Care Process Model

Pediatric Appendicitis
What is Multidisciplinary Care?

Multidisciplinary care is agreed upon, interdisciplinary, patient-centered, disease-focused, care delivery systems that are informed by a series of evidence-based care process models. Multidisciplinary care supports the achievement of the BIG(GER) Aim systematically across the continuum of care.

What is a Care Process Model (CPM)?

Care process models ensure that all care delivered by a hospital and its caregivers is medically necessary, the leading edge in medical science and the appropriate treatment intensity. Put into effect, these models will systemize treatment processes across all hospitals and practices, improving consistency as well as effectiveness. This CPM summarizes Mission Health’s tiered approach to care in the patient presenting with symptoms of appendicitis.

What are the benefits of a CPM?

- Reduces variation
- Utilizes the best practice from literature and expert opinion
- Improves care delivery process
- More readily exposes errors
- Variation study informs revisions to CPMs
Why Focus on Pediatric Appendicitis?

Appendicitis is the most common disease requiring urgent surgical treatment in the pediatric population, and appendectomy has been the standard treatment for a century. Though a universally survivable condition in this country, it carries with it significant morbidity and hospital cost. More than 100 pediatric appendectomies are performed per year by the Mission Health System (Midas+ data for FY2016).

GOALS:

The Care Process Model aims to do the following:

- Improve coordination of care between referring providers, surgeons and inpatient providers with respect to the management of acute appendicitis.
- Provide guidance on how to diagnose appendicitis.
- Provide guidance on appropriate imaging modalities.
- Educate providers on preferred antibiotic choices based on evidence-based literature and Mission’s antibiogram.
- Streamline inpatient process to improve pain control and LOS.

Executive Summary

Appendicitis is inflammation of the appendix, caused by obstruction of the appendiceal lumen, and often producing a constellation of dull and steady pain, fevers, nausea and vomiting. Since 1886 when Reginald Fitz first described appendicitis, the thought was that after 24 to 36 hours of the onset of pain the appendix will rupture and cause peritonitis unless removed surgically. Because of this risk it is has been imperative that appendicitis is quickly identified and diagnosed through physical examination, lab testing, and, if necessary, imaging technology. Once diagnosed or suspected, immediate referral and preparation for surgery has and still remains the appropriate next step. However, throughout the decades, many aspects of appendicitis management have been repeatedly questioned and subsequently revised. These would include the addition of antibiotic therapy in conjunction with surgery, the improvement in radiologic diagnostics, the timing of appendectomy, the introduction of laparoscopy, and most recently the notion of non-operative (antibiotic only) approach to simple non-perforated appendicitis. As early as 1956 there were reports of successfully treated appendicitis with antibiotics only, reporting a recurrent appendicitis rate of 14% 2. Today there are many studies underway examining this possible alternative to the traditional surgical treatment. Results are revealing greater than 90% 30 day success in treating appendicitis non-operatively, and anywhere from a 60-75% success at 1 year of not requiring appendectomy 2,3,4. Many institutions have begun adopting the non-operative approach in select patients with acute, non-perforated appendicitis, but the cost-effectiveness and long term results are still uncertain and dependent upon length of hospitalization, duration of IV antibiotics, and willingness to accept a small risk of recurrent appendicitis. Although there has been an increase in non-operative management, a large recent retrospective analysis demonstrated that this patient population had an increase in ED visits as well as hospitalizations. In addition, up to 46% of patients managed non-operatively went on to have an appendectomy.5

At Mission, we are continuing to increase the efficiency of our operative management with shorter hospital stays, and are not yet convinced of the superiority of non-operative management, especially long term. That being said, we are constantly considering new data as it is presented in the literature.
Key Interventions

A physical examination is typically necessary to diagnose appendicitis. Signs of appendicitis may include:

- Pain with walking or coughing and abdominal tenderness peaking at the McBurney point.
- Rebound tenderness of the abdomen, or even a positive Rovsing’s sign where palpation of the left abdomen reproduces the pain located in the RLQ.
- Right-sided tenderness present during rectal examination (rarely done or necessary).

Steps should also be taken to rule out other diagnoses with similar symptoms:

- Additional infectious testing may be necessary including but not limited to a CBC, UA and urine culture, strep testing, as well as PID screening and STD testing when appropriate.
- A lung examination should be performed to rule out pneumonia in all patients.
- A pelvic examination and/or pregnancy testing may be necessary for adolescent girls to rule out gynecological conditions.

Applicable lab studies:

- Appendicitis can be indicated with a white blood cell count in the range from 10,000 to 20,000/mcL, but this measure should not indicate diagnosis independently due to its lack of specificity.
- Urinalysis can rule out urinary tract infections or diabetic ketoacidosis.

A consistent history, high white blood cell count and right lower quadrant abdominal tenderness are strong signs of appendicitis and imaging may occasionally be unnecessary.

Recently, scoring systems have been created to help identify patients with acute appendicitis. The Pediatric Appendicitis Score (PAS) was first introduced in 2002 by Samuel.⁶

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptoms</td>
<td></td>
</tr>
<tr>
<td>Migration of pain</td>
<td>1</td>
</tr>
<tr>
<td>Anorexia</td>
<td>1</td>
</tr>
<tr>
<td>Nausea/vomiting</td>
<td>1</td>
</tr>
<tr>
<td>Signs</td>
<td></td>
</tr>
<tr>
<td>Right lower quadrant tenderness</td>
<td>2</td>
</tr>
<tr>
<td>Rebound pain</td>
<td>2</td>
</tr>
<tr>
<td>Elevation of temperature ≥38°C</td>
<td>1</td>
</tr>
<tr>
<td>Laboratory</td>
<td></td>
</tr>
<tr>
<td>Leukocytosis ≥10 × 10⁹/L</td>
<td>1</td>
</tr>
<tr>
<td>Polymorphonuclear neutrophilia ≥75%</td>
<td>1</td>
</tr>
</tbody>
</table>

The Pediatric Appendicitis Score
In further validation studies, the PAS has been found to be of assistance in diagnosing acute appendicitis but not of adequate predictive value to be used independently in the absence of expert pediatric surgical input.\textsuperscript{7,8} Therefore, we conclude that the use of the Pediatric Appendicitis Score (PAS) in the Urgent Care and Primary Care setting may be helpful in evaluating patients with possible appendicitis (see algorithm for application). Imaging may be recommended.

At present, imaging diagnostics are highly sensitive and specific for appendicitis. Imaging studies have dramatically decreased the negative appendectomy rate, and thus radiologic imaging has been incorporated into the standard of care.\textsuperscript{9} Both the American College of Radiology and the American Academy of Pediatrics have put forth recommendations that ultrasound of the right lower quadrant should be the initial imaging modality for evaluating pediatric patients for appendicitis.\textsuperscript{9} Though the limited CT scan with IV and PO contrast has both specificity and sensitivity up to 97\%, the higher cost and exposure to ionizing radiation have pushed us to reserve it for those in whom the appendix cannot be visualized on ultrasound. The accuracy of ultrasound varies dramatically by institution, and greatly depends upon whether the appendix is visualized or whether secondary signs of inflammation are recognized, reflecting its dependency upon the operator skill and training.\textsuperscript{9}

Currently our algorithm directs providers towards the following if moderate to high suspicion of appendicitis:

- Ultrasound at Mission Children’s Specialists (Reuter Outpatient Center) during office hours.
- Limited CT with PO and IV contrast if after hours or if ultrasound unavailable, due to technologist training and availability.

If appendicitis is confirmed, the patient will advance to a surgical consultation and administration of antibiotics. At Mission, this can be facilitated via a direct admission to the Pediatric Hospitalist Service. The patient will need to be prepared for surgery:

- No food or fluids
- Ceftriaxone 50mg/kg up to 2,000mg \textsuperscript{10}
- Metronidazole (Flagyl) 30mg/kg up to 1,500mg \textsuperscript{10}
- Normal saline 20mL/kg
- MIVF of D5 NS and KCL
- Confirm how imaging will be transferred to surgeon
- Confirm method of transport of the patient
- Perform pain management with oral Tylenol and IV morphine
Postoperative Care will include:

- MIVF
- Antibiotics according to level of complication.\(^{12}\)
  - In the setting of perforated appendicitis and/or the presence of peritonitis, ceftriaxone IV and metronidazole (Flagyl) IV will be continued post-operative at the surgeon’s discretion.
  - If indicated, oral antibiotics to include coverage of E. coli and anaerobes will be continued on discharge. Based on review of antibiograms at Mission, antibiotics of choice will include a 3rd generation cephalosporin, such as cefdinir, and metronidazole (Flagyl).\(^{11}\)
- Initial pain control post-operatively will be with Tylenol and anti-inflammatories such as ibuprofen or Toradol. Narcotics, both IV and PO, for pain management will be limited and reserved for moderate to severe breakthrough pain.
- Diet plan according to surgeon’s orders.
- Hospitalization if warranted for post-operative care at the surgeon’s discretion.
- Discharge Planning.
- Patient education for care at home.
Care Process Model

CHILDREN'S

Acute Appendicitis – Postoperative Care

Uncomplicated
- Continue MIVF
- Discontinue antibiotics
- Initiate PRN oral narcotic / scheduled IV toradol (6h from intraop dose if given)
- Nurse to advance diet as tolerated unless alternate diet entered by surgeon
- Home when tolerating regular diet with ibuprofen and tylenol

Suppurative (local contamination)
- Continue MIVF
- Continue antibiotics
- Initiate PRN oral narcotic / scheduled IV toradol (6h from intraop dose if given)
- Nurse to advance diet as tolerated unless alternate diet entered by surgeon

Complicated (gros perforation)
- Continue MIVF
- Continue IV antibiotics for minimum of 3 days postoperatively
- Initiate PRN oral narcotic / scheduled IV toradol (6h from intraop dose if given)
- NPO unless alternate diet entered by surgeon

Advance diet when passing gas / stooling
- Continue IV abx until afebrile for 24h postoperative
- Discomfort minimal and tolerating a regular diet
- Consider repeat imaging if persistent fever, ileus, dysuria, pain >5-7 days from surgery to evaluate for abscess

If gross perforation, consult with surgery to determine need to continue oral antibiotics on discharge for 5-7 days with cefdinir + metronidazole
- Cefdinir
  - 7mg/kg/dose PO BID suspension (max dosing 300 mg per dose)
  - 300mg PO BID tabs
- Metronidazole
  - 10mg/kg/dose TID suspension (max dosing 500mg per dose)
  - If suspension used, consider use of compounding pharmacy
  - 500mg PO TID tabs
Metrics

These metrics are to serve as important elements in the creation of the templates in the electronic medical record and will be collected and reported as they become available in our information systems.

The following metrics will be used by Mission Health as a measure of the quality care we provide. These measures are based on national standards of care and signal critical points in the care of adolescents with appendicitis.

**Average Length of Stay (LOS):** Calculated by dividing the sum of inpatient days by the number of patient admissions with a diagnosis of appendicitis.

**Average Cost per Case:** Calculated by dividing the sum of costs for patients with a diagnosis of appendicitis by total number of patient admissions.

**Readmission Rate:** All cause readmissions within 30 days of discharge in patients discharged with a diagnosis of appendicitis.

**Use of Imaging:** Percent of patients with appendicitis who received an ultrasound only, ultrasound followed by CT, or CT only.

**Use of CT Scan:** Number of abdominal or pelvis scans from outside facilities or Mission ER out of diagnosed patients.

**IV Narcotics Use:** Number of patients administered IV Narcotics out of patients who had appendectomies. Number of doses of narcotic per patient.

**Antibiotics Use:** For both pre and post operation the number of patients conforming to the plan.

**Advancing Ambulation/Incentive Spirometry:** Utilization rate in patients who have undergone appendectomy.

Resources

Includes patient education and patient engagement materials.

Healthwise:

- Abdominal Pain: Frequent: Pediatric
- Abdominal Pain: Pediatric
- Abscess: Perineal
- Adhesions
- Adhesions: Post-Op
- Adhesions: Pre-Op
- Appendectomy: Pediatric Inpatient: General Info
- Appendectomy: Pediatric: Post-op
- Appendicitis: Pediatric


