Appendicitis/ Abdominal Pain: Emergency Department Evaluation
Clinical Practice Guideline (CPG)

Clinical Practice Guideline
Protocol Approved by: Division of Pediatric Emergency Medicine, Pediatric Radiology and Pediatric Surgery
Date of Approval: 2/09, 8/14, 12/16, 07/18
Suspected Appendicitis/ Abdominal Pain Evaluation and Management

History and Physical Exam

Suspected diagnosis of Appendicitis

EXCLUDE
* Bloody stool
* Acute pelvic disease (PID, pregnancy)
* Known GI disease

Triage
* Vital signs
* Calculate BMI

Diagnostic studies
* CBC with differential
* HCG* (If >11 years or post menarcheal)
* In urine if sexually active
* In serum if not sexually active

Pain Management
* IV line
* IVFs
* Antiemetics
* Analgesics (Based on pain score protocol)

Females: Suspected ovarian pathology

Transabdominal/Transvag pelvic Ultrasound (US)*

US: +Ovarian torsion or ruptured cyst

US: Normal ovary equivocal appendix

ALVARADO SCORE

Surgery Consult

Unlikely Appendicitis
Score ≤ 4

* Look for other causes of abdominal pain
* Pain management

Possible Appendicitis
Score 5-6

BMI ≤ 85th percentile and before 5pm

BMI > 86th percentile or after 5pm

Probable/Likely Appendicitis
Score ≥ 7

Surgery Consult†
Senior surgical evaluation within 30 min

Additional studies as clinically indicated
* CMP
* Urinalysis
* CRP
* Lipase

†If at an outside hospital: Transfer all patients with score ≥ 5 to CGCH for evaluation.
The Transabdominal/Transvaginal pelvic Ultrasound (US) is available after normal business hours for females ONLY under suspicion of ovarian pathology. Avoid emptying the bladder for a urine HCG if a Pelvic US is likely to be ordered. Order a RLQ ED US to visualize appendix and rule out appendicitis.

Confirm availability of ultrasound technician as per institutional regulations and schedule.

If at an outside SSM Health hospital, transfer all patients with an Alvarado score ≥ 5 to Cardinal Glennon Children’s Hospital without imaging. Follow Appendicitis/Abdominal Pain clinical practice guideline prior to surgery consult.
Appendicitis Definition
Appendicitis is caused by obstruction of the appendix from either inflammation in the intestinal wall, lymphoid hyperplasia, fecolith or less commonly by calculus, tumor, foreign body or parasites. It is characterized by diffuse periumbilical or central abdominal pain followed by migration of pain to the right lower quadrant, nausea, vomiting and fever.

Appendicitis/Abdominal pain Clinical Practice Guideline Application
This guideline was developed for the evaluation and management of previously healthy children with suspected appendicitis (typically with right lower quadrant pain). Consider other causes of right lower quadrant pain in your differential diagnosis, including (but not limited to): urologic disease (ie. renal calculus), ovarian pathology (ie. torsion, tubo-ovarian abscess) and other gastrointestinal pathology (ie. colitis). This guideline does not apply to children with history of appendectomy, bloody stools, acute pelvic disease (pelvic inflammatory disease, pregnancy) or known history of gastrointestinal disease such as past medical history of chronic diseases like chronic abdominal pain, abdominal migraine, cystic fibrosis, inflammatory bowel disease, immunodeficiency, including those with HIV infection or recipients of solid organ or hematopoietic stem cell transplant.

Alvarado Score
The Alvarado score is a clinical scoring system used to determine the likelihood of acute appendicitis. The score has 6 clinical items and 2 laboratory measurements with a total of 10 points.

<table>
<thead>
<tr>
<th>Mnemonic (MANTRELS)</th>
<th>Value</th>
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<tbody>
<tr>
<td><strong>Symptoms</strong></td>
<td></td>
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<tr>
<td>Migration of pain to the Right Lower Quadrant</td>
<td>1</td>
</tr>
<tr>
<td>Anorexia</td>
<td>1</td>
</tr>
<tr>
<td>Nausea or vomiting</td>
<td>1</td>
</tr>
<tr>
<td><strong>Signs</strong></td>
<td></td>
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<tr>
<td>Right Lower Quadrant tenderness</td>
<td>2</td>
</tr>
<tr>
<td>Rebound tenderness</td>
<td>1</td>
</tr>
<tr>
<td>Elevated temperature (37.3°C or 99.1°F)</td>
<td>1</td>
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<tr>
<td><strong>Laboratory findings</strong></td>
<td></td>
</tr>
<tr>
<td>Leukocytosis &gt; 10,000 WBC/µL</td>
<td>2</td>
</tr>
<tr>
<td>Leukocyte left shift (neutrophils &gt; 75%)</td>
<td>1</td>
</tr>
</tbody>
</table>

Total Score
A score of less than 4 is consistent with unlikely appendicitis (Sens 96%, Spec 67%), a score of 5 or 6 is compatible with possible appendicitis (Sens 36%, Spec 94%), and a score of 7 to 8 indicates probable appendicitis (Sens 89%, Spec 100%, Positive predictive value 93%).

Additional laboratory studies for consideration
| CMP | Evaluation of electrolytic imbalance, elevated liver enzymes (transaminitis) and hypoalbuminemia. |
| Lipase | Evaluation of pancreatitis. Lipase level must be at least 3 times the normal value. |
| C-reactive protein (CRP) | May be used as an adjuvant to evaluate suspected acute appendicitis.  
• Alone: Sensitivity 77%, Specificity 52%, PPV 59%, NPV 71%  
• Alvarado score (AS) + CRP: Sens 50%, Spec 89%, PPV 74%, NPV 74%  
• Highest degree of diagnostic accuracy for complicated appendicitis |
| Urinalysis | Evaluation of urinary tract infection, renal calculus and ureterolithiasis. |
### Diagnostic Imaging

<table>
<thead>
<tr>
<th>Test Description</th>
<th>Procedure Details</th>
<th>Abnormal Findings Consistent with Acute Appendicitis</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| **Graded Compression Ultrasonography (US)** | Performed by applying continuous pressure with the transducer in the right lower quadrant during transabdominal ultrasound. It is particularly useful in women of child-bearing age when diagnosis is unclear. | - Appendiceal diameter > 6 mm  
- No compressibility of appendix  
- Collection of fluid surrounding the appendix  
- Sensitivity 85-90%, Specificity 92-96% | Safe, relatively inexpensive, can rule out pelvic diseases in females, better for children | Operator dependent, technically inadequate study due to gas, pain and obesity |
| **Computed Tomography (CT) Scan of Abdomen and Pelvis with IV Contrast** | **Main indication**: Suspected Acute Appendicitis without perforation  
- Very sensitive and specific for appendicitis  
- Confirmatory test of choice in equivocal situations  
- Accuracy >90%, Sensitivity 90-100%, Specificity 95-97% | More accurate, better identification of phlegmon, abscess, better identification of normal appendix | Cost, ionizing radiation, contrast use |
| **CT Abdomen and Pelvis with IV and Oral Contrast** | **Main indication**: Suspected Acute Appendicitis with perforation, or when considering alternative diagnoses, including Crohn’s disease or infectious colitis. | More accurate, better identification of phlegmon, abscess | Cost, ionizing radiation, contrast use |
| **Magnetic Resonance Imaging (MRI) Abdomen and Pelvis without Contrast** | **Main indication**: Suspected Acute Appendicitis, scan fields cover lung bases through pelvis.  
- Perform in children ≥ 4 years old (if able to hold still and cooperate)  
- Exam length with breath holds (i.e. patient able to hold their breath on command) about 15-20 minutes  
- Alternative diagnoses detected in ~20% of cases  
- Sensitivity 92-99%, Specificity 73-99% | Comparable alternative to CT, lack of ionizing radiation, ability to perform without sedation, no need for oral/IV contrast, similar sensitivity to US for ovarian pathology | Limited availability after normal business hours |

### Considerations when ordering diagnostic imaging in EPIC at Cardinal Glennon Children’s Hospital

#### “US ER RLQ pain”
- This study is available anytime of day or night for females ONLY under suspicion of ovarian pathology.  
- Order to evaluate the presence of Acute Appendicitis.  
- This study will evaluate the right lower quadrant for appendicitis.  
- Bilateral kidneys, gallbladder, liver and pancreas, ovaries and uterus (females) may be visualized by specifically directing the technologist to look at these structures. The ordering physician needs to modify the US order to visualize additional organs.  
- For females who are NOT sexually active, the bladder must be FULL.
Before ordering this study (for further details, see “Pelvic Ultrasound”). DO NOT order this study until the bladder is full.

- For females who are sexually active, the bladder does NOT need to be full for the transvaginal portion of this study (for further details, see “Pelvic Ultrasound”). May order this study without a full bladder.
- When ordering this study, there is NO need to order a Pelvic US (the US technologists will transform this order in EPIC to match the limited studies performed).

**Pelvic Ultrasound**

- This study should be ordered separately ONLY as clinical suspicion dictates for underlying pelvic disease.
- It DOES NOT need to be ordered as part of “US ER RLQ pain”
- When ordering this US as separate study, order as follows:
  * “Pelvic (US Pelvis with Transvag and Doppler)
    - For sexually active females ONLY
    - Bladder may be empty for this study
  * “Pelvic (US Pelvis with Doppler Uterus Ovaries)
    - Avoid emptying the bladder for a urine HCG if a Pelvic US is likely to be ordered
    - For non-sexually active females ONLY
    - Must have a full bladder to perform Transabdominal Pelvic US
  * Physician/RN to perform bladder scan prior to ordering Transabdominal Pelvic US
    - Obtain the bladder volume by measuring the bladder in 3 planes
    - Formula = (length x width x height of bladder)/2
    - Minimal bladder volume (mL) = [Age (years) +2] x 30
    - Minimal for adult/teenager = 400-600 mL

If the bladder is not full, follow the following protocol:

1. **Begin filling the patient’s bladder** by starting normal saline or 5% dextrose in normal saline bolus of 20-40 mL/kg to run over 30 minutes. Inform the family of the importance of a sufficiently full bladder to obtain an accurate study.
2. After confirming a full bladder by bladder scan, order the Transabdominal Pelvic US as above and then contact the radiology department and inform them of the order for Transabdominal Pelvic US and of the need to call in the on-call ultrasound technologist (if after normal business hours).
3. **When the ultrasound technologist calls for the patient**, transfer her to the radiology department with an appropriate size Foley catheter and inform the family and patient that the bladder is not sufficiently full for the study, then the Foley will need to be inserted to complete filling the bladder. **If the ultrasound technologist assesses that the bladder is not full, the emergency department nurse will be responsible for placing the Foley catheter in the US Suite.**

**Treatment considerations**

<table>
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<tr>
<th>Antiemetics</th>
<th>Ondansetron 0.15mg/kg IV every 6 hours, Max: 4 mg/dose</th>
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<tbody>
<tr>
<td>Analgesia (Pain protocol,</td>
<td>Toradol 0.5 mg/kg IV every 6 hours, Max: 15 mg/dose</td>
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<td>Morphine sulfate 0.1 mg/kg IV every 2-4 hours, Max: 8 mg/dose</td>
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Antibiotics

Pre-operative antibiotics are indicated for ALL patients with appendicitis. Single dose for **uncomplicated appendicitis**, continued antibiotic regimen for complicated/perforated appendicitis.

**Non-penicillin-allergic patients**
- Ceftriaxone 50 mg/kg/day IV (Max. 2 grams per dose)
- Metronidazole 30 mg/kg/day IV every 8 hours (Max. 500 mg per dose)
  
  Dose adjustment for GFR ≤ 10 mL/min/m² or severe hepatic impairment

**Penicillin-allergic patients**
- Metronidazole 30 mg/kg/day IV every 8 hours (Max. 500 mg per dose)
  
  Dose adjustment for GFR ≤ 10 mL/min/m² or severe hepatic impairment
- Ciprofloxacin 15 mg/kg/dose IV every 12 hours (Total 20-30 mg/kg/day)
  
  (Max. 400 mg per dose)
  
  Dose adjustment for renal impairment (GFR < 50mL/min/1.73m²)

Use at physician’s discretion for critically ill, immunocompromised or failed previous antibiotic regimen in non-penicillin-allergic patients.

Piperacillin/tazobactam (Zosyn) – Dosing based on piperacillin component

- Infants 2-9 months 80 mg/kg/dose IV every 8 hours
- Children > 9 months and ≤ 40 kg 100 mg/kg/dose IV every 8 hrs
  
  (Max. 3 grams per dose)
- Children > 40 kg 3 grams IV every 6 hours
  
  Dose adjustment for renal impairment (GFR < 50mL/min/1.73m²)

**Goals and Metrics**
- Encourage use of Alvarado score
- Decrease overuse of imaging: Proportion of CT, US, no imaging prior to OR
- Treatment: IVFs, analgesia, antibiotics, antiemetics
- Time to treatment: analgesia, antibiotics
- Time to consult of surgery service
- Decrease ED length of stay and revisit rate

**References**


