Reduction of CT utilization for Pre-op Imaging of Pediatric Appendicitis

Implementation Guide
## Contents:

- **Introduction** ................................................. 4
- **How to use this Guide** ................................. 6
- **Aim Statement** ........................................... 9
- **Quality Measures** ....................................... 10
- **Intervention Strategies** ............................. 11

### Appendices

- **Appendix i-Flowchart** .................................. 16
- **Appendix ii-Illustrations** ......................... 19
  - 1b Fishbone
  - 1c Key Driver
- **Appendix iii-Validated triage tools** .......... 22
  - a. PAS
  - b. Alvarado
- **Appendix iv-Triage Protocols** ................... 23
  - a. Wisconsin Triage Protocol
  - b. Texas Children’s Triage Protocol
  - c. Penn State Triage Protocol
- **Appendix v-Imaging Protocols** ............... 27
  - a. Penn State MRI imaging protocol
  - b. Wisconsin Ultrasound imaging protocol
- **Appendix vi-Imaging Report Templates** ...... 29
  - a. Wisconsin Ultrasound reporting template

### Resources

- ................................................................. 32
Attachments

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

On October 1, 2020, the PSQC formally launched the CT utilization reduction project. In Dr. Hauptman’s 2018 study from The Netherlands, pediatric patients who had 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 American College of Radiologists Appropriateness Criteria recommends the use of non-ionizing radiation imaging techniques as a first line approach for acute appendicitis diagnosis in all patients.

The members of the pediatric surgery community agree with the principle of ALARA*. There is also a strong desire to reduce any unnecessary surgery (negative appendectomy rate-NAR). Most of our hospitals receive patients from community hospitals where CT utilization may be higher than at a children’s hospital. The differences in diagnostic approaches creates a bit of a dilemma in achieving a meaningful reduction in CT utilization for pediatric patients with suspected appendicitis.

The PSQC undertook a qualitative approach to assessing best practice among our collaborative members with the intent of developing a resource for all members who might wish to reduce their reliance on CT scans in diagnostic work-ups of patients. We invited our low and high performers on this metric to participate in qualitative interviews with members of our Implementation Committee (IC). Interviewees included a broad range of disciplines: NSQIP surgeon champions; surgical chart reviewers (SCRs); Pediatric Radiologists; and Pediatric Emergency Medicine physicians.
The interviews were conducted using a guide (appendix) to promote consistency in developing responses. The guide was predicated on the Theoretical Domains Framework (TDF) approach to understanding what motivates behavior and how 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 exerted the greatest influence on practice: environment; memory, attention and decision processes; motivation and goals; beliefs about capabilities (self-efficacy); social/professional role and identity.

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 illustrate those 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 IC appreciates there are many different ways a hospital might approach change. This implementation guide is built on what we found in our interviews to be the most prevalent factors influencing behavior among the hospitals we interviewed. We anticipate each of our member hospitals who elect to participate in this quality improvement project, may find their immediate environment may respond better to a different approach.

*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.
How to Use This Guide

Please consider this guide as a tool to assist you in initiating change at your hospital. This guide can be used by any of our member hospitals to improve their radiation stewardship—our high outliers, low outliers and our ‘as expected’ performers. 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 as a means to moving their performance into exemplary territory.

As stated earlier, guide development was based on our qualitative interviews. The majority of our high performing interview participants utilize ultrasound as their primary imaging modality in suspected acute appendicitis cases. The PSQC recognizes that MRI as a primary imaging modality, or secondary if ultrasound is equivocal, is also a best practice and the primary approach at many of the high performing sites within the collaborative. This approach is not mentioned in the fishbone or key drivers due to the fact the qualitative assessment did not reveal significant enough data to incorporate into these tools. This guide can be used in either setting however. The change strategies can be adapted to an MRI focus if your site decides this is the best approach. The PSQC does not endorse ultrasound as being superior to MRI or vice versa. Either imaging modality is appropriate for this indication.

The guide consists of: the PSQC global aim for this CT reduction project; quality measures to assist our members in documenting where and how much 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 triage algorithms currently in use by some of our members; imaging protocols currently in use by some of our members; the Theoretical Domains Framework (TDF) definitions; and a step-by-step guide to pulling your raw data from NSQIP.
The first place to start is to review your most recent Collaborative Appy Targeted SAR from NSQIP with your SCR or NSQIP manager to identify where your hospital is relative to other PSQC hospitals. It is suggested you review at least the last three Appy SARs, if available, to have a better appreciation of how your hospital performs over a longer time frame.

Secondly, review the quality measures on page 8. You may find your hospital has several of the structural measures in place now. You can collect all the documents or guides currently outlines in your hospital policy and review. Are these protocols in actual use in your emergency department? Perhaps they were introduced at some point but have fallen into disuse due to lack of training of new staff as they come on board or a general tendency for policies, however well intentioned, to be forgotten or misunderstood in practice.

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 physician with some level of authority from PEM, pediatric radiology or pediatric surgery. From our interviews, we found our most successful implementers of change had a strong champion. The intradepartmental workgroup should consist of a leader from PEM, Ped Radiology, Ped Surgery, Hospital QI (if in place at your site), the SCR or NSQIP program manager and, if possible, an experienced sonographer.

In order to have a true understanding of the intake process for suspected acute appendicitis in your ED, one member of your intradepartmental workgroup should conduct a Gemba Walk of the entire process—from the time a patient is received in the ED, either as a walk-in or transfer, until patient is admitted for surgery or discharged home.

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

Take care to start small. You can build on small successes to achieve your higher-level goal. Insisting that an increase in imaging options, i.e. more ultrasound machines for pediatric ED or more sonographers, is the way to improve your results on CT utilization for these patients, is not likely to be successful. Some smaller changes may move the needle in a positive direction.
which will further support any ask you may eventually bring to Administration on capital investment in equipment and personnel.

Next-measure, measure, measure. You can’t know what effect any change you’ve instituted is having on your goal without measuring its effect. There are several tools you can use to measure whether your change is having any effect—either positive or negative. We have attached in the appendix the quality improvement essentials toolkit collated from the Institute for Healthcare Improvement for your use.
Aim Statement

By June 30, 2022, the aggregate CT utilization rate for the Collaborative will be reduced from 24.5% to 15%.

Balancing Measure

The negative appendectomy rate for the Collaborative will remain at or below 1.75%.
Quality Measures:

Structural Measure #1: Presence of a written ED triage algorithm for assessment of patients who present with RLQ complaint utilizing a validated tool (PAS, Alvarado, etc.)

Structural Measure #2: Presence of a written guideline/protocol/algorith on imaging for pediatric patients with suspected appendicitis who present in ED

Structural Measure #3: Presence of an ultrasound imaging report template for appendicitis in pediatric patients

Process Measure #1: Development of an intradepartmental imaging workgroup

Process Measure #2: Proportion of patients presenting with RLQ pain triaged utilizing your institution’s designated tool

Process Measure #3: Proportion of patients presenting with RLQ pain with CT scans ordered

Outcome Measure #1: Reduction of CT utilization
Intervention Strategies

**Key Driver 1:** Multidisciplinary approach to quality improvement using best practices in imaging

*Cultivate a workgroup with representation from key stakeholders*

Change Strategies:

- Identify a physician champion
- Develop committee composed of representation from pediatric surgery, pediatric radiology, pediatric emergency medicine and hospital quality improvement if it exists
- Meet regularly to review the NSQIP SARs to assess any changes in CT utilization
- Implement small tests of change through a PDSA cycle

**Key Driver 2:** Written protocol/algorith for triage of suspected appendicitis in ED

*A written protocol/algorith would incorporate a validated pediatric appendicitis assessment tool (PAS, Alvarado, etc.-see appendix) in any imaging decisions made in the ED for suspected appendicitis.*

Change Strategies:

- Identify a physician champion
- Develop a written protocol/algorith that provides a visual flow to triage decisions in pediatric appendicitis patients. Should indicate the following:
  - Legend to facilitate scoring
  - Score with titration
  - Imaging decision based on triage tool score
  - Read of outside imaging
  - When to request surgery consult
When to start antibiotics

Which antibiotics and dosing

When discharge home is appropriate

• Share triage algorithm with all front-line ED staff (PEM, RNs, sonographers, radiology) and pediatric surgery

**Key Driver 3: Written protocol for performance and interpretation of ultrasound for appendicitis**

A written protocol which details how an ultrasound for suspected appendicitis is conducted (see appendix for examples) with guidance on grading of imaging, what level of appendix visualization qualifies as a positive finding, negative finding or equivocal finding, and what secondary factors support a positive finding.

**Change Strategies:**

• Develop a written protocol that provides discreet direction on how sonographer conducts an imaging study for appendicitis. Should indicate the following:
  
  o Prep guidelines
  
  o Imaging protocol
  
  o Additional imaging if appendix is visualized
  
  o Additional imaging if appendix is visualized with suspected appendicitis
  
  o Imaging of appendix and ovaries in menstruating females
Key Driver 4: Training of ultrasound technicians on imaging of appendix

_Develop a standardized training for all sonographers._

Change Strategies:

- Create a curriculum for all ultrasound technicians
- Provide supervised practical training on how to conduct an ultrasound for appendicitis
- Create a process to assure in-service for all new sonographers on imaging technique with a senior sonographer

Key Driver 5: Ultrasound report template in EHR

_Develop a standardized report for imaging for appendicitis embedded in the EHR_

Change Strategies:

- Use templates endorsed by the Society of Pediatric Radiologists for ultrasound reports on appendicitis
- Modify as appropriate for your hospital setting
- Template should address:
  - exam quality;
  - visibility of appendix;
  - transverse outer diameter of appendix;
  - hyperemia of appendix;
  - Visualization of appendicolith
  - Fluid
  - Tenderness
  - Echogenicity of mesenteric fat;
  - Other findings; and
Key Driver 6: Imaging strategy for patients with BMI ≥ 30.

Develop a protocol around conducting ultrasound imaging of patients with high BMI when an initial ultrasound is inconclusive

Change Strategies:

- Create work group to develop best approach for successful ultrasound on heavier patients
- Approach should consider:
  - Positioning of patient for exam
  - Repeat imaging for equivocal findings
Appendices
Appendix i
Step 1: Review Appy SAR

Is your CT use > 15%

Yes: Create intra department workgroup: PEM, Rad, Surgery, Hosp. QI, SCR

No: Create intra department workgroup: PEM, Rad, Surgery, Hosp. QI, SCR

No change

Step 2: Establish meeting schedule

Identify physician champion for project

Step 3: Gemba walk to document current process

Identify point in current process where tool can be inserted

Yes: Go To Step 4

No: Does ED use an appy triage tool? (PAS/Alvarado /etc.)

Yes: Go To Step 4

No: Provide inservice on process

Assure every dept touched by process is aware of outputs

Measure!
Step 4:

Conduct imaging resources inventory

Are US/MRI available consistently?

- Yes: Work w/change team to create process to make better use of resources
- No: Strategize w/champion to influence admin to make investment

Are staff trained for ped appy imaging?

- Yes: Strategize w/champion and rad to create training opps
- No: Train staff

Train staff

Go To Step 5
Step 5:

- Review appy SAR

---

Has CT use decreased?

- Yes: Has neg appy rate increased?
  - Yes: Identify process break
  - No: Great! Keep going!

- No: Review cases for RCA

---

Measure!
Appendix ii
Aim

Reduce on-site CT utilization in pre-op appendicitis cases from 24.5% to 15% by July 1, 2022

Primary Drivers

- Utilization of non-ionizing imaging modalities
- Improve working relationship across disciplines

Secondary Drivers

- Screening patients
- Imaging efficacy
- Quality improvement culture

Change Concepts

- Written protocol for triage of all suspected appendicitis cases in ED
- Written protocol for ultrasound performance and interpretation for appendicitis
- Training of ultrasound technicians on imaging of appendix
- Ultrasound report template in the EHR
- Strategy for patients with BMI > 30
- Multidisciplinary work group-PEM, Ped RAD, Ped Surg, Hospital QI, SCR
Appendix iii
Validated triage tools

Table 2. Pediatric Appendicitis Score

<table>
<thead>
<tr>
<th>Diagnostic Indicators</th>
<th>Score Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cough/percussion or hip tenderness</td>
<td>2</td>
</tr>
<tr>
<td>Anorexia</td>
<td>1</td>
</tr>
<tr>
<td>Pyrexia</td>
<td>1</td>
</tr>
<tr>
<td>Nausea/emesis</td>
<td>1</td>
</tr>
<tr>
<td>Tenderness in RLQ</td>
<td>1</td>
</tr>
<tr>
<td>Leukocytosis &gt; 10,000</td>
<td>2</td>
</tr>
<tr>
<td>Polymorphonuclear neutrophilia</td>
<td>1</td>
</tr>
<tr>
<td>Migration of pain</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10</strong></td>
</tr>
</tbody>
</table>

PAS = Pediatric Appendicitis Score; RLQ = right lower quadrant.

<table>
<thead>
<tr>
<th>Assessment item</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain migration to RIF</td>
<td>1</td>
</tr>
<tr>
<td>Anorexia</td>
<td>1</td>
</tr>
<tr>
<td>Nausea and vomiting</td>
<td>1</td>
</tr>
<tr>
<td>RIF tenderness</td>
<td>2</td>
</tr>
<tr>
<td>Rebound tenderness</td>
<td>1</td>
</tr>
<tr>
<td>Fever ≥ 37.5 °C</td>
<td>1</td>
</tr>
<tr>
<td>Raised WCC</td>
<td>2</td>
</tr>
<tr>
<td>Shift of WCC to left</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total score</strong></td>
<td><strong>10</strong></td>
</tr>
</tbody>
</table>

Guidelines for management according to total score:
<4, probability of acute appendicitis (AA) unlikely; 4–7, AA suspected; >7, definite AA.

RIF, right iliac fossa; WCC, white cell count.
Appendix iv
Pediatric Appendicitis Score (PAS)

EDTC/Surgery Pediatric Appendicitis Tool is intended for use by the EDTC and Surgery staff in evaluation of children with possible appendicitis. The Pediatric Appendicitis Score (PAS) and the Physician Evaluation Time Log are to be completed by the practitioners involved in the patient’s evaluation.

### Pediatric Appendicitis Score

<table>
<thead>
<tr>
<th>History</th>
<th>Exams</th>
<th>Labs</th>
<th>Total Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nausea/Vomiting</td>
<td>Anorexia</td>
<td>Migration of Pain (Periumbilical to RLQ)</td>
<td>Fever (&gt;38°C, oral)</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Tenderness in RLQ</td>
<td>Cough, Percussion, Hop Tenderness</td>
<td>Leukocytosis (&gt;10,000/mm³)</td>
<td>PMN Neutrophilia, Left Shift (&gt;7,500/mm³)</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**Total Points** Suspicious (4-6); Obvious (≥7)

<table>
<thead>
<tr>
<th>Initial heart rate elevated for age?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1 yr</td>
<td>1-6 yrs</td>
<td>6-12 yrs</td>
</tr>
<tr>
<td>&gt; 150</td>
<td>&gt; 110</td>
<td>&gt; 95</td>
</tr>
</tbody>
</table>

### Physician Evaluation Time Log

<table>
<thead>
<tr>
<th>Signature</th>
<th>Date/Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDTC Resident/NP/PA Evaluation</td>
<td></td>
</tr>
<tr>
<td>EDTC Fellow/Attending Evaluation</td>
<td></td>
</tr>
<tr>
<td>Pain Medicine Given</td>
<td></td>
</tr>
<tr>
<td>Surgery Consult Paged</td>
<td></td>
</tr>
<tr>
<td>Surgery Resident/PA Evaluation</td>
<td></td>
</tr>
<tr>
<td>Surgery Fellow/Attending Evaluation</td>
<td></td>
</tr>
<tr>
<td>Surgical Decision Made</td>
<td></td>
</tr>
</tbody>
</table>

### Pediatric Appendicitis Tool

**PAS ≥ 4**
NPO, IVF, pain meds, β-HCG*

**PAS = 4 - 6**
Ultrasound

**PAS ≥ 7**
No imaging
Surgery consult

**Ill-appearing; onset > 3 days**
Surgery consult (possible abscess)
IV contrast CT; IV antibiotics

**Positive**
Surgery consult

**Negative**
Disposition per EDTC

**Appendix not visualized**
IV contrast CT

**Positive/Equivocal**
Consult surgery

**Negative**
Disposition per EDTC

* For menstruating females
Immediately refer to the Septic Shock guideline and intervene rapidly if patient has toxic appearance, altered mental status, and/or compromised perfusion with abnormal vital signs.

**Pediatric Appendicitis Score (PAS)**

*Use for children ≥2 years*

- Migration of pain [1]
- Cough/Hooping/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.*

**Discharge Criteria (DC):**

- Afebrile x 24 hours (<39.9°F)
- Tolerating regular diet
- Pain controlled with oral pain medications
- Ambulating
- Benign abdominal physical exam (no tenderness/mass)

If ≥7 days duration, localized pain/tenderness, able to maintain oral intake

**Advanced/Complicated appendicitis (perforated or gangrenous)?**

- Obtain culture of abscess if present
- Continue antibiotics post-operatively until discharge criteria are met

**Reassess discharge criteria after 48 hours**

**Reassess discharge criteria after 48 hours**

**Discharge home**

**Discharge home**

**Discharge criteria met?**

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

**Reassess discharge criteria after 48 hours**

**Discharge criteria met**

- If complicated intra-abdominal abscess(es), recurrent abscess or multiple drains, prolonged length of stay >14 days, Consult Infectious Disease. OFF algorithm

**Discharge home**

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

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

**Discharge home**

**Image positive for appendicitis?**

- Consult Surgery

**Discharge home**

**Order analgesia as warranted**
- Consider initiating PCA
- Order US examination

**OFF algorithm**

Explore alternate diagnosis OR DC home if DC criteria met

**For clinical findings of acute gastroenteritis, refer to the AGE guideline.**

**For clinical findings of urinary tract infection, refer to the UTI guideline.**

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

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

**Pt ≥2 years and PAS ≥4**

**Pt ≥4 years and PAS ≤4**

**Pt ≥3 years:**

- Low suspicion for appendicitis

- Equivocal suspicion for appendicitis

- High suspicion for appendicitis

**Pt ≥4 years and PAS 5-7**

**Pt ≥4 years and PAS ≥8**

**Pt ≥2 years:**

**OFF algorithm**

**Acute Appendicitis**

- Suspicion for appendicitis

- Suspicion for abscess

- US at 6-7 days only if clinical suspicion for abscess

- Perform appendectomy

- Immediate refer to the Appendicitis guideline

- Consult Surgery

- Image positive for abscess/phlegmon

- Order CT

- Consult Surgery

- Order CT

- Obtain surgery consult prior to ordering CT

- Discharge Criteria

- Afebrile x 24 hours (<39.9°F)

- Tolerating regular diet

- Pain controlled with oral pain medications

- Ambulating

- Benign abdominal physical exam (no tenderness/mass)

- Advanced/Complicated appendicitis (perforated or gangrenous)?

- Discharge Criteria

- Afebrile x 24 hours (<39.9°F)

- Tolerating regular diet

- Pain controlled with oral pain medications

- Ambulating

- Benign abdominal physical exam (no tenderness/mass)

- Obtain culture of abscess if present

- Continue antibiotics post-operatively until discharge criteria are met

- Reassess discharge criteria after 48 hours

- Discharge home

- Reassess discharge criteria after 48 hours

- Discharge home

**Appendectomy Management Algorithm**

**TCH Evidence-Based Outcomes Center**

**Acute Appendicitis/Appendectomy Management Algorithm**

**Begin**

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

**US exam & pregnancy test in pubescent females**
Pediatric patient (age <18 years) with suspected appendicitis

Nurse & provider evaluation
Nurse places LMX if desired
Resuscitation if unstable

Imaging already performed at outside facility?

Orders:
NPO
Peripheral IV
Labs: CBC, CRP, BMP, urine dip, Hcg (if postmenarchal)
COVID-19 in-house if likely appy
Meds: Tylenol IV prn fever or mild pain
Morphine prn
Zofran prn
NS bolus if dehydrated

Imaging:
- Able to hold still & no concern for COVID:
  MRI abdomen & pelvis*
  - Symptoms ≤5 days: w/o contrast
  - Symptoms >5 days: w/ contrast
- Unable to hold still: US abdomen limited
  (most patients age <5yrs, developmental delay, etc)
- Has positive COVID screening questions: US abdomen limited
Imaging not completed within 1hr of order:
Consult surgery for recommendations

Imaging read

Negative for appendicitis
Inconclusive (appendix not visualized)
Positive for appendicitis

Give antibiotics:
Ceftriaxone
Flagyl
MIVFs (NS)
Pain control

Pediatric Surgery Consult
Page surgery resident:
Weekdays 8am-5pm:
- Peds surgery resident
After 5pm & weekends:
- General surgery ED consult resident
Consider observation versus CT abdomen/pelvis for patients with inconclusive US

Med Dosing:
Tylenol IV: 15mg/kg q4hrs prn
Zofran IV: 0.1mg/kg max 4mg
Morphine IV: 0.05-0.1mg/kg
Ceftriaxone: 50mg/kg max 2g
Flagyl: 30mg/kg max 1500mg

Positive for appendicitis
Negative for appendicitis
Inconclusive or differs from outside read

HMC imaging read

Update 7/2020. Authors: Gail Rudnitsky MD, Mary Santos MD, Kathryn Kasmire MD

*COVID-19 testing required preoperatively. Order early if high-suspicion for appendicitis
Put comment in MRI order if COVID-19 testing ordered for pre-op only in patients with no COVID-19 symptoms or exposures
Appendix v
**PEDS APPENDICITIS MRI IMAGING**

**AGES:** 5 years old to 17 years 364 days/younger children (4-3 years old) if able to hold still without sedation

**SEDATION:** None/Exam not done on sedated patients

**CONTRAST:** No IV contrast. No Oral Contrast

**NOTE:** Haste sequences should be run free-breathing, no breath holds or triggering

<table>
<thead>
<tr>
<th>Plane/Sequence</th>
<th>Area of Coverage</th>
<th>FOV</th>
<th>Slice Thickness</th>
<th>GAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CORONAL T2 HASTE</td>
<td>Lung Bases to Pubic Symphysis</td>
<td>Varies depending on size of pt.</td>
<td>4mm</td>
<td>10%</td>
</tr>
<tr>
<td>2. CORONAL T2 HASTE WITH FATSAT</td>
<td>Lung Bases to Pubic Symphysis</td>
<td>Varies depending on size of pt.</td>
<td>4mm</td>
<td>10%</td>
</tr>
<tr>
<td>3. AXIAL T2 HASTE</td>
<td>Lung Bases to Pubic Symphysis</td>
<td>Varies depending on size of pt.</td>
<td>4mm</td>
<td>10%</td>
</tr>
<tr>
<td>4. AXIAL T2 HASTE WITH FATSAT</td>
<td>Lung Bases to Pubic Symphysis</td>
<td>Varies depending on size of pt.</td>
<td>4mm</td>
<td>10%</td>
</tr>
</tbody>
</table>
Ordered as:
1. US Appendix
2. US Appendix and Pelvis Complete with Ovarian Doppler

Prep Guidelines: None if ordered as US Appendix; if ordered with a pelvis, patient must have a full bladder as stated under the US Pelvis protocol.

Exam Time: 30 to 60 minutes

Indications for Exam:
1. Evaluation of right lower quadrant pain
2. To assess for free fluid or abscess formation

Imaging Protocol:
The highest frequency linear transducer should be used. A graded compression technique should be utilized starting in the region of maximal pain indicated by the patient. The anterior abdominal wall is compressed slowly and firmly with the transducer to displace bowel loops to locate the appendix. When appendix is not seen, scan time should be at LEAST 20 minutes. A second sonographer should make an attempt to locate the appendix, when possible. An EPIC dot phrase (.usappendix) should be utilized at the end of exam for exam note details.

Imaging protocol should be as follows at a minimum:
1. Transverse Bladder
2. Transverse RLQ, color Doppler image of iliac artery and iliac vein
3. Transverse RLQ still images
4. Transverse RLQ cine clips
5. Transverse RLQ, area of max pain indicated by the patient
6. Long RLQ still images
7. Long RLQ cine clips
8. Long RLQ, area of max pain indicated by the patient
9. Transverse cine clip from RUQ – RLQ
10. All the above should be repeated in LLD positioning if appendix is not found.

Additional imaging if Appendix is visualized:
1. Transverse and Long RLQ Grayscale stills and cines of the normal appendix from base to tip
2. Cine clip demonstrating the blind end of the appendix should be obtained
3. Transverse RLQ appendix cine clip demonstrating compressibility or utilization of a dual screen image showing compression
4. Measurement in AP Diameter, place within machine measurement package
5. Transverse RLQ Color Doppler/Power Doppler
6. Long RLQ Color Doppler/Power Doppler

Additional imaging if Appendix is visualized with suspected appendicitis:
- Special attention should be placed on the surrounding mesenteric fat, as inflammation will cause the fat to be echogenic.
- Be sure to note if there is an appendicolith in the appendix, if present measure in 3 planes
- Be sure to note if there is free fluid within the RLQ

US Appendix and Pelvis Complete with Ovarian Doppler:
- Be sure to include above appendix protocol and US Pelvis Complete Protocol
Appendix vi
US Report Template

CLINICAL HISTORY: Reason For Study

COMPARISON: None.

PROCEDURE: Graded compression ultrasound was performed in the potential locations of the appendix.

FINDINGS:

Exam quality:
Exam Quality: Limited evaluation due to bowel gas./ Limited evaluation due to patient size./ Limited evaluation due to patient motion./ Not limited.

Visibility of the appendix:
Appendix: The appendix is not seen./ The appendix is partially seen./ The appendix is seen to the tip.

Transverse outer diameter of appendix:
Transverse outer diameter: The appendix is not seen./ The appendix is not completely seen./ ___ mm.

Hyperemia of the appendix:
Hyperemia: The appendix is not seen./ The appendix is not completely seen./ There is no hyperemia within the wall of the appendix./ There is hyperemia within the wall of the appendix.

Appendicolith:
Appendicolith: The appendix is not seen./The appendix is not completely seen./No appendicolith is seen./An appendicolith is seen within the appendix.

Fluid adjacent to the appendix:
Fluid adjacent to the appendix: The appendix is not seen./The appendix is not completely seen./No free fluid is seen adjacent to the appendix./Free fluid is seen adjacent to the appendix.

Tenderness with sonographic compression of the appendix:
Tenderness: The appendix is not seen./The appendix is not completely seen./The patient did not exhibit tenderness with sonographic palpation of the appendix./The patient exhibited tenderness with sonographic palpation of the appendix./The evaluation is limited, as the patient was given pain medication prior to the exam.

Echogenicity of the mesenteric fat in the right lower quadrant:
Echogenicity: There is normal echogenicity of the mesenteric fat of the right lower quadrant./There is increased echogenicity within the mesenteric fat of the right lower quadrant, consistent with inflammatory changes./Evaluation of the mesenteric fat of the right lower quadrant is limited.

Other findings:
None.

IMPRESSION:
Impression: Normal appendix is identified with no sonographic findings of appendicitis./Appendix is seen with equivocal findings for appendicitis./Appendix is seen with findings consistent with appendicitis./Appendix is not seen, but no secondary inflammatory changes are seen in the right lower quadrant./Appendix is not seen, but there are secondary signs of inflammation in the right lower quadrant, which could be associated with appendicitis./Limited evaluation due to ***
Resources:

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


