain = 2 points
8. Temperature > 38.5 degrees Celsius = 1 point

- Higher the score higher the chance of having appendicitis
- Score 1-4 Low-risk of having appendicitis

Case of SDS

- 12 yo Asian female presents to the ED
- CC: Abdominal pain
- HPI: 1 day of abdominal pain
  - Location of pain: Initially at umbilicus and now RLQ
  - Increasing intensity
  - Nausea, no vomiting
- PMH: Healthy female, No previous hospitalizations, no previous surgeries
- Immunizations: UPD, HSV, Mumps, None
- V/C: T 38.5 PO, PP14, BP 120/80
- Wt: 45 kg (50th %ile), 155 cm HT (75th %ile)
- General: Quiet child holding her cell phone
- Chest: BS clear and equal, RRR, no murmur
- Abdomen: Soft, distended, + stethoscope sign RLQ
- Labs: WBC 12, Neutrophils 86%, Electrolytes low CO₂, Urinalysis WNL, Urine HCG neg
- Radiologic: US 8 mm, non-compressible, no appendicolith

Question

What differential diagnoses are you considering?
A. Appendicitis
B. Urinary Tract Infection
C. Ovarian Torsion
D. Gastroenteritis
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Question
What are treatment options?
A. IV Antibiotics
B. Appendectomy
C. IV Antibiotics and Appendectomy
D. IV Antibiotics and Interval Appendectomy

No Surgery for Acute Appendicitis
• 10 studies to date have been reported evaluating non-operative management in children
• Success rates range from 75-80% for antibiotics alone
• Increased rates of perforated appendix for failure subgroup

No Surgery for Appendicitis
• Inclusion Criteria
  – 7-17 years old
  – Abdominal pain less than 48 hours with no history of chronic AP
  – Labs
    • WBC 5-18
  – Imaging
    • Hyperemia ≤ 1.1 cm in diameter, compressible or non-compressible, no abscess, no fecolith/appendicolith, no phlegmon
    • No preoperative concern for perforation
    • No diffuse peritonitis
    • Not pregnant
    • None-study: No malignancy, not currently taking antibiotics

No Surgery for Appendicitis
• Study treatment includes 10 days of antibiotics
  – 2 days in the hospital
  – Feed after 12 hours of symptoms stable or improving

Lurie No Surgery for Appendicitis
• Participated in the study for 1 year as part of the Midwestern Pediatric Surgery Consortium
• N=36 (25% of subjects have received IV antibiotics and no OR)
• Phone follow-up for antibiotic subjects at 2 to 5 days after discharge and at 2 weeks and by Nationwide Children’s at 1 month, 6 month and a year
• To date, no antibiotic subjects have “failed” at Lurie
  – 1 in 4 will fail
Case of SDS

- Parents elect to have an appendectomy
- Child noted to have acute appendicitis
- Post-op care
  - No more antibiotics
  - IV fluids until drinking "well" and have voided
  - OOB and ambulate ASAP
  - Lots of pain meds

Same Day Discharge

- Current evolving standard for acute appendicitis
  - Lurie LOS 20 hours
  - Goal per standards 6 hours
  - Strive for earlier OR times
  - Can be all about patient and family expectations
  - Pain management
    - SAM's strategy give lots IV and discharge with some PO opioid (Hydrocodone and Norco, NEVER Codeine, and rarely Ultram)
    - Get opioid in hand early in the post-op trajectory
    - Others "should be comfortable on PO before discharge"
  - Follow up
    - Often now by phone

Case of PA: When things get tricky

- 4 yo Hispanic male presents to the ED
- CC: Abdominal pain
- HPI:
  - 3 days of abdominal pain
  - Increasing intensity
  - Increase pain with walking
  - Location of pain: RLQ
  - Nausea, no vomiting
- PMH: Healthy male with exercise induced asthma, No previous hospitalizations, no previous surgeries
- Immunizations: UTD, NEDSA, Meds: Albuterol prn wheezing last dosed three months ago
- VS: T 39, HR 122, RR 28, BP 110/60
- Wt: 13.8 kg (60th %ile), HT 96.5 cm (90th %ile)
- General: Tired appearing male
- Chest: BBS clear, RRR
- Abdomen: Soft, distended, diffusely tender
- Labs: WBC 17, Neutrophils 85%, Lymphs 10%, ANC 14.45, Electrolytes WNL, Urinalysis WNL

Perforated (Complicated) Appendicitis

- Complicated Appendicitis is defined as the presence of an abscess, phlegmon or free fluid on radiologic imaging or noted at the time of operation
- Time from start of symptoms till perforation is 24-36 hours
- Research efforts on complicated appendicitis are focusing on reducing antibiotic duration
- The rates of perforation have been nearly the same in the past 10-15 years

Factors Increasing Risk of Perforation

- Age
- Gender
- Socioeconomic status
- Ethnic and racial background
Question
What would be the next step in making an appropriate diagnosis?
A. STAT surgical consult
B. Abdominal Ultrasound
C. Abdomen and Pelvis CT scan
D. Observation

Imaging Options
- US abdomen
- CT scan
  - “Appy”
  - Abdomen
  - Abdomen and pelvis
- MR abdomen

Ultrasound Abdomen

CT Scan
MR Abdomen

- No ionizing radiation
- High sensitivity and specificity
- Lack of availability in many hospitals
- High cost
- Motion sensitivity (may require sedation for younger children)

Treatment Plan

- Antibiotics only
- Antibiotics followed by interval appendectomy
- OR for laparoscopic appendectomy
- IR for drainage of abdominal abscess followed by interval appendectomy

Antibiotics only

- Daily Ceftriaxone and Flagyl (24 hour dosing)
- Transition to oral antibiotics when afebrile, tolerating a diet, pain improved
- Oral antibiotics: Augmentin X 7-10 days
- No surgical removal of the appendix

Antibiotics followed by interval appendectomy

- Daily Ceftriaxone and Flagyl
- Transition to oral antibiotics when afebrile, tolerating a general diet and pain improved
- Oral antibiotics: Augmentin to complete a 7 day course
- Laparoscopic interval appendectomy in 6-8 weeks
Appendectomy at time of presentation
- Daily Ceftriaxone and Flagyl x 3-5 days
- Laparoscopic appendectomy
- Post operative pain control with Tylenol, Toradol, Morphine
- Advance diet as tolerated
- Discharge home when afebrile, pain well controlled with oral pain medication and tolerating a diet
- Transition to oral antibiotics for discharge home to complete a 5-7 day course

IR drainage of abscess
- Daily Ceftriaxone and Flagyl
- IR drainage of abscess
- TPA to drain if concerns for retained abscess
- Drain remains in place approximately 2-4 days
- Home on oral antibiotics when drain is removed, afebrile, eating a general diet and pain improved
- Oral antibiotics: Augmentin to complete a 5-7 day course
- +/- interval appendectomy in 6-8 weeks

Back to the Case of PA
- Underwent an immediate laparoscopic appendectomy for perforated appendicitis
- Ceftriaxone and Flagyl daily dosing
- POD #3 Afebrile, vomiting, diarrhea, continuing to have abdominal pain
- POD #5 CT scan with IV and PO contrast
- POD #6 IR drainage of an intraabdominal abscess
- POD #8 IR drain removed and was transitioned to oral Augmentin
- POD #9 Discharged home to complete a 7 days course of Augmentin from time of IR drainage

Post perforated Appendicitis Complications
- Complications rates for perforated appendicitis is approximately 10-20%
  - Abscess formation
  - Bowel obstruction
  - Bowel fistula formation
  - Wound infection

WHEN TO IMAGE, THAT IS THE QUESTION??
- Onset of new fever
- Not tolerating a diet on POD #3 image on POD #5
- POD #5 if still having fever, abdominal pain, decreased PO intake
- POD #7 if still having fever, abdominal pain, decreased PO intake
- No need to image
  - POD #5 if elevated CBC and no other symptoms
  - POD #7 if elevated CBC and no other symptoms

***No rates are risk- or demographic-adjusted***
Post-operative IR Drainage of Intraabdominal Abscess

- US guided drain placement
- Anaerobic and aerobic cultures obtained
  - E. coli
  - Bacteroides
  - Klebsiella
  - C. difficile
  - Enterobacter
  - Pseudomonas
- Drain remains in place till output decreases
- Occasional TPA instillation

A lot of Work to be Done!

- No consensus exists on optimal management of complicated appendicitis
- Decrease the rate of perforated appendicitis
- Develop standard treatment protocols
  - Initial imaging
  - Antibiotics
  - Length of antibiotics
  - Repeat imaging

References


References


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