

## Appendicitis

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# What is a Clinical Pathway?

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An evidence-based guideline that decreases unnecessary variation and helps promote safe, effective, and consistent patient care.

# Objectives of Pathway

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- To standardize care of patients with both acute simple (non-perforated) appendicitis, complicated (acute perforated) appendicitis in the pediatric population
- To delineate guidelines on when to consider operative vs non-operative management
- To standardize care of patients with operative and non-operative management
- To provide evidence-based recommendations for key elements of care for appendicitis
- To clearly delineate discharge criteria and instructions

# Why is Pathway Necessary?

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- Abdominal pain is a common reason for presentation to the Emergency Department, pediatric and surgical offices
- Appendicitis is a common surgical etiology for this type of pain.
- American Pediatric Surgical Association has altered their guidelines to help decrease the following:
  - number of CT scans used for diagnosis
  - inappropriate antibiotic choices and duration
  - need for inpatient management post-operatively
- Pathway was developed to ensure an optimal consistent approach to the surgical management of children who present with appendicitis

# Epidemiology of Appendicitis

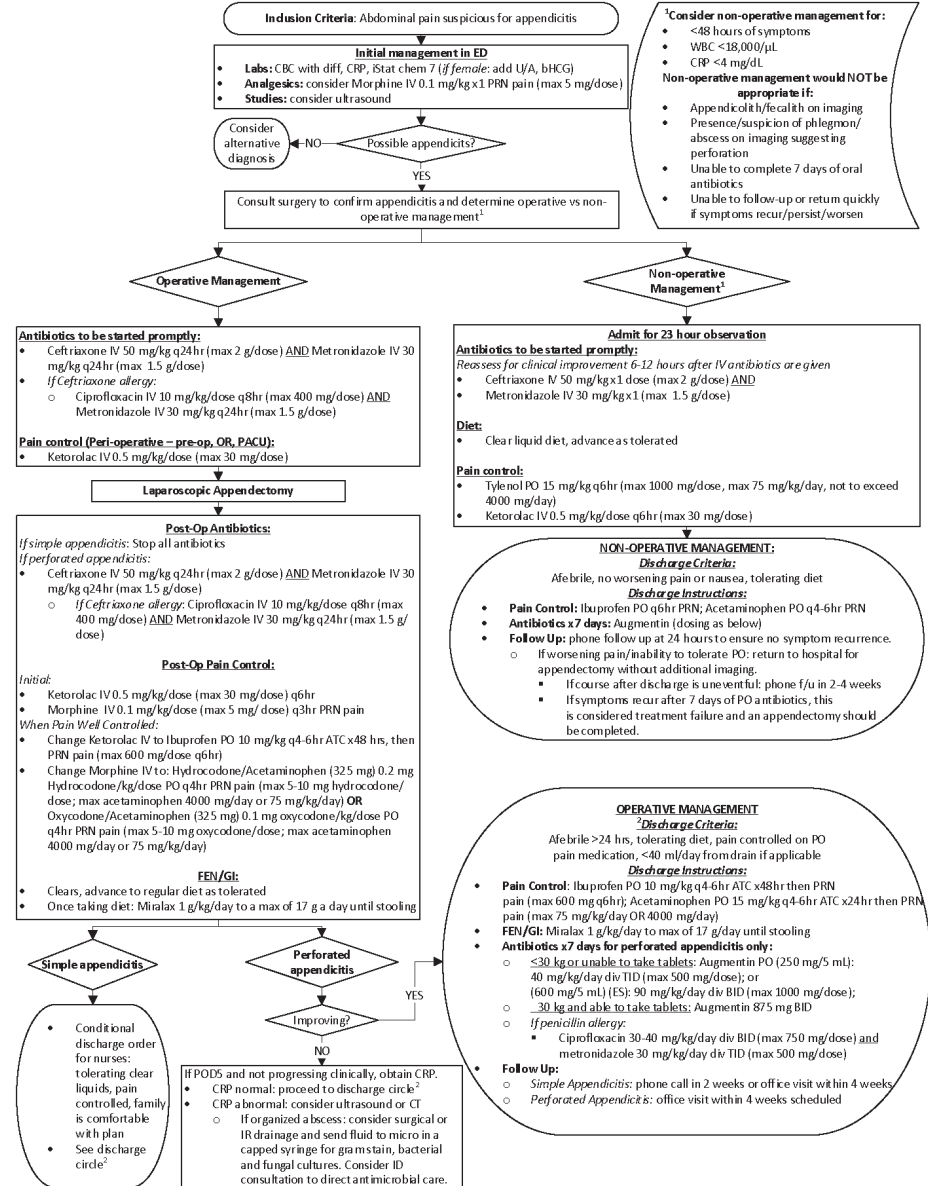


- Overall lifetime risk is 8.6% in males, 6.7% in females
- Luminal obstruction that subsequently leads to infection
  - Fecaliths are the most common cause; however the cause of the obstruction may not always be clear
  - Hyperplasia of appendiceal lymphoid follicles
  - Associated with :
    - Bacterial Infections: Yersinia, Salmonella, Schistosoma, Enterobius, Ascaris
    - Viral Infections: Measles, Chicken Pox, CMV

- Improved outcomes  $\neq$  Increased resource utilization
- Good evidence-based recommendations to guide care include:
  - Ultrasound as first line imaging approach for diagnosis
  - Once daily dosing for antibiotics (ceftriaxone/metronidazole)
  - Post-op labs/imaging should be minimized
  - TPN is not beneficial in the majority of cases

# CLINICAL PATHWAY: Appendicitis

THIS PATHWAY  
SERVES AS A GUIDE  
AND DOES NOT  
REPLACE CLINICAL  
JUDGMENT.



This is the Appendicitis Clinical Pathway.  
We will be reviewing each component in the following slides.

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Initial management in the ED includes obtaining screening labs, managing pain, and considering obtaining an ultrasound to help determine potential for appendicitis.

**Inclusion Criteria: Abdominal pain suspicious for appendicitis**

**Initial management in ED**

- **Labs:** CBC with diff, CRP, iStat chem 7 (if female: add U/A, bHCG)
- **Analgesics:** consider Morphine IV 0.1 mg/kg x1 PRN pain (max 5 mg/dose)
- **Studies:** consider ultrasound

**Possible appendicitis?**

**Antibiotics to be started promptly:**

- Ceftriaxone IV 50 mg/kg q24hr (max 2 g/dose) AND Metronidazole IV 30 mg/kg q24hr (max 1.5 g/dose)
- If Ceftriaxone allergy:
  - Ciprofloxacin IV 10 mg/kg/dose AND Metronidazole IV 30 mg/kg/dose

**Pain control (Peri-operative = pre-op, OR, PACU):**

- Ketorolac IV 0.5 mg/kg/dose (max 30 mg/dose)

**Admit for 23 hour observation**

**Antibiotics to be started promptly:**

- Ceftriaxone IV 50 mg/kg x1 dose (max 2 g/dose) AND Metronidazole IV 30 mg/kg x1 (max 1.5 g/dose)

**Pain control:**

- Tylenol PO 15 mg/kg q6hr (max 1000 mg/dose, max 75 mg/kg/day, not to exceed 4000 mg/day)
- Ketorolac IV 0.5 mg/kg/dose q6hr (max 30 mg/dose)

**Laparoscopic Appendectomy**

**Post-Op Antibiotics:**

If simple appendicitis: Stop all antibiotics

If perforated appendicitis:

- Ceftriaxone IV 50 mg/kg q24hr (max 2 g/dose) AND Metronidazole IV 30 mg/kg q24hr (max 1.5 g/dose)
- If Ceftriaxone allergy: Ciprofloxacin IV 10 mg/kg/dose q8hr (max 400 mg/dose) AND Metronidazole IV 30 mg/kg q24hr (max 1.5 g/dose)

**Post-Op Pain Control:**

**Initial:**

- Ketorolac IV 0.5 mg/kg/dose (max 30 mg/dose) q6hr
- Morphine IV 0.1 mg/kg/dose (max 5 mg/dose) q3hr PRN pain

**When Pain Well Controlled:**

- Change Ketorolac IV to Ibuprofen PO 10 mg/kg q4-6hr ATC x48 hrs, then PRN pain (max 600 mg/dose q6hr)
- Change Morphine IV to: Hydrocodone/Acetaminophen (32.5 mg/0.2 mg Hydrocodone/kg/dose PO q4hr PRN pain (max 5-10 mg hydrocodone/dose; max acetaminophen 4000 mg/day) OR Oxycodone/Acetaminophen (32.5 mg/0.1 mg oxycodone/kg/dose PO q4hr PRN pain (max 5-10 mg oxycodone/dose; max acetaminophen 4000 mg/day or 75 mg/kg/day)

**FEN/GI:**

- Clears, advance to regular diet as tolerated
- Once taking diet: Miralax 1 g/kg/day to a max of 17 g a day until stooling

**NON-OPERATIVE MANAGEMENT:**

**Discharge Criteria:**

Afebrile, no worsening pain or nausea, tolerating diet

**Discharge Instructions:**

- **Pain Control:** Ibuprofen PO q6hr PRN; Acetaminophen PO q4-6hr PRN
- **Antibiotics x 7 days:** Augmentin (dosing as below)
- **Follow Up:** phone follow up at 24 hours to ensure no symptom recurrence.
  - If worsening pain/inability to tolerate PO: return to hospital for appendectomy without additional imaging.
    - If course after discharge is uneventful: phone f/u in 2-4 weeks
    - If symptoms recur after 7 days of PO antibiotics, this is considered treatment failure and an appendectomy should be completed.

**OPERATIVE MANAGEMENT**

**Discharge Criteria:**

Afebrile >24 hrs, tolerating diet, pain controlled on PO pain medication, <40 ml/day from drain if applicable

**Discharge Instructions:**

- **Pain Control:** Ibuprofen PO 10 mg/kg q4-6hr ATC x48hr then PRN pain (max 600 mg q6hr); Acetaminophen PO 15 mg/kg q4-6hr ATC x24hr then PRN pain (max 75 mg/kg/day OR 4000 mg/day)
- **FEN/GI:** Miralax 1 g/kg/day to max of 17 g/day until stooling
- **Antibiotics x 7 days for perforated appendicitis only:**
  - ≤30 kg or unable to take tablets: Augmentin PO (250 mg/5 mL): 40 mg/kg/day div TID (max 500 mg/dose); or (600 mg/5 mL) (ES): 90 mg/kg/day div BID (max 1000 mg/dose);
  - ≥30 kg and able to take tablets: Augmentin 875 mg BID
  - If penicillin allergy:
    - Ciprofloxacin 30-40 mg/kg/day div BID (max 750 mg/dose) and metronidazole 30 mg/kg/day div TID (max 500 mg/dose)
- **Follow Up:**
  - Simple Appendicitis: phone call in 2 weeks or office visit within 4 weeks
  - Perforated Appendicitis: office visit within 4 weeks scheduled

**Simple appendicitis**

- Conditional discharge order for nurses: tolerating clear liquids, pain controlled, family is comfortable with plan
- See discharge circle<sup>2</sup>

**Perforated appendicitis**

Improving?

YES

NO

If POD5 and not progressing clinically, obtain CRP.

- CRP normal: proceed to discharge circle<sup>2</sup>
- CRP abnormal: consider ultrasound or CT
  - If organized abscess: consider surgical or IR drainage and send fluid to micro in a capped syringe for gram stain, bacterial and fungal cultures. Consider ID consultation to direct antimicrobial care.

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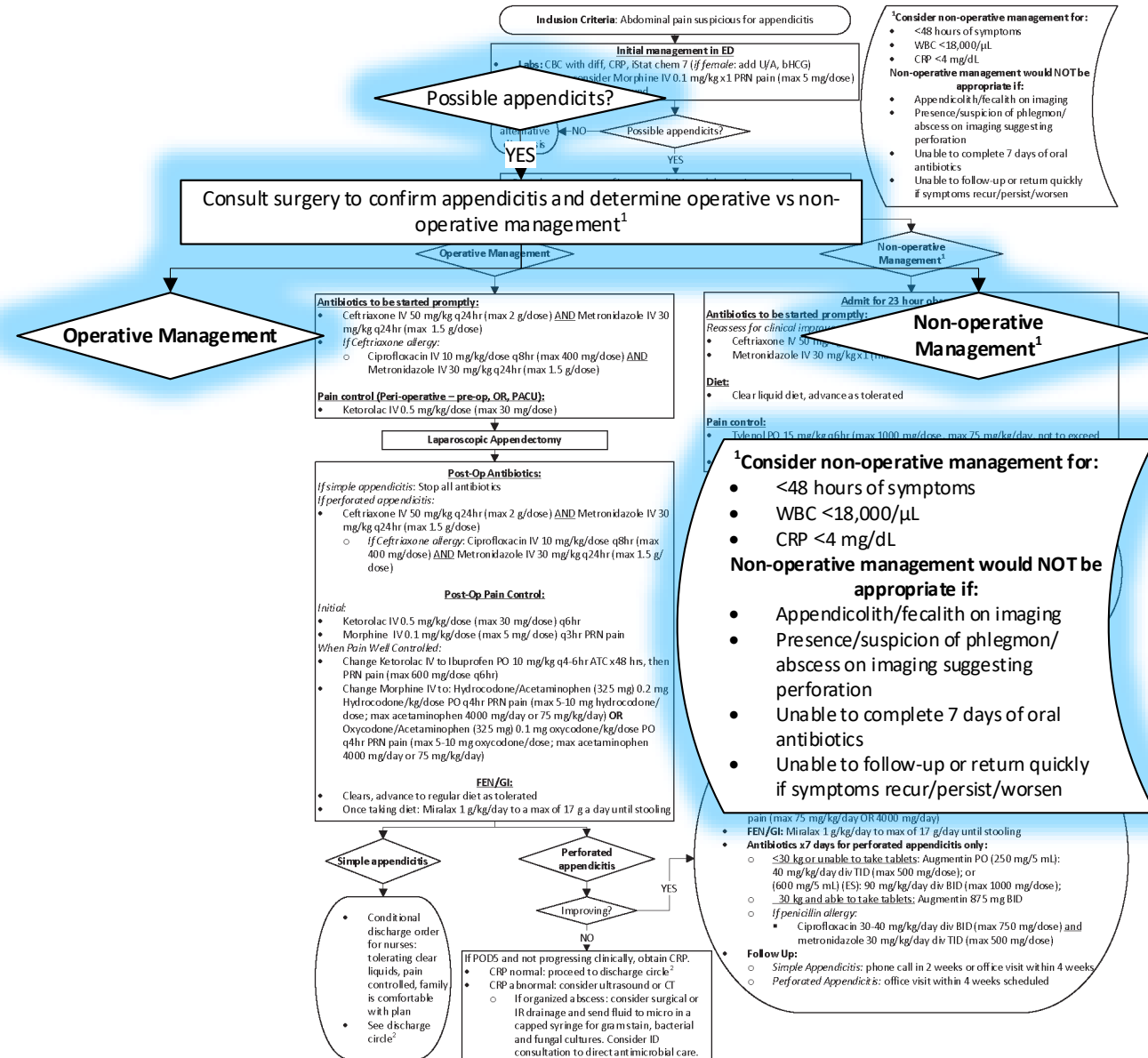




**CLINICAL PATHWAY:**  
**Appendicitis**

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- If appendicitis is suspected, consult surgery to confirm the diagnosis.
- Surgery will decide on operative vs non-operative management based on certain criteria.
- Non-surgical management should be considered based on duration of symptoms and reassuring WBC and CRP.
- Criteria have been outlined for when non-operative management would NOT be appropriate.



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## Non-Operative Management

If the patient meets criteria for non-operative management, admit for 23 hour observation

- IV Antibiotics should be started promptly
- Reassessment should be done every 6-12 hrs after IV antibiotics given
- Pain should be controlled and diet should be advanced as tolerated
- Upon discharge, antibiotics should continue for 7 days with follow up at 24 hours.
- Guidance is given for further management, including surgical intervention if necessary.



**Initial management in ED**

- Labs: CBC with diff, CRP, (Stat  $\alpha$ -fetoprotein 7 (if female: add U/A, bHCG)
- Analgesics: consider Morphine 0.1 mg/kg x1 PRN (max 5 mg/dose)

**Consider non-operative management for:**

- <48 hours of symptoms
- WBC <18,000/ $\mu$ L
- CRP <4 mg/dL

Non-operative management would NOT be

### Admit for 23 hour observation

**Antibiotics to be started promptly:**

Reassess for clinical improvement 6-12 hours after IV antibiotics are given

- Ceftriaxone IV 50 mg/kg x1 dose (max 2 g/dose) AND
- Metronidazole IV 30 mg/kg x1 (max 1.5 g/dose)

**Diet:**

- Clear liquid diet, advance as tolerated

**Pain control:**

- Tylenol PO 15 mg/kg q6hr (max 1000 mg/dose, max 75 mg/kg/day, not to exceed 4000 mg/day)
- Ketorolac IV 0.5 mg/kg/dose q6hr (max 30 mg/dose)

### NON-OPERATIVE MANAGEMENT:

**Discharge Criteria:**

Afebrile, no worsening pain or nausea, tolerating diet

**Discharge Instructions:**

- **Pain Control:** Ibuprofen PO q6hr PRN; Acetaminophen PO q4-6hr PRN
- **Antibiotics x7 days:** Augmentin (dosing as below)
- **Follow Up:** phone follow up at 24 hours to ensure no symptom recurrence.
  - If worsening pain/inability to tolerate PO: return to hospital for appendectomy without additional imaging.
    - If course after discharge is uneventful: phone f/u in 2-4 weeks
    - If symptoms recur after 7 days of PO antibiotics, this is considered treatment failure and an appendectomy should be completed.

• Conditional discharge order for nurses: tolerating clear liquids, pain controlled, family is comfortable with plan

• See discharge circle<sup>2</sup>

**IF POD5 and not progressing clinically, obtain CRP.**

- CRP normal: proceed to discharge circle<sup>2</sup>
- CRP abnormal: consider ultrasound or CT
  - If organized a bscs: consider surgical or IR drainage and send fluid to micro in a capped syringe for gram stain, bacterial and fungal cultures. Consider ID consultation to direct antimicrobial care.

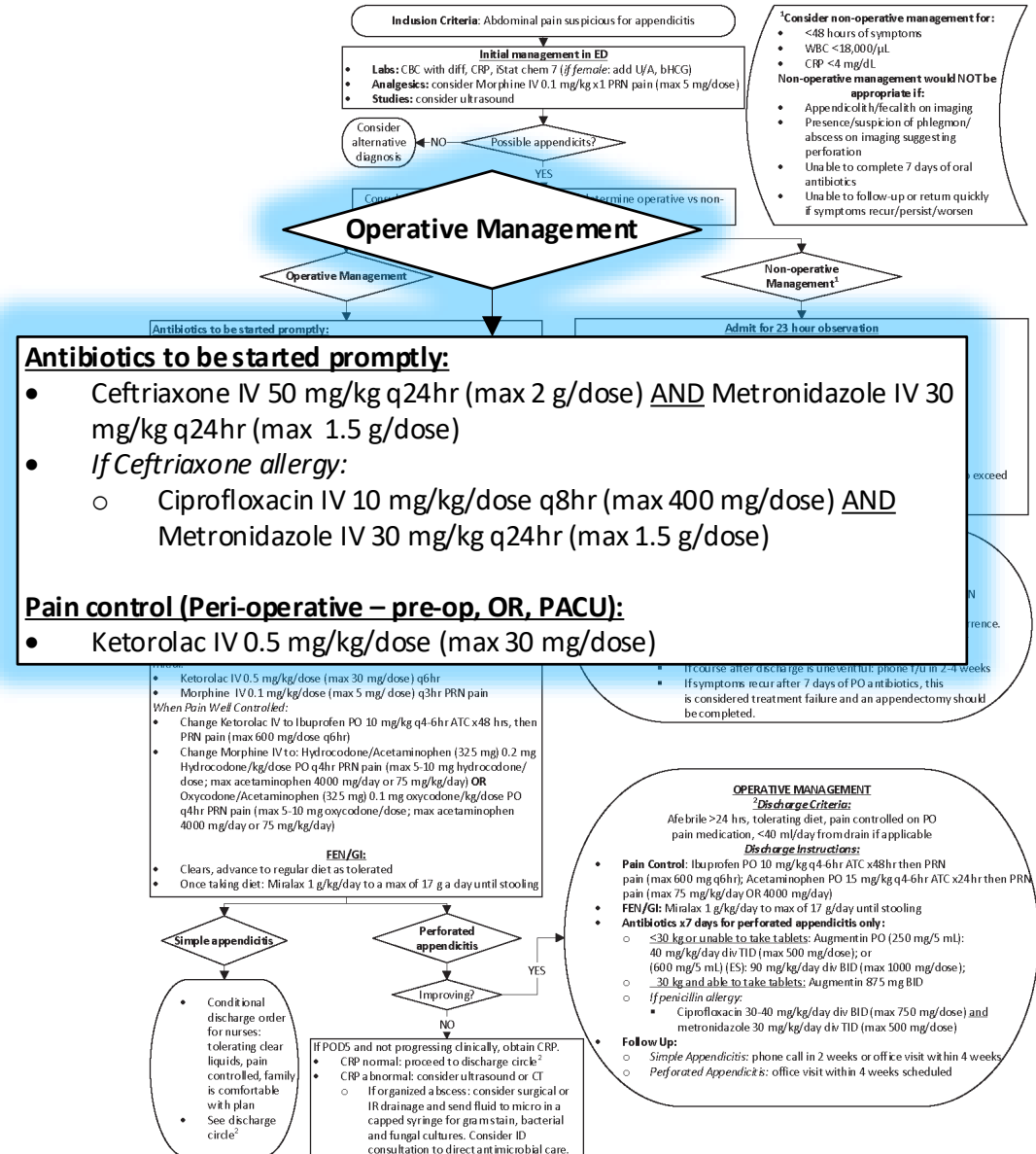
**Follow Up:**

- Simple Appendicitis: phone call in 2 weeks or office visit within 4 weeks
- Perforated Appendicitis: office visit within 4 weeks scheduled

## Operative Management

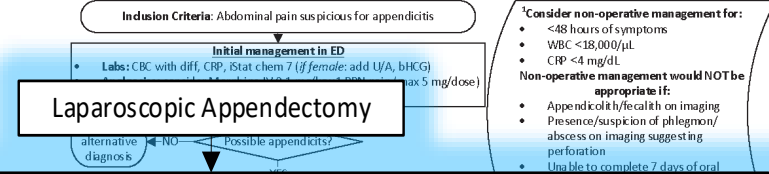
If the patient meets criteria for operative management:

- Surgery to give the “OK” for ED provider to order Ceftriaxone AND Metronidazole prior to incision
  - If Penicillin and/or Ceftriaxone allergy, use Ciprofloxacin AND Metronidazole
- Peri-operative pain control includes Ketorolac



## Operative Management

- After laparoscopic appendectomy, post-op antibiotics are only given if there is a perforated appendicitis. Otherwise, antibiotics are not indicated and should be discontinued.
- It is important to continue to assess pain level and adjust medications as needed
- Diet should be advanced as tolerated; miralax should be started and continued until the patient is stooling



### Post-Op Antibiotics:

*If simple appendicitis:* Stop all antibiotics

*If perforated appendicitis:*

- Ceftriaxone 50 mg/kg q24hr (max 2 g/dose) AND Metronidazole 30 mg/kg q24hr (max 1.5 g/dose)
  - *If Ceftriaxone allergy:* Ciprofloxacin 10 mg/kg/dose q8hr (max 400 mg/dose) AND Metronidazole 30 mg/kg q24hr (max 1.5 g/dose)

### Post-Op Pain Control:

*Initial:*

- Ketorolac 0.5 mg/kg/dose (max 30 mg/dose) IV q6hr
- Morphine 0.1 mg/kg/dose (max 5 mg/dose) IV q3hr PRN pain

*When Pain Well Controlled:*

- Change Ketorolac to Ibuprofen 10 mg/kg PO q4-6 hr ATC x48 hrs then PRN pain (max 600 mg q6hr)
- Change Morphine to: Hydrocodone/Acetaminophen (325 mg) 0.2 mg Hydrocodone/kg/dose PO q4hr PRN pain (max 5-10 mg hydrocodone/dose; max acetaminophen 4000 mg/day or 75 mg/kg/day) **OR** Oxycodone/Acetaminophen (325 mg) 0.1 mg oxycodone/kg/dose PO q4hr PRN pain (max 5-10 mg oxycodone/dose; max acetaminophen 4000 mg/day or 75 mg/kg/day)

### FEN/GI:

- Clears, advance to regular diet as tolerated
- Once taking diet: Miralax 1g/kg/day to a max of 17g a day until stooling

discharge order for nurses: tolerating clear liquids, pain controlled, family is comfortable with plan  
• See discharge circle<sup>2</sup>

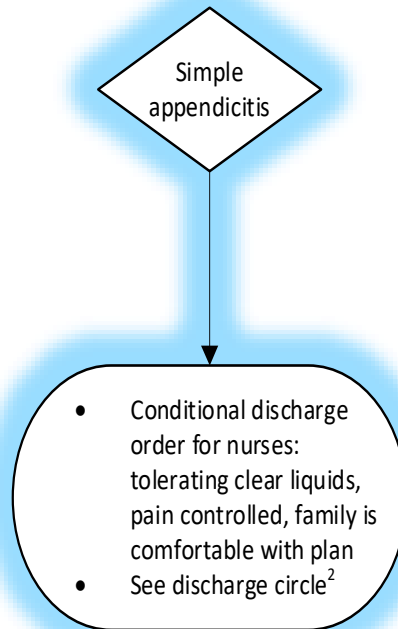
IF POD5 and not progressing clinically, obtain CRP.  
• CRP normal: proceed to discharge circle<sup>2</sup>  
• CRP abnormal: consider ultrasound or CT  
○ If organized abscess: consider surgical or IR drainage and send fluid to micro in a capped syringe for gram stain, bacterial and fungal cultures. Consider ID consultation to direct antimicrobial care.

**Follow Up:**  
○ *Simple Appendicitis:* phone call in 2 weeks or office visit within 4 weeks  
○ *Perforated Appendicitis:* office visit within 4 weeks scheduled

## Simple Appendicitis Management:

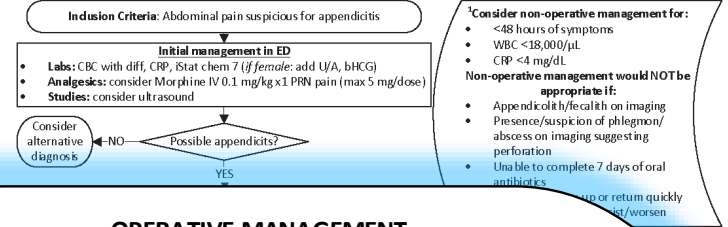
During surgery, if the appendix is noted to be normal, inflamed, or abnormal *without* perforation:

- No additional antibiotics post-op should be given
- To facilitate discharge, there is a conditional discharge order for nurses. Patients can be discharged when they are tolerating clears, pain is well controlled, and the family is comfortable with the plan.
- Discharge instructions include pain control, Miralax, and follow up via phone or office visit



## CLINICAL PATHWAY: Appendicitis

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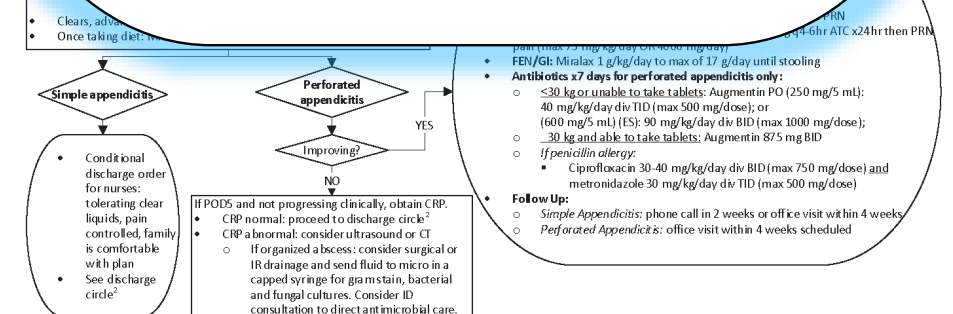
### OPERATIVE MANAGEMENT

#### <sup>2</sup>Discharge Criteria:

Afebrile >24 hrs, tolerating diet, pain controlled on PO pain medication, <40 ml/day from drain if applicable

#### Discharge Instructions:

- **Pain Control:** Ibuprofen PO 10 mg/kg q4-6hr ATC x48hr then PRN pain (max 600 mg q6hr); Acetaminophen PO 15 mg/kg q4-6hr ATC x24hr then PRN pain (max 75 mg/kg/day OR 4000 mg/day)
- **FEN/GI:** Miralax 1 g/kg/day to max of 17 g/day until stooling
- **Antibiotics x7 days for perforated appendicitis only:**
  - <30 kg or unable to take tablets: Augmentin PO (250 mg/5 mL): 40 mg/kg/day div TID (max 500 mg/dose); or (600 mg/5 mL) (ES): 90 mg/kg/day div BID (max 1000 mg/dose);
  - ≥30 kg and able to take tablets: Augmentin 875 mg BID
  - *If penicillin allergy:*
    - Ciprofloxacin 30-40 mg/kg/day div BID (max 750 mg/dose) and metronidazole 30 mg/kg/day div TID (max 500 mg/dose)
- **Follow Up:**
  - *Simple Appendicitis:* phone call in 2 weeks or office visit within 4 weeks
  - *Perforated Appendicitis:* office visit within 4 weeks scheduled



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## Perforated Appendicitis:

The appendix may be noted to be ruptured on imaging or during surgery. There is often purulent fluid in the abdomen.

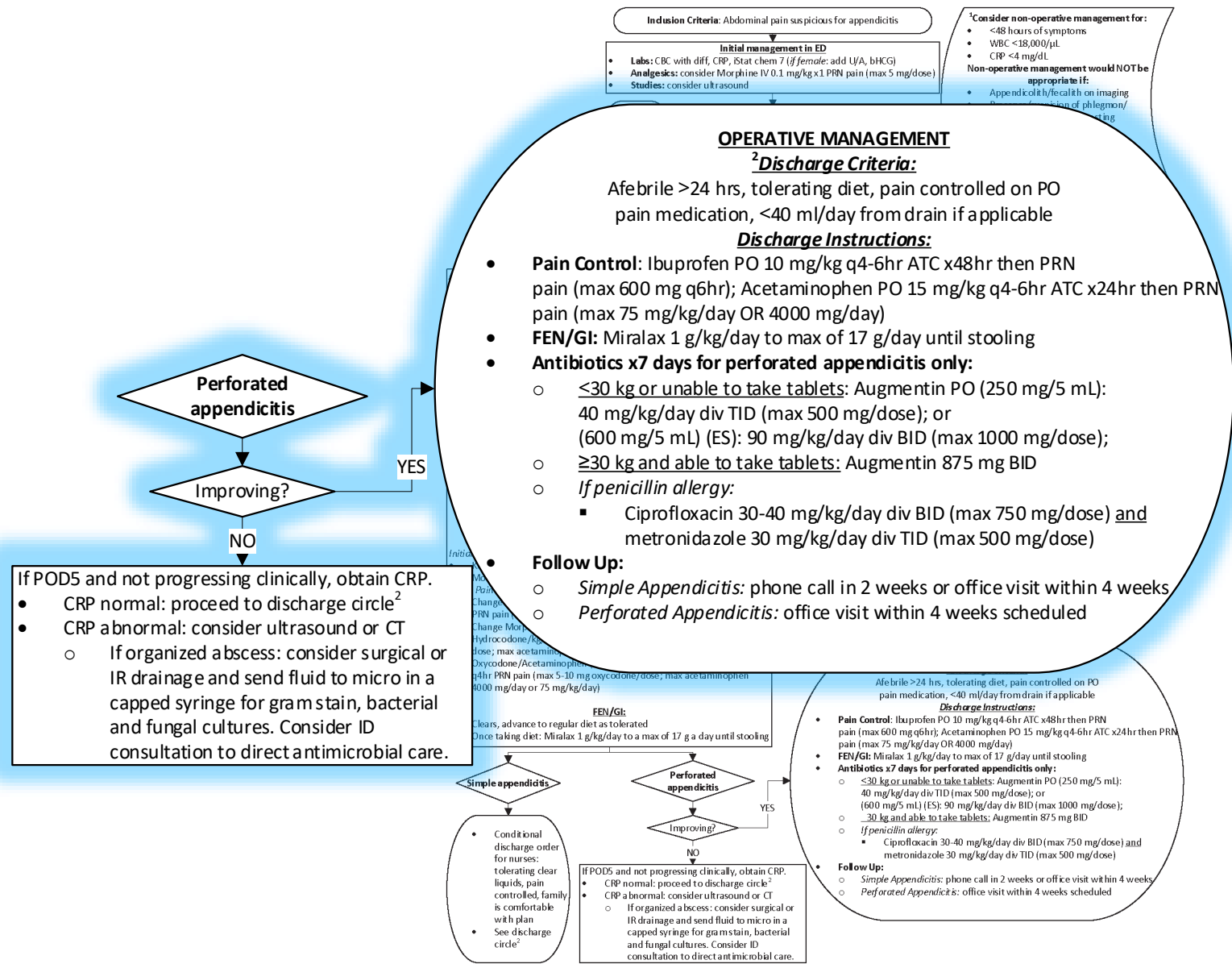
If the patient is not improving, a CRP should be obtained to determine next steps for management.

If the patient is improving as expected, then they can be considered for discharge.

Remember that antibiotic management should be given for those with perforated appendicitis.

### CLINICAL PATHWAY: Appendicitis

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# Review of Key Points



- Once pediatric surgeon attending has confirmed diagnosis of appendicitis, Ceftriaxone (or Ciprofloxacin) AND Metronidazole should be given promptly
  - Antibiotics should be given prior to surgery
- There are certain situations where non-operative management may be appropriate
- Simple appendicitis does not require additional antibiotic therapy post-operatively
- Duration of antibiotics for perforated appendicitis is 7 days
- Pain relief should include Ketorolac, and should be transitioned to oral medication as soon as patient is tolerating a regular diet
- Uncomplicated patients with simple appendicitis may have a conditional discharge order placed in the PACU

# Quality Metrics

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- Percentage of eligible patients treated per pathway
- Percentage of eligible patients with appendicitis order set usage
- Percentage of patients with appropriate post-op antibiotic selection
- Average duration of post-op antibiotic course (days) for complicated appendicitis
- Mean length of stay (simple, complicated stratified)



# Pathway Contacts

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- Christine Rader, MD
  - Department of Pediatric Surgery and Trauma
- Evan Fusaro, PA-C
  - Department of Pediatric Surgery and Trauma
- Jennifer D'Amato, RN
  - Department of Pediatric Surgery and Trauma

# References

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- Craig, S., Brenner, B (Ed.). (2022). Appendicitis Practice Essentials. *Medscape*.  
<https://emedicine.medscape.com/article/773895-overview>.
- Lee, S.L., Islam, S., Cassidy, L.D., Abdullah, F., Arca, M.J. (2010). Antibiotics and appendicitis in the pediatric population: an American Pediatric Surgical Association Outcomes and Clinical Trials Committee Systematic Review. *Journal of Pediatric Surgery*. 45(11):2181-2185.

# Thank You!



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## **About Connecticut Children's Pathways Program**

Clinical pathways guide the management of patients to optimize consistent use of evidence-based practice. Clinical pathways have been shown to improve guideline adherence and quality outcomes, while decreasing length of stay and cost. Here at Connecticut Children's, our Clinical Pathways Program aims to deliver evidence-based, high value care to the greatest number of children in a diversity of patient settings.

These pathways serve as a guide for providers and do not replace clinical judgment.