Reduction of CT utilization for Post-Op Imaging in Pediatric Complicated Appendicitis

Implementation Guide
Contents:

Introduction.................................................. 4
How to use this Guide........................................ 6
Aim Statement.................................................. 9
Quality Measures............................................. 10
Intervention Strategies................................. 11
Appendices...................................................... 15
  Appendix i-Illustrations................................. 16
     1b Fishbone
     1c Key Driver
Appendix ii-Sample Post-op Care
   And Discharge Protocols..... 19
     a. Mercy Children’s
     b. Randall Children’s
     c. Nemours Children’s
     d. Texas Children’s
     e. Dell Children’s
     f. New Orleans Children’s
     g. Atlanta Children’s
     h. Arnold Palmer Children’s

Appendix iii- Sample Drain Management
   Protocol................................. 37
     a. Yale

Appendix iv- PSQC Antibiotic Protocol........... 39

Resources..................................................... 43
Attachments

a) TDF definitions
b) IHI Toolkit
c) NSQIP Data Collection guide
d) PSQC Interview Guide
Introduction

On May 26, 2022, the Pediatric Surgery Quality Collaborative (PSQC) formally launched the Post-Operative Computed Tomography (CT) utilization reduction project for patients with complicated appendicitis. In 2016, a large review of the available evidence by Kutani et al described the increase in associated cancers over a lifetime among pediatric patients having received a diagnostic CT scan, especially of the head and/or abdomen. In Dr. Hauptman’s 2018 study from The Netherlands, pediatric patients who had low-dose ionizing radiation CT scans had a greater risk of developing cancer later in life than one would expect in the general population. In 2021, Lee et al. found an increased risk for leukemia among a national cohort of pediatric patients in South Korea who were administered CT scans specifically prior to an appendectomy.

The members of the pediatric surgery community agree with the principle of ALARA*, as do the majority of pediatric interventional radiologists (IR). There is also a strong desire to reduce the incidence of surgical site infections (SSI) post appendectomy during the hospital stay and after discharge. For this project, the majority of SSIs documented occurred during the post-surgery hospital stay.

The PSQC undertook a qualitative approach to assessing best practice among our collaborative members with the intent of developing a resource for all members and a wider audience who might wish to reduce their reliance on CT scans in the diagnostic work-up for possible postoperative abscess after appendectomy in patients with complicated appendicitis. We invited our low and high performers on this metric to participate in qualitative interviews with members of our Post-Op CT Reduction Workgroup. Interviewees included a broad range of disciplines: NSQIP-pediatric surgeon champions; NSQIP surgical chart reviewers (SCRs); and pediatric Interventional Radiologists.

The interviews were conducted using a guide to promote consistency in developing responses. You can find this guide in the Appendix. The guide was

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*ALARA is an acronym for “as low as (is) reasonably achievable,” which means making every reasonable effort to maintain exposures to ionizing radiation as far below the dose limits as practical, consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations.
predicated on the *Theoretical Domains Framework (TDF)* approach to understanding motivators of behavior and mechanisms by which to implement practice change.

The TDF has a total of 12 domains (see Appendix). Our coding of the interviews with 14 PSQC member hospitals indicated five domains that exerted the greatest influence on practice: skills; beliefs about capabilities; intentions or goals; memory and decision points; and environment.

Working with the coded responses (illustration 1a), we created a fishbone diagram (illustration 1b) to identify the potential root causes influencing the use of CT scans in our high and low outlier hospitals. We identified contributing factors under each of our five predominant categories which might lend themselves to a quality improvement approach and yield measurable benefit.

We developed a key driver diagram (illustration 1c) to demonstrate change concepts discovered in the qualitative interview process which have significant influence on CT utilization. A total of 6 key change concepts are detailed within this implementation guide with accompanying change strategies.

The PSQC appreciates there are many different mechanisms by which a hospital might approach change. This implementation guide is based on the most prevalent factors influencing behavior among the hospitals interviewed. We anticipate each of our member hospitals who elect to participate in this quality improvement project may find their immediate environment responds better to a different approach.
How to Use This Guide

Please consider this guide as a tool to assist in initiating change at your hospital. This guide can be used by any hospital to improve radiation stewardship—high outliers, low outliers and ‘as expected’ performers all may benefit. Current low outliers may choose to use this guide as a training tool. Current high outliers may choose to use this guide as a tool to affect incremental change where possible. Our ‘as expected’ performers may choose to use this guide as a tool to move their performance into exemplary status.

As stated earlier, guide development was based on our qualitative interviews. The majority of our high performing interview participants delayed any post-op imaging to post-op day 7 (+/− 1 day for weekends/holidays/etc). Most utilize ultrasound as the first line imaging modality in their initial approach to ascertain the presence of any fluid collections or pus pockets indicative of an abscess. All of these sites had a very collegial relationship with their radiology partners. All the interventional radiologists who participated in this project indicated their awareness of and agreement with ALARA. These same IRs also expressed concern over missing a pocket of infection using ultrasound only, and the risk of perforation injury to other intra-abdominal structures using ultrasound guided drain placement. Adherence to practice guidelines consisting of: delay in imaging based on the clinical picture; adherence to discharge criteria; and appropriate antibiotic management, resulted in reduction in CT imaging. The PSQC recognizes that cross-sectional imaging is a best approach for drain placement when ultrasound is equivocal. There may be a role for MRI in the diagnosis of post-appendectomy abscess depending on institutional resources. This guide can be used in any setting regardless of imaging availability and skill given the focus on post-op discharge guidelines.

The guide consists of: the PSQC global aim for this CT reduction project; quality measures to assist our members in documenting where and how such change is being made; intervention strategies based on the six (6) key drivers.
identified during the qualitative interview process along with suggested change strategies; a step-by-step implementation flowchart; and an Appendix organized by: supporting literature; appendicitis treatment algorithms currently in use by some of our members; imaging protocols currently in use by some of our members; and the Theoretical Domains Framework (TDF) definitions.

You should first start with review of the most recent Site-Specific Appendicitis variables in the current semi-annual review (SAR) from NSQIP with the SCR or NSQIP manager at your institution. As this provides information about only a single time period, it is suggested that appendicitis variables from at least three SARs be reviewed, if available, to allow for appreciation of trends in hospital performance and, therefore, minimize the effect of outliers.

Secondly, review the quality measures on page 9. Review the structural measures currently in place at your institution and collect documents or guides currently outlined in your hospital policy. Evaluate if these guidelines or protocols are currently in place, and if not, how to best implement them. Over time, previously existing guidelines or protocols may be forgotten or misinterpreted in practice, or fail to be incorporated into the onboarding of new staff.

Next look to the key drivers and change strategies for organizing an intra-departmental work group to tackle this quality improvement project at your hospital. A project champion is essential! The champion should either be a surgeon with some level of authority from general pediatric surgery and/or a radiologist with some level of authority from pediatric radiology. From our interviews, we found our most successful implementers of change had a strong champion. The intradepartmental workgroup should consist of a leader from Ped Radiology, Ped Surgery, Ped Nurse Practitioner or Physician Assistant, Hospital QI (if in place at the institution), the SCR or NSQIP program manager and, if possible, an experienced sonographer.

In order to have a true understanding of how imaging for suspected SSI in post-op complicated appendicitis patients is conducted in reality, one member of your intradepartmental workgroup should conduct a Gemba Walk of the entire process-from the time of discharge from the PACU to discharge.
home. A *Gemba Walk* means going to the location where the actual work is taking place to observe the work in action.

This process will identify if any guideline or protocol that was intended to be utilized is being used in actual practice. The *Gemba Walk* will also highlight elements in the process for focus in your first QI approach.

Take care to start small. You can build on small successes to achieve your higher-level goals. For example, immediately requesting more MRI machines or sonographers to reduce CT utilization is unlikely to be successful. However, first demonstrating success in smaller efforts to achieve change may be met with greater enthusiasm from administration to provide more capital investment in equipment and personnel.

Next-measure, measure, measure! We advocate for a Plan-Do-Study-Act (PDSA) cycle approach. You can’t know what effect any change you’ve instituted is having on your goal without measuring its effect. There are several tools that can be implemented to measure the effect of the instituted change. We have attached in the Appendix the quality improvement essentials toolkit collated from the Institute for Healthcare Improvement for your use.
Aim Statement

By December 31, 2025, the aggregate post-op CT utilization rate for patients with complicated appendicitis managed by the Collaborative will be reduced from 14% to 10%.

Balancing Measure

30-day readmissions/revisits for patients with complicated appendicitis will remain at or below 12%.
Quality Measures:

<table>
<thead>
<tr>
<th>Measure Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Measure #1</td>
<td>Presence of written discharge criteria for post-op pediatric patients following appendectomy for complicated appendicitis</td>
</tr>
<tr>
<td>Structural Measure #2</td>
<td>Presence of a written guideline/protocol/algorithm on imaging for pediatric patients with suspected SSI post-op following appendectomy for complicated appendicitis</td>
</tr>
<tr>
<td>Structural Measure #3</td>
<td>Presence of an antibiotic protocol for pediatric patients following appendectomy for complicated appendicitis</td>
</tr>
<tr>
<td>Process Measure #1</td>
<td>Rate of US utilization post-op</td>
</tr>
<tr>
<td>Process Measure #2</td>
<td>Proportion of patients imaged on post-op day 7 or later</td>
</tr>
<tr>
<td>Process Measure #3</td>
<td>Proportion of patients undergoing CT scans</td>
</tr>
<tr>
<td>Process Measure #4</td>
<td>Reduction of CT utilization for pediatric patients following appendectomy for complicated appendicitis</td>
</tr>
<tr>
<td>Outcome Measure #1</td>
<td>Proportion of patients with an SSI</td>
</tr>
<tr>
<td>Outcome Measure #2</td>
<td>Reduction of CT utilization post-op</td>
</tr>
<tr>
<td>Balancing Measure #1</td>
<td>30-day readmissions/revisits for patients with complicated appendicitis will remain at or below 12%.</td>
</tr>
</tbody>
</table>
Intervention Strategies

**Key Driver 1:** Image no sooner than post-op day 7 (+/-1 day)

*Create a written guide on the appropriate timing of post-operative imaging in the setting of complicated appendicitis*

Change Strategies:

- Identify a surgeon and/or radiology champion
- Identify a Nurse Practitioner or Physician’s Assistant as implementation gatekeeper
- Educate all fellows, faculty, and advanced practice providers (NP, PA, etc.) on this requirement
- Educate all residents at the start of each rotation on this requirement
- Have intradepartmental team present to all service lines faculty
- Have radiology query any CT scan ordered in the period following appendectomy for perforated appendicitis
- Meet regularly to review your NSQIP SARs to assess any changes in CT utilization in the setting of complicated appendicitis
- Implement small tests of change through PDSA cycles

**Key Driver 2:** Standardized discharge guideline (examples in appendix)

*A written protocol/guideline/algorithm provides criteria to assess the clinical picture of patients with complicated appendicitis following appendectomy including: PO intake, return of bowel function, pain control, fever*

Change Strategies:

- Identify a physician champion
- Develop a written protocol/guideline/algorithm that provides a visual flow to decisions in pediatric patients with complicated appendicitis following appendectomy. This should indicate the following:
  - PO intake
o Pain control using appropriate pain scoring tool
o Return of bowel function
o Afebrile for ≥ 24 hours
o Discretionary use of CBC for assessment
  ▪ The evidence suggests little predictive value
  ▪ Avoid unless clinical picture warrants
• Share discharge criteria protocol/guidelines with all pediatric surgery staff (attendings, fellows, residents)
• Build such a protocol/guideline/algorithm into the EMR

**Key Driver 3:** Written post-op imaging guideline for suspected SSI based on clinical picture (examples in appendix)

_A written guideline/algorithm which details when imaging should be conducted (see above for restrictions) and imaging modality. Ultrasound should be considered as the initial diagnostic imaging modality. Depending on institutional resources, there may also be a role for MRI. In collaboration with the interventional radiologists, it should be agreed upon if there are any patient or abscess characteristics that warrant cross-axial imaging prior to drain placement._

Change Strategies:

- Develop a written protocol/guideline/algorithm that provides discrete direction on how a sonographer conducts an imaging study for suspected SSI. This should indicate the following:
  o Prep guidelines
  o Imaging and reporting template
  o Additional imaging if fluid pockets or other signs of infection visualized
- Provide supervised practical training on how to conduct an ultrasound for SSI suspicion in pediatric patients
- Create a process to assure in-service for all new sonographers on imaging technique with a senior sonographer
Key Driver 4: Establish protocol/guideline/algorithm for the management of pediatric patients with complicated appendicitis following appendectomy (examples in appendix)

*Develop a standardized guide on best practices for managing a patient post-operatively following appendectomy for complicated appendicitis.*

Change Strategies:

- Develop a checklist in EMR
- Provide specifics on antibiotics administered (class, dosage, duration)
- Daily assessment of discharge criteria
- When to change antibiotic approach if no improvement

Key Driver 4a: Standardized antibiotic guideline (PSQC protocol in Appendix)

*Develop a standardized guideline for complicated appendicitis*

Change Strategies:

- Collaborate with hospital infectious disease physicians
- Modify as appropriate for your hospital setting
- Protocol should address:
  - Class of antibiotics appropriate for region;
  - Dosage/frequency for surgical prophylaxis;
  - Dosage/frequency following appendectomy;
  - Administration vehicle (I.V. vs P.O.);
  - Total duration of antibiotics; and
  - Dosage and duration post-discharge
**Key Driver 4b:** Drain placement imaging guideline. (see example in appendix)

*Develop a guideline addressing imaging modality for placement of a drain by IR*

Change Strategies:

- Collaborate with sonographers/imaging technicians and interventional radiology (IR) on best approach
- Guideline should address:
  - Visualization of any fluid collections or abscesses using ultrasound
  - Preferential use of ultrasound for placement of drain
  - Indications for CT-guided drain placement
Appendices
Appendix i
Illustration 1b: Fishbone Diagram based on Qualitative Interviews
Illustration 1c: Key Driver Diagram based on Qualitative Interviews
Appendix ii
- Pre-operative dose of intravenous ceftriaxone and metronidazole

Perforated?
Hole in the appendix or fecolith in the abdomen during the operation. St. Peter, SD et al. 2008

Post-operative abscess greater than 20cm²?

Non-Perforated Appendicitis
- Inject Trocar sites with 0.25% Marcaine in the Operating Room.
- Parenteral Toradol in the operating room and every 6 hours thereafter.
- Regular Diet in the recovery unit
- Prescription for oxycodone (0.15mg/kg) every 4 hours as needed for 10 doses. Tylenol and Motrin every 6 hours at home as needed for pain.
- Expected Same Day Discharge- Currently, 87% rate. Aguayo, P et al 2014, Benedict et al. 2018-

Perforated Appendicitis
- Suction alone of the peritoneal cavity, no irrigation. St. Peter, SD et al. 2008
- No PICC line, no additional labs.
- Clear liquid diet if no evidence of emesis on POD#1
- Initiate solid food on POD #2
- Discharge if tolerating a regular diet, afebrile and with good pain control. Knott, EM et al. 2013
- Obtain CBC on day of discharge: if WBC count elevated treat with 4 additional days of oral antibiotics. Desai et al. 2015
- Alternatively, If WBC count is below 10 on day of discharge, no need for additional antibiotics. (Augmentin or Cipro/flagyl). Work in progress.
- If still in the hospital and no clinical improvement by POD #6, obtain US imaging to evaluate for an abscess. If inconclusive, CT. Knott, EM et al. 2013.

• No drain placement (Gasior et al. 2013)
• Admission to the surgical service with single daily dosing of IV ceftriaxone and IV metronidazole.
• When tolerating food, discharge home with a 2 week course of Augmentin or cipro/flagyl. Benedict et al. 2017-in progress

• Drain placement by Interventional Radiology (IR) if over 20cm² Svetenoff et al. 2020, Gasior et al 2013
• Admission to the surgical service with single daily dosing of IV ceftriaxone and IV metronidazole.
• When tolerating food, discharge with drain if drain still needed and home with a 2 week course of Augmentin or cipro/flagyl. Sujka et al. 2019-in progress
### Preoperative Work-Up

- **See algorithm**
- **History and Physical**
- **Labs**: CBC with differential, CRP
- **Imaging**: Ultrasound to start
  - IF ultrasound non-diagnostic:
    - No alternative diagnosis - consider cross-sectional imaging (CT A/P with IV contrast, MRI appy)
    - Alternative diagnosis likely (large stool burden, adenitis, etc) - consider discharge versus observation without antibiotics
  - Imaging positive or clinical suspicion sufficient —> preoperative management protocol

* May consider cross sectional imaging if duration of symptoms >5-7 days or 3+ cm fluid collection on ultrasound
May consider non-operative pathway if has drainable fluid collection, symptoms >5-7 days or if clinical circumstance dictates
**Pre-operative management**

- **Admit to Pediatric Surgery**
- **Diet**: NPO
  - If patient going to the OR the following morning may consider CLD or regular diet at the discretion of the attending surgeon until midnight
- **Fluid bolus**: 20 mL/kg bolus with Lactated Ringers (repeat as necessary to maintain UOP > 1 cc/kg/hr)
- **mIVF**: 1.5x mIVF (D5 NS with 20 mEq KCL as it is compatible with the antibiotics)
- **Pain medications**: Morphine 0.05 - 0.1 mg/kg/dose q3 hr PRN. If eating can get Tylenol PO (12.5 mg/kg q6 hr) and ibuprofen (10 mg/kg q6 hr)
- **Antiemetics**: Zofran 0.1 mg/kg q6 hours PRN
- **Probiotics**: Lactobacillus - attempt to give one dose preop if possible
- **Antibiotics**: Broad spectrum antibiotics
  - Current formulary: Ceftriaxone 50 mg/kg daily (max 2 g) and Metronidazole 30 mg/kg daily (max 1.5 g)
  - IF allergic (anaphylactic) to penicillin or cephalosporins then use ciprofloxacin (25mg/kg/day divided q12 hr with max dose of 500mg per dose) and Metronidazole 30 mg/kg daily (max 1.5 g)
- **Consent**: Laparoscopic appendectomy (templates available)
- **Book for OR**: See Appendix A for attending specifics (Only for booking case, not for consent)
- **Education**: Do not tell family whether or not the appendix is perforated. Let patient and family know that if acute appendicitis then expect they will be able to go home the same day as OR

**Post-operative acute appendicitis management - same day discharge**

- **Preop education is key** - expectation is that they should go home the same day
- **Diet**: Regular diet
- **Fluids**: Saline lock after PACU
- **Pain medications**: Alternating scheduled acetaminophen (12.5 mg/kg q6 hr) and ibuprofen (10 mg/kg q6 hr) such that one is being taken every 3 hours.
- **Antiemetics**: DC after PACU
- **Probiotics**: DC
- **Antibiotics**: None
- **Discharge criteria**: Expectation is to go home the same day after 4 hours of observation and pain controlled. May stay if late in the day, long drive to home or attending has concern
- **Discharge medication**: Alternating scheduled acetaminophen (12.5 mg/kg q6 hr) and ibuprofen (10 mg/kg q6 hr) such that one is being taken every 3 hours while awake. Continue this schedule for at least 24 hours then PRN

**Post-operative gangrenous appendicitis management**

- **Diet**: Regular diet
- **mIVF**: 1x mIVF (preferably D5 NS with 20 mEq KCL as it is compatible with the antibiotics)
- **Pain medications**: 
  - Alternating scheduled acetaminophen (12.5 mg/kg q6 hr) and ibuprofen (10 mg/kg q6 hr)
  - If not tolerating PO and/or pain uncontrolled consider ketorolac +/- IV Tylenol
- **Antiemetics**: Zofran 0.1 mg/kg q6 hours PRN
- **Probiotics**: Lactobacillus while on antibiotics
- **Antibiotics**: Continue same preoperative broad spectrum antibiotics for an additional 24 hours
- **Discharge criteria**: 
  - Completed 24 hours of IV antibiotics
  - No post op fevers
  - Improved pain post operatively
  - May be moved to the perforated protocol if there is any concern by the attending surgeon
- **Discharge medications**: 
  - Alternating scheduled acetaminophen (12.5 mg/kg q6 hr) and ibuprofen (10 mg/kg q6 hr) such that one is being taken every 3 hours while awake. Continue this schedule for at least 24 hours.
  - No further antibiotics unless directed by the attending surgeon
Post-operative perforated appendicitis management

- **Diet:** Regular diet
- **mIVF:** 1.5x mIVF (preferably D5 NS with 20 mEq KCL as it is compatible with the antibiotics) until UOP >1.0 cc/kg/hr for 24 hours then decrease as PO intake increased.

- **Pain medications:**
  - Alternating scheduled acetaminophen (12.5 mg/kg q6 hr) and ibuprofen (10 mg/kg q6 hr)
  - If not tolerating PO and/or pain uncontrolled consider ketorolac +/- IV Tylenol
  - May consider gabapentin 5 mg/kg PO q4-6 hours PRN as adjunct
  - Morphine 0.05 - 0.1 mg/kg/dose q3 hr PRN x 4 doses

- **Antiemetics:** Zofran 0.1 mg/kg q6 hours PRN

- **Probiotics:** Lactobacillus while on antibiotics

- **Antibiotics:** Continue same preoperative broad spectrum antibiotics until discharge criteria met

- **Discharge criteria:**
  - No post op fevers x 48 hours
  - No right lower quadrant pain or tenderness
  - Tolerating diet similar to baseline
  - No severe or worsening watery diarrhea that may cause dehydration

**IF PROGRESSING**

- **Labs:** CBC with differential and CRP (for baseline)
  - WBC normal for age, % neutrophils normal and immature granulocyte # normal - discharge with oral antibiotics to complete a TOTAL of 5 days of antibiotics
  - WBC elevated for age, increased % neutrophils OR increased immature granulocyte # - discharge with oral antibiotics to complete an ADDITIONAL 5 days of antibiotics

- **Discharge medications:**
  - Alternating PRN acetaminophen (12.5 mg/kg q6 hr) and ibuprofen (10 mg/kg q6 hr) such that one can be taken every 3 hours
  - **Antibiotics**
    - Duration as described above
    - Augmentin 40 mg/kg/day BID if <40 kg or Augmentin 875 mg BID if >40 kg
      - If allergic to penicillin or cephalosporins then use ciprofloxacin (25mg/kg/day divided q 12hours with max dose of 500 mg per dose) and metronidazole (30mg/kg/ once daily, max 1500 mg)
  - **Probiotics** for the duration of antibiotic treatment course

**IF NOT PROGRESSING**

- Consider PICC after 3-7 days if young, prolonged NPO, poor oral intake and/or unreliable peripheral vascular access
- **Day 6-7** not meeting discharge criteria -> Imaging
  - Consider ultrasound (possibly day 6 to avoid delay) versus cross sectional (CT A/P with PO and IV contrast or MRI)
  - **Drainable fluid collection:**
    - IR consultation
    - Continue IV antibiotics per perforated appendicitis protocol until discharge criteria met
    - Follow up cultures and tailor antibiotics per sensitivities
    - See drain management protocol
  - **No drainable fluid collection:**
    - Continue IV antibiotics per perforated appendicitis protocol until discharge criteria met
    - Consider antibiotic change and/or infectious disease consolation if not progressing
    - Consider repeat imaging studies in 5-7 days if not improving
    - Discharge home with an additional 5 days of oral antibiotics once discharge criteria are met
Non-operative management of perforated appendicitis

- **Admit** to Pediatric Surgery

- **Diet**: NPO for possible drain placement
  - If patient going to IR the following morning may consider CLD or regular diet at the discretion of the attending surgeon until midnight

- **Fluid bolus**: 20 mL/kg bolus with Lactated Ringers (repeat as necessary)

- **mIVF**: 1.5x mIVF (preferably D5 NS with 20 mEq KCl as it is compatible with the antibiotics) until UOP >1.0 cc/kg/hr for 24 hours then decrease as PO intake increased.

- **Pain medications**: Morphine 0.05 - 0.1 mg/kg/dose q3 hr PRN. If eating - alternating scheduled acetaminophen (12.5 mg/kg q6 hr) and ibuprofen (10 mg/kg q6 hr). If not tolerating PO and/or pain uncontrolled consider ketorolac +/- IV Tylenol

- **Antiemetics**: Zofran 0.1 mg/kg q6 hours PRN

- **Probiotics**: Lactobacillus

- **Antibiotics**: Broad spectrum antibiotics
  - Current formulary: Ceftriaxone 50 mg/kg daily (max 2 g) and Metronidazole 30 mg/kg daily (max 1.5 g)
    - If allergic (anaphylactic) to penicillin or cephalosporins then use ciprofloxacin (25mg/kg/day divided q12 hr with max dose of 500mg per dose) and Metronidazole 30 mg/kg daily (max 1.5 g)

- **Interventions**: IR drain if possible, follow drain protocol

- **Discharge criteria**: 
  - No fevers x 48 hours post drain placement (or admission if no drain placed)
  - No right lower quadrant pain or tenderness
  - Tolerating diet similar to baseline
  - No severe or worsening watery diarrhea that may cause dehydration
  - Follow drain protocol

**IF PROGRESSING**

- **Labs**: CBC with differential and CRP (for baseline)
  - WBC normal for age, % neutrophils normal and immature granulocyte # normal - discharge with oral antibiotics to complete a TOTAL of 5 days of antibiotics
  - WBC elevated for age, increased % neutrophils OR increased immature granulocyte # - discharge with oral antibiotics to complete an ADDITIONAL 5 days of antibiotics
  - IF no source control obtained (i.e. no drain placed) then the patient should receive an additional 5 days of oral antibiotics regardless

- **Discharge medications**: 
  - Alternating PRN acetaminophen (12.5 mg/kg q6 hr) and ibuprofen (10 mg/kg q6 hr) such that one can be taken every 3 hours
  - Antibiotics
    - Duration as described above. Reminder *IF no source control, provide an additional 5 days of antibiotics
    - Augmentin 40 mg/kg/day BID if <40 kg or Augmentin 875 mg BID if >40 kg
      - If allergic to penicillin or cephalosporins then use ciprofloxacin (25mg/kg/day divided q12 hours with max dose of 500mg per dose) and metronidazole (30mg/kg/ once daily, max 1500 mg)
  - Probiotics for the duration of antibiotic treatment course

**IF NOT PROGRESSING**

- Consider PICC shortly after admission if young, prolonged NPO, poor oral intake and/or unreliable peripheral vascular access
- Day 5-7 not meeting discharge criteria -> Repeat imaging
  - Typically cross sectional (CT A/P with PO and IV contrast or MRI)
  - Drainable fluid collection:
    - IR consultation
    - Continue IV antibiotics per non-op perforated appendicitis protocol until discharge criteria met
    - Follow up cultures and tailor antibiotics per sensitivities
    - See drain management protocol
  - No drainable fluid collection:
    - Continue IV antibiotics per non-op perforated appendicitis protocol until discharge criteria met
    - Consider antibiotic change and/or infectious disease consolation if not progressing
    - Consider repeat imaging studies in 5-7 days if not improving
    - Discharge home with an additional 5 days of oral antibiotics once discharge criteria are met
Management of re-admission for perforated appendicitis

- **Work-Up:** H&P, CBC and CRP, U/S +/- CT or MRI to evaluate for fluid collection
- **Admit to Pediatric Surgery**
- **Diet:** NPO for possible drain placement
  - If patient going to IR the following morning may consider CLD or regular diet at the discretion of the attending surgeon until midnight
- **Fluid bolus:** 20 mL/kg bolus with Lactated Ringers (repeat as necessary)
- **mIVF:** 1.5x mIVF (preferably D5 NS with 20 mEq KCL as it is compatible with the antibiotics)
- **Pain medications:** Morphine 0.05 - 0.1 mg/kg/dose q3 hr PRN. If eating can get Tylenol PO.
- **Antiemetics:** Zofran 0.1 mg/kg q6 hours PRN
- **Probiotics:** Lactobacillus
- **Antibiotics:** Broad spectrum antibiotics
  - Scenario 1: Re-admission while still taking oral antibiotics at home (treatment failure)
    - Change IV antibiotics to cefepime and flagyl and consider ID consultation
  - Scenario 2: Re-admission after completing antibiotic course at home (recurrent infection)
    - Restart previous IV antibiotic regimen
- **Interventions:** IR drain if possible, follow drain protocol

### IF PROGRESSING

- **Labs:** CBC with differential and CRP
  - WBC normal for age, % neutrophils normal and immature granulocyte # normal - discharge with oral antibiotics to complete a TOTAL of 5 days of antibiotics
  - WBC elevated for age, increased % neutrophils OR increased immature granulocyte # - discharge with oral antibiotics to complete an ADDITIONAL 5 days of antibiotics
  - IF had untrainable fluid collection and no drain then the patient should receive 5 days of oral antibiotics regardless
- **Discharge medications:**
  - Alternating PRN acetaminophen (12.5 mg/kg q6 hr) and ibuprofen (10 mg/kg q6 hr) such that one can be taken every 3 hours
  - Antibiotics
    - Duration as described above. Reminder *IF residual and undrained fluid collection, provide an additional 5 days of antibiotics
    - Augmentin 40 mg/kg/day BID if <40 kg or Augmentin 875 mg BID if >40 kg
      - If allergic to penicillin or cephalosporins then use ciprofloxacin (25mg/kg/day divided q 12 hours with max dose of 500mg per dose) and metronidazole (30mg/kg/ once daily, max 1500 mg)
    - Probiotics for the duration of antibiotic treatment course

### IF NOT PROGRESSING

- Consider PICC shortly after admission if young, prolonged NPO, poor oral intake and/or unreliable peripheral vascular access
- **Day 5-7 not meeting discharge criteria -> Repeat imaging**
  - Typically cross sectional (CT A/P with PO and IV contrast or MRI)
- **Drainable fluid collection:**
  - IR consultation
  - Continue IV antibiotics per non-op perforated appendicitis protocol until discharge criteria met
  - Follow up cultures and tailor antibiotics per sensitivities
  - See drain management protocol
- **No drainable fluid collection:**
  - Continue IV antibiotics per non-op perforated appendicitis protocol until discharge criteria met
  - Consider antibiotic change and/or infectious disease consolation if not progressing
  - Consider repeat imaging studies in 5-7 days if not improving
  - Discharge home with an additional 5 days of oral antibiotics once discharge criteria are met
Management of intra abdominal fluid collection with percutaneous drain

- **Imaging:** ultrasound and cross sectional (CT A/P with IV and PO contrast or MRI A/P)
- **Consultations:** IR for drainage
- **Drain care:**
  - Bedside RN to flush drain with 10 mL of saline BID and PRN
- **Drain management:**
  - Continue drain until <10 mL per day x 2 consecutive days
  - To remove or not to remove:
    - Primarily assessed by clinical improvement (afebrile, pain/tenderness improvement, improved PO intake)
    - Insufficient clinical improvement or minimal drainage despite large collection on imaging
      - Ultrasound to assess for residual fluid collection
      - Consider tPA x3 days and then reassess
  - If all criteria being met but drain output remains > 10 mL the may consider discharge to home with drain in place
Acute appendicitis Q1
Ceftriaxone/metronidazole*

Operative Appendicitis

Uncomplicated Appendicitis
(Nonperforated, gangrenous)

Postop
No antibiotics
Diet- ADAT

Discharge Criteria
Afebrile <38C
Ambulating
Analgesia PO
Tolerating PO

Follow up
2 weeks in Ped Surg clinic
Analgesia PO
Tolerating PO

Complicated Appendicitis
(visible hole in appendix,
fecalith outside appendix,
abscess, diffuse fibrinopurulent exudate
Ceftriaxone/metronidazole*
minimum 3 days post-operatively

Discharge Criteria
Afebrile <38C
Ambulating
Analgesia PO
Tolerating PO

Complete 7 day post-operative course of augmentin TID*
Follow up 2 weeks in Ped Surg clinic

Non-operative appendicitis

IR drainage
Ceftriaxone/metronidazole*
Diet- ADAT

Discharge Criteria
Afebrile <38C
Ambulating
Analgesia PO
Tolerating PO

yes

yes

Clinically well
Complete total 10 days post- IR drainage
Ceftriaxone/metronidazole*

Not clinically well by POD7?

Imaging

Antibiotic dosage: Ceftriaxone 50mg/kg/dose, max 2000mg; Metronidazole 30mg/kg/dose, max 1500mg; Augmentin 10mg/kg/dose amoxicillin component Q8, max 500mg amoxicillin component

*PCN allergic: Ciprofloxacin 15mg/kg/dose Q12, max 400mg; Metronidazole 30mg/kg/dose, max 1500mg
**Acute Appendicitis/Appendectomy Management Algorithm**

**Child ≥ 2 years presents w/ suspected appendicitis**

**US exam & pregnancy test in pubescent females**

**Pediatric Appendicitis Score (PAS)**

*Use for children ≥ 4 years*

- Migration of pain [1]
- Cough/Hopping/Percussion tenderness in RLQ [2]
- Anorexia [1]
- Elevation of temperature [1]
- Nausea/Vomiting [1]
- Leukocytosis (>10,000) [1]
- RLQ tenderness [2]
- Differential WBC w/ left shift [1]

*The PAS is the cumulative point total from all clinical findings.*

**Pt 2-3 years: low suspicion for appendicitis**

- OR
  - Pt ≥ 4 years and PAS ≤ 4

**Pt 2-3 years: equivocal suspicion for appendicitis**

- OR
  - Pt ≥ 4 years and PAS 5-7

**Pt 2-3 years: high suspicion for appendicitis**

- OR
  - Pt ≥ 4 years and PAS ≥ 8

**OFF algorithm**

*Explore alternate diagnosis OR DC home if DC criteria met*

- Consult Surgery
- Order CT

*NOTE: Obtain surgery consult prior to ordering CT*

**Discharge Criteria (DC):**

- Afebrile x 24 hours (<99.9°F)
- Tolerating regular diet
- Pain controlled with oral pain medications
- Ambulating
- Benign abdominal physical exam (no tenderness/mass)

**Chronic abscess/plegmon signs and symptoms:**

- >5 days duration, localized pain/tenderness, able to maintain oral intake

**Image positive for appendicitis?**

- Yes
  - Consult Surgery
  - Order CT
  - NOTE: Obtain surgery consult prior to ordering CT

**Image positive for chronic abscess/plegmon?**

- Yes
  - Admit
  - Provide analgesia
  - Begin empiric therapy w/piperacillin/tazobactam
  - Consider IR drainage of abscess

**Discharge criteria after 48 h**

- Yes
  - Reassess DC criteria after 48 h
  - US at 6-7 days only if clinical suspicion for abscess

- No
  - Reassess DC criteria after 48 h
  - US if ≥2 h since antibiotic dose, re-dose w/ full minimum dosing
  - Request to see Child Life
  - Perform appendectomy

**Discharge criteria after 48 h**

- Yes
  - Reassess discharge criteria after 48 hours
  - Discharge home

- No
  - Discharge criteria met?

- Yes
  - Discharge home

- No
  - If complicated intra-abdominal abscess(es), recurrent abscess or multiple drains, prolonged length of stay > 14 days, Consult Infectious Disease.
  - OFF algorithm

- If US shows organized fluid collection, consult IR.
  - If drain is placed, keep until output is <10 mL/day.
  - If US shows plegmon, consider repeat US at least 48-72 hours later
  - If US shows 'other', OFF algorithm

- If US shows organized fluid collection, consult Infectious Disease.
  - OFF algorithm

- Reassess discharge criteria after 48 hours
  - Discharge home
Any pt with signs of a surgical abdomen (rigidity, guarding, or peritonitis) should warrant a STAT surgery consult.

APPY SCORE assigned for children ≥ 4 years old with suspected Appendicitis ①

APPY SCORE ≤ 4 – low suspicion of Appendicitis

APPY SCORE S-7 – equivocal suspicion of Appendicitis

- Consider MRI ⑥
- Immediate placement of IV, order labs ②
- Order “Limited abdominal ultrasound to rule out appendicitis”
- Order Analgesia (Refer to ED pain management guidelines)
- Child Life Consult
- IVF hydration
- Consider Pelvis US for teenage girls

Off algorithm
Explore alternate diagnosis or discharge home if criteria are met
- If still concerned for Appendicitis, consult surgery

US positive for Appendicitis

Consult Surgery
- Disposition to Floor per surgery
  - Admit or OR
  - Provide analgesia
  - Begin empiric therapy with Rocephin/Flagyl
  - Pre-operative Checklist performed in ED ③
- Perform appendectomy

Appy Score ≥ 8 – high suspicion of Appendicitis

- Immediate surgical consult. Discuss management and imaging plan
  - Order analgesia (Refer to ED pain management guidelines)
  - Child Life Consult
  - IVF hydration
  - Order Labs ②

- Consult Surgery
- Transfer to OR or admit to surgery floor

Equivocal or Appendix not seen

Call/Consult Surgery

- Decision to order CT within 60mn
- To MRI as soon as available

- Appendicitis
- Appendicitis & abscess
- Appendicitis & + abscess

- Off algorithm
- Explore alternate diagnosis or discharge home if criteria are met
- Admit
- Consider IR drainage

Culture all abscesses drained in IR

BEST PRACTICE:
- Consider MRI before US:
  - Adolescent females: ovaries need to be visualized
  - Children with high BMI
  - Provider discretion during high volumes
- Immediate Surgical Consult for >8 and high clinical suspicion for appendicitis
- If imaging needed, US preferred as first test, consider MRI vs Surgery consult vs CT

Throughput:
- Labs drawn and sent within 10 minutes of order
- US completed and read within 45 mins of order
- Surgery consult completed with plan within 60 minutes of call

For questions concerning this pathway, Click Here
Last Updated October 2022

Acute Appendicitis Diagnostic Pathway
Evidence Based Outcome Center

The Pediatric Appendicitis Score (Appy Score)
- use for children ≥ 4 years

- Migration of pain (1)
- Pain with cough/hopping/percussion (2)
- Anorexia (1)
- Fever >38°C (100.5°F) (1)
- Nausea/vomiting (1)
- Leukocytosis (≥ 10,000) (1)
- RLQ tenderness (2)
- Neutrophils plus band forms >7500 cells/µL (1)

*The APPY SCORE is the cumulative point total from all clinical findings.*

Labs:
- UA with micro and culture
- CBC with Diff
- BMP
- Consider:
  - CMP
  - CRP (for hold in lab for low likelihood cases)
  - Always: Urine pregnancy test for all post-pubescent females

Pre-Operative Checklist:
- Evaluate for Sepsis/SIRS
- IVF Resuscitation
- Pain Control
- IV Antibiotics
- NPO
- Consent in Chart

ED Discharge Criteria:
- Tolerating liquids
- Pain able to be controlled at home
- Ambulating
- Benign abdominal exam

Imaging:
- MRI Availability
- Ordering Timing
- Patient Presentation

MRI Protocol:
- Age ≥ 5 Years
- Stable Condition
- Can hold still for 10 minutes without sedation
- No MRI Contraindications
- MRI Suite Available (Call to Verify)
Acute Appendicitis Treatment Pathway
Evidence Based Outcome Center

For questions concerning this pathway, Click Here
Last Updated October 2022
CHNOLA Appendicitis Protocol

This protocol is based on what we understand to be the most current data (which includes better outcomes with a standardized protocol - Khan, 2020). That means that this is ALWAYS open for discussion if any team member finds new studies that might improve our outcomes. These guidelines will be applicable in most patients, but the attending of record has the final say.

***There is an orderset for this! PEDS Sur Appendectomy It is in the process of being updated, so just make sure you’re ordering what you want to order.***

SIMPLE APPENDICITIS - acute or non-perforated

**Antibiotics**
- Zosyn - first dose at time of diagnosis, want to start treating the appendicitis ASAP. We feel this is great coverage, well proven, and reasonable in cost. There are other options which are reasonable, but because standardizing protocols leads to less variation and better outcomes, this is what we are going with now.
- If the most recent Zosyn dose has not been given within one hour of incision, ask staff if they want any antibiotics in the OR. We will usually give a dose of Ancef.
- None after surgery (Abounozha, 2021)
- For pcn allergic patients, or patients with renal issues:
  - Rocephin 50 mg/kg q day, max dose 2 gm
  - Flagyl 30 mg/kg qd (max dose 2 gm) or TID (ask staff)

**Pain Meds**
- Schedule acetaminophen q6hr, can use IV for first 24 hours and then transfer to PO
- Can alternate acetaminophen with scheduled ibuprofen (each q6h) so they’re getting something every 3 hours
- Can also schedule toradol (confirm with staff prior to ordering) q6 hours x 48 hrs, can do an additional 24 hours after that if not taking much PO, no motrin if scheduling toradol
- prn oxycodone q4h for pain 4-7
- prn morphine q4h for pain 8-10

**Discharge criteria**
- Same day is ok - confirm plan with staff (Yu, 2017)
- Patient should be able to do well at home (pain ok on po meds, eating, walking)

**Discharge meds**
- Scheduled and/or prn non-opioids

**Follow-up, post-op instructions**
- Staff preference as to timing, prn
- No soaking in a tub or swimming for 7 days post-op
- Activity ad lib, ok to return to school POD 3-ish
COMPLICATED APPENDICITIS (gangrenous or perforated = bacteria have escaped the appendix, perforation is defined as a hole in the appendix or a fecalith in the abdominal cavity)

Message for patient and family

- Perforated appendicitis can be a frustrating process. 20-30% of these patients get a post-op abscess no matter what we do. We re-evaluate every day to see if the pt is ready for discharge. The things that we are looking for for discharge are listed below. In the meantime, we control their pain and continue antibiotics. They will slowly get better, and (if they had their appendectomy) they will never get appendicitis again! If they are still here on day 7, we will get a CT to evaluate for an abscess. It takes about that long for a drainable abscess to develop so that is why we wait 7 days.

Non-op management:

- This is usually reserved for patients that have been having pain and symptoms for more than 5 days, but may vary depending on staff and patient.
- Diet per staff
- Zosyn
- Pain control

Post-op perforated appendicitis:

Antibiotics

- Zosyn - First dose at time of diagnosis. We want to start treating the appendicitis ASAP. We feel this is great coverage, well proven, and reasonable in cost. There are other options which are reasonable, but because standardizing protocols leads to less variation and better outcomes, this is what we are going with now.
- If the most recent Zosyn dose has not been given within one hour of incision, ask staff if they want any antibiotics in the OR. We will usually give a dose of Ancef.
- For pcn allergic patients, or patients with renal issues:
  - Rocephin 50 mg/kg q day, max dose 2 gm
  - Flagyl 30 mg/kg qd (max dose 2 gm) or TID (ask staff)

Antibiotic duration

- We do not use football scores (7,10, 14 etc) for duration of antibiotics since the data supports using physiologic criteria, and longer does not decrease abscess formation (van der Boom, 2020)
- Continue antibiotics post-op. Antibiotics are generally stopped when the patient meets discharge criteria.

Pain Meds
- Schedule **acetaminophen** q6hr, can use IV for first 24 hours (currently have to schedule each specific dose) and then transfer to PO if tolerating PO
- Staff dependent: **Toradol** (unless there are kidney issues, low urine output) as a scheduled drug q6 hours x 72 hrs (**Lieu, 2013, Creamer, 2020**).
- Try to alternate acetaminophen and NSAIDS so pt is getting something for pain every 3 hours
- PRN oxycodone (pain 4-7) and morphine (pain 8-10) for breakthrough

**Diet**
- Staff preference

**Post-op imaging**
- We wait until post-op day 7 to order any imaging looking for an abscess (**Ingraham, 2020**), as it takes about that long for an abscess to be well-formed and amenable to IR drainage.
- This is done with a CT with IV and PO contrast.
- Sometimes we will adjust this timing based on the weekend and the appearance of the child.
- If there is a drainable collection, consult IR
- If there is a small abscess (< 2 cm), scattered fluid, or a difficult to reach abscess, then the first plan will most likely be continued IV antibiotics

**Discharge criteria**
- Afebrile (<100.4) x 24 hours
- Ambulating
- Drinking enough to stay hydrated and keeping down some regular diet. They often don’t have a great appetite initially, but their appetite will come back, especially once they aren’t being fed hospital food.
- Pain controlled with PO meds
- If there is concern about possible intra-abdominal abscess despite meeting these criteria, a WBC may be helpful in determining the need for additional antibiotics. (**Fallon, 2013**)

**Discharge Meds**
- Almost every kid with perforated appendicitis will do well on scheduled and/or prn Tylenol/Motrin
- If they have needed significant opioids in the hospital or the family is concerned, it’s ok to order a few days worth of oxycodone

**Follow-up**
- Clinic follow-up after discharge, 2-4 weeks depending on staff preference
- If the family lives far away or has issues with transportation we can offer a phone or tele-medicine follow-up (confirm with the attending)
Appendectomy with a Complicated Appendix (Category 2b & 2c) (PERFORATED)

Initial Post-operative Management

**Antibiotic Therapy**
- See table on pg. 2 for dosing schedule
- Ceftriaxone
- Metronidazole

**Antibiotic Step up Therapy**
- post op if febrile, vomiting, poor po intake
  - D/C Ceftriaxone & Metronidazole
- Start Zosyn unless pt. has a PCN Allergy (See table on pg. 2 for dosing schedule)

**Nutrition/GI**
(NG not recommended)
- Clear liquids
- Clear diet
- Start PO (max 17 gm) prn no stool for 24 hours
- Advance to oral pain medications* once tolerating reg. diet

**Pain Control**
- Acetaminophen: 10mg/kg/dose po q4hr (max 500mg) for pain
- Toradol: 0.5mg/kg/dose IV q 6hrs (max 30 mg/dose) Max 20 doses
- Morphine: 0.1mg/kg/dose IV q 3hr PRN pain if acetaminophen or toradol is not effective (max 5mg/dose)
- Gabapentin 10 mg/kg/dose po TID (max 300mg)

**Activity/Consults**
(Routine Labs not recommended)
- OOB on surgical day X1 minimally & ambulate 3x qd
- Consult Child Life
- Consult PT as needed
- Consult Nutrition as needed
- Avoid placing a foley; if used in surgery remove on POD 1

**Evaluate Fever Curve (including daily T-max), Pain response, and GI response to diet**
Every Day

- Fever Curve improved, Pain decreased & ileus resolved, monitor T max daily
- ≥ POD 7?
- Abscess Present?
- Obtain Labs & Imaging US/CT per surgeon discretion

**Abscess Management**
(Obtain cultures from abscess when draining)

- Continue Antibiotics reassess in 48-72 hrs
- Is/Are any of the abscesses ≥ 2cm?
- Drain in IR or Operating Room

- ≥ 3 abscesses?
- Drain in OR

2 Discharge Criteria

- Afebrile (< 38° C) > 24 hrs
- Tolerating regular diet
  - 50% of 3 consecutive meals
- Adequate pain control with oral medications
  - Pain score is 3 or less within 1 hr.
- Ambulation without assistance (250 feet)
- If discharging home with a drain, include drainage care instructions

*ADVANCING ORAL PAIN REGIMEN:
Once pain controlled and tolerating po change:
- Toradol to Ibuprofen 10mg/kg/dose po q 6hr prn (max 400mg/dose)
- Morphine to: Hydrocodone with Acetaminophen 325 mg 0.2mg hydrocodone/kg/dose po q6hr PRN pain (max 5mg hydrocodone/dose):
- If discharged on narcotics also order Miralax qd X 5 days
- Consider Gabapentin as a discharge medication

1 Fever Curve improved, Pain decreased & ileus resolved, monitor T max daily

Patient meets D/C Criteria

Continue IV atb therapy
No labs necessary
Reassess in 24hrs.

Recheck labs in 24hr.
Keep on IV atb and reassess oral tolerance in 24hr
Discharge* Home and complete a total of 7 day course of antibiotics (IV & PO combined)

Transition to Oral Amoxicillin/Clavulanate (if no PCN allergy)
Tolerating Oral atb?

Update Draft
11.9.21

Developed through the efforts of Children’s Healthcare of Atlanta and physicians on Children’s medical staff in the interest of advancing pediatric healthcare. This pathway is a general guideline and does not represent a professional care standard governing providers’ obligation to patients. Ultimately the patient’s physician must determine the most appropriate care. © 2016 Children’s Healthcare of Atlanta, Inc.
Empiric IV Therapy for Appendicitis

<table>
<thead>
<tr>
<th>Indication</th>
<th>Antibiotics</th>
<th>Dose &amp; Schedule</th>
<th>Max Single Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complicated Appendicitis (CA)</td>
<td>Ceftriaxone + Metronidazole</td>
<td>75mg/kg q 24h IV</td>
<td>2000mg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30 mg/kg q 24h IV</td>
<td>1500mg</td>
</tr>
<tr>
<td>Complicated Appendicitis with severe penicillin allergy¹</td>
<td>Ciprofloxacin + Metronidazole</td>
<td>15 mg/kg q 12hr IV</td>
<td>400mg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30 mg/kg q 24h IV</td>
<td>1500mg</td>
</tr>
<tr>
<td>Complicated Appendicitis with sepsis</td>
<td>Piperacillin/tazobactam²</td>
<td>100mg/kg q 8h IV</td>
<td>4000mg</td>
</tr>
</tbody>
</table>

¹Type 1 allergy defined by urticaria or anaphylaxis
²Metronidazole does not need to be added to a regimen with piperacillin/tazobactam since anaerobic coverage is adequate with piperacillin/tazobactam

PO Stepdown Therapy

<table>
<thead>
<tr>
<th>Indication</th>
<th>Antibiotic</th>
<th>Dose &amp; Schedule</th>
<th>Max Single Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complicated Appendicitis (CA)</td>
<td>Amoxicillin/Clavulanate</td>
<td>45/mg/kg/day divided BID</td>
<td>875 mg</td>
</tr>
<tr>
<td></td>
<td>Liquid 400mg/5mg for &lt;40kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Amoxicillin/Clavulanate</td>
<td>1 tablet BID</td>
<td>875mg</td>
</tr>
<tr>
<td></td>
<td>Tablet (875mg) for &gt;40kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complicated Appendicitis (CA) with Severe PCN Allergy</td>
<td>Ciprofloxacin + Metronidazole</td>
<td>15mg/kg q 12h po 10mg/kg q 8h po</td>
<td>500mg</td>
</tr>
</tbody>
</table>

Miralax Dosing

When tolerating regular diet start Miralax po (max 17 gm) prn no stool for 24 hours AND If discharged on narcotics also order Miralax qd X 5 days
- Age 1-5 years 4.25 grams (1/4 capful)
- Age 6-11 years 8.5 grams (1/2 capful)
- Age 12 and up 17 grams (1 whole capful)
Post Operative Management of Appendicitis

Perforated (defined as Fecalith in peritoneal cavity, purulent fluid present or obvious perforation visible)

Non-Perforated

Continue IV Antibiotics until patient meets D/C criteria: tolerating diet (defined as taking 50% of two meals with no episodes of emesis), pain controlled, afebrile for 24 hrs., ambulating and flatulence/BM. Must receive a minimum 3-day course of IV antibiotics and meet all above criteria before discharge home.

If patient has not met D/C criteria by POD 7, assess and consider CT.

Discharge home when tolerating diet (defined as taking 50% of two meals with no episodes of emesis) and pain is controlled.

Post-operative Antibiotics

* ONLY recommended for perforated appendicitis patients
  o No post-op antibiotics recommended for non-perforated appendicitis

* Begin postoperative antibiotics 4 hours after surgery
  - Ceftriaxone, 50 mg/kg/dose IV every 24 hours, max dose 2 grams
  - Metronidazole, 30 mg/kg/dose IV every 24 hours, max dose 1.5 grams

* Type-1 cephalosporin allergy (anaphylaxis, hives)
  o No history of type-1 penicillin allergy
    - Piperacillin/tazobactam 100 mg/kg/dose IV every 8 hours, extended infusion over 4 hours, max dose 3000 mg piperacillin
  o History of type-1 penicillin allergy
    - Ciprofloxacin 10 mg/kg/dose IV every 12 hours, max dose 400 mg WITH
    - Metronidazole (as above)

* Continue IV antibiotics for at least 48-72 hours

* After completion of 3 doses of postoperative antibiotics (48-72 hours), Afebrile > 24 hours, tolerating diet, and/or on other oral meds (i.e. for pain control), evaluate for discharge and discontinue antibiotics at time of discharge if meeting all criteria and attending-approved

*If patient does not meet criteria for discharge at 48-72 hours, IV antibiotic therapy should be continued until clinically well, or until post-op day 7, whichever comes first

* If not clinically well by post-op day 7, assess for post-operative abscess
  o For post-operative abscess:
    - Obtain source control if possible
    - Continue IV antibiotics until afebrile and clinically stable
    - Switch from IV to PO as above to complete a TOTAL of 10-14 days of antibiotics
Appendix iii
DRAIN PLACED

- Inpatient: Daily rounding with monitoring of output
- Outpatient: Weekly clinic visit with drain output diary

Output<20ml/day for last 2 days?

- No
  - >14 Days post drain placement?
    - No: Continue Drain
    - Yes: Fistula?
      - Yes: Fistula Management
      - No: Ultrasound

- Yes
  - Clinically well?
  - Afebrile for 48 hours?
  - Access window straightforward?
  - Yes: Discontinue Drain
  - No: Residual Collection?
    - Yes: Ultrasound Contrast Study
    - No: Drain Appropriately Positioned/and Patent?
      - Yes: Drain Change or New Placement
      - No: Continue Drain

Drain Study
Appendix iv
Rationale: Building on the work of the STOP-IT trial in adults, and other trials in the pediatric population such as Boom, et al, the PSQC is recommending the adherence to the below protocol on antibiotic duration for complicated appendicitis post appendectomy in all pediatric patients. Multiple well-designed randomized control trials in the U.S. and abroad support the limiting of post-op antibiotic duration in this patient population to no more than 4 days (±1). The PSQC supports implementing these clinical findings into standardized practice.

Inclusion: All pediatric patients <18 undergoing an appendectomy for a perforated appendix, commonly referred to as complicated appendicitis. Complicated appendicitis is defined as per NSQIP guidance:

Any of the following operative findings noted in the immediate or formal operative report are indicative of a complicated appendicitis diagnosis:

- Visible hole in appendix
- Fecalith in peritoneal cavity outside of the appendix
- Abscess
- Diffuse fibrinopurulent exudate in peritoneal cavity*

In order for Diffuse fibrinopurulent exudate in peritoneal cavity to meet criteria, documentation needs to meet both A & B below:

A. Description of fluid or exudate (any ONE of the following):

- Purulence
- Purulent fluid
- Purulent debris
- Purulent-fecal material
- Pus
- Fibrous exudate
- Fibrous or fibrinopurulent peel

B. Description of location of the fluid (any ONE of the following):

1. Anatomic quadrant
   - Left lower quadrant (LLQ)
   - Left upper quadrant (LUQ)
   - Right upper quadrant (RUQ)
2. Diffuse/generalized involvement
   - Throughout the peritoneal cavity
   - Throughout the peritoneum
   - Throughout the abdomen/abdominal cavity
   - All quadrants of the abdomen
3. **Involvement of specific organ**
   - Below/under/contact with/involving/adjacent to the diaphragm
   - Below/under/contact with/involving/adjacent to the liver
   - Below/under/contact with/involving/adjacent to the spleen

**Antibiotics:** First dose of antibiotic is administered at time of diagnosis. Antibiotic class should be based on an individual hospital’s prevalent antibiogram in collaboration with your Infectious Disease department. Most frequently administered antibiotic classes are cephalosporins (ceftriaxone), penicillins (zosyn) and metronidazole (flagyl). If the first dose is not administered within one hour of incision, surgical prophylaxis as per usual institutional practice should be followed.

**Post-op Antibiotics:** After good source control has been achieved*, antibiotics, either via IV or PO, should be stopped at 4 days (+/-1) after skin closure. If the clinical picture indicates an extended course be prescribed, that is left to the provider’s discretion.

The type of antibiotic administration, IV or PO, and the timing of any transition of antibiotic administration, is left to the center/surgeon’s discretion.

**Post-op Antibiotic Duration:** The duration of antibiotic administration recommendation is independent of the patient’s length of stay. If they are discharged on day 3, 5, 7 or 10, the antibiotic administration recommendation remains 4 days +/- 1 day.

**Discharge Criteria:** Discharge should be based on generally accepted criteria: no fever, pain controlled on oral medication, tolerating diet and return of bowel function.

**Labs:** The recommendation of this protocol is no WBC is needed for determining whether patient meets discharge criteria. WBC and CBC are not recommended as a routine part of determining discharge status unless the clinical picture indicates its necessity.

*Good source control is defined as procedures that eliminate ongoing contamination of the peritoneal cavity and removes the majority of contaminated contents to the extent that no further acute interventions are necessary. For purposes of this project, an appendectomy would satisfy this requirement. Other methods of treating complicated appendicitis such as drainage would not qualify as good source control.
Resources:


Resources:

American Pediatric Surgical Association (APSA) Quality and Safety Toolkit.


