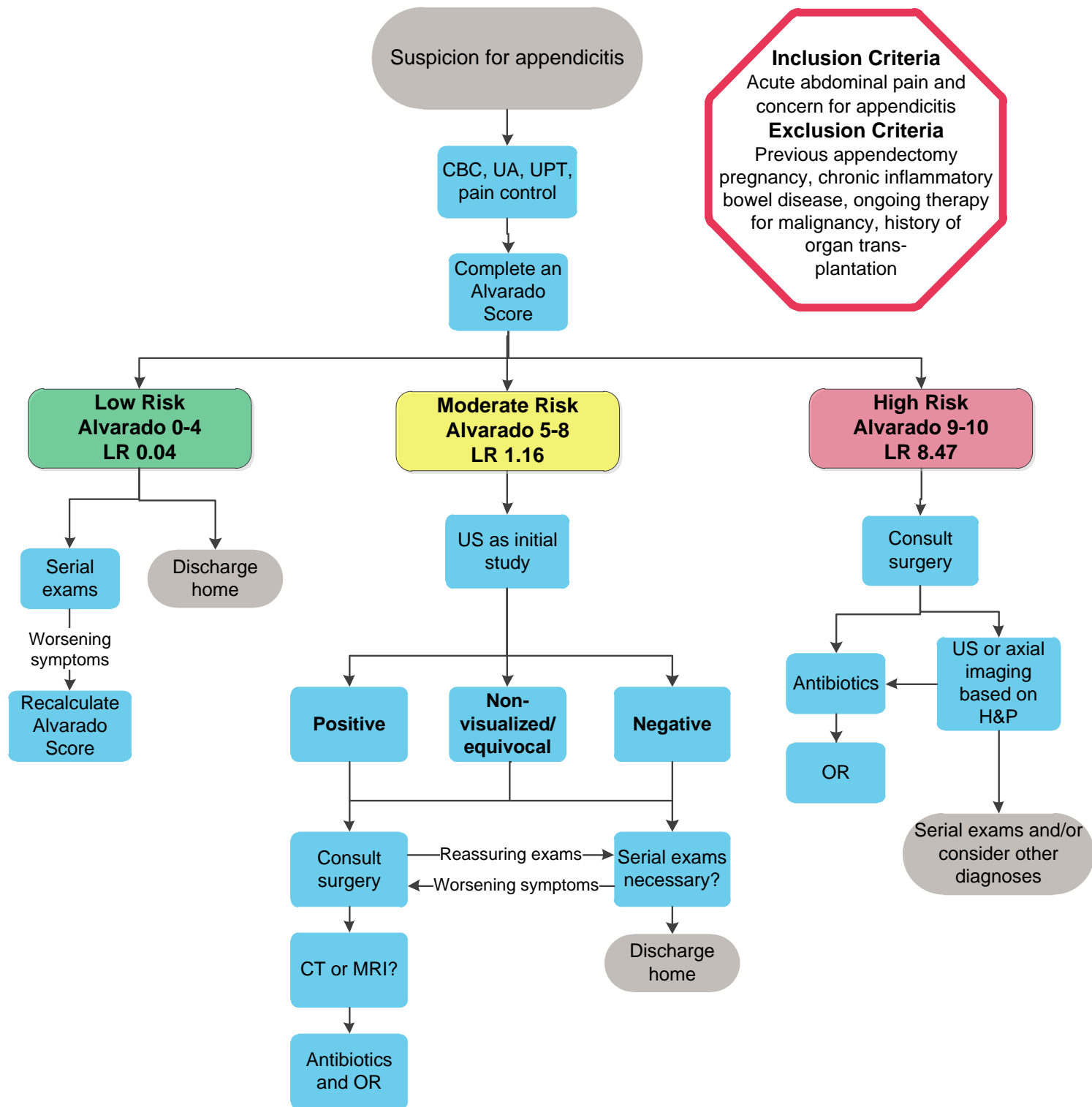
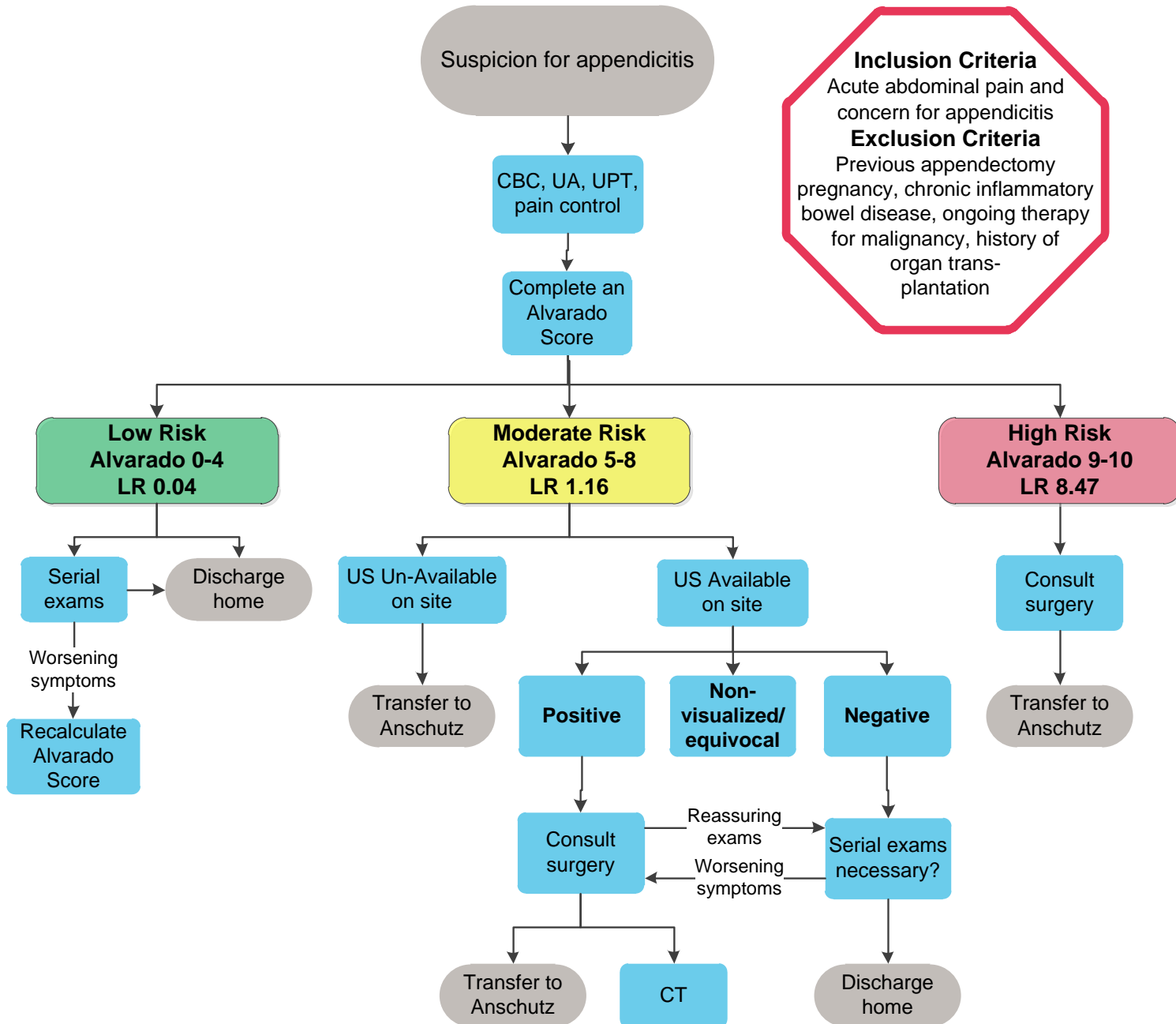


# PEDIATRIC ACUTE APPENDICITIS (ALL ED/UC SITES)

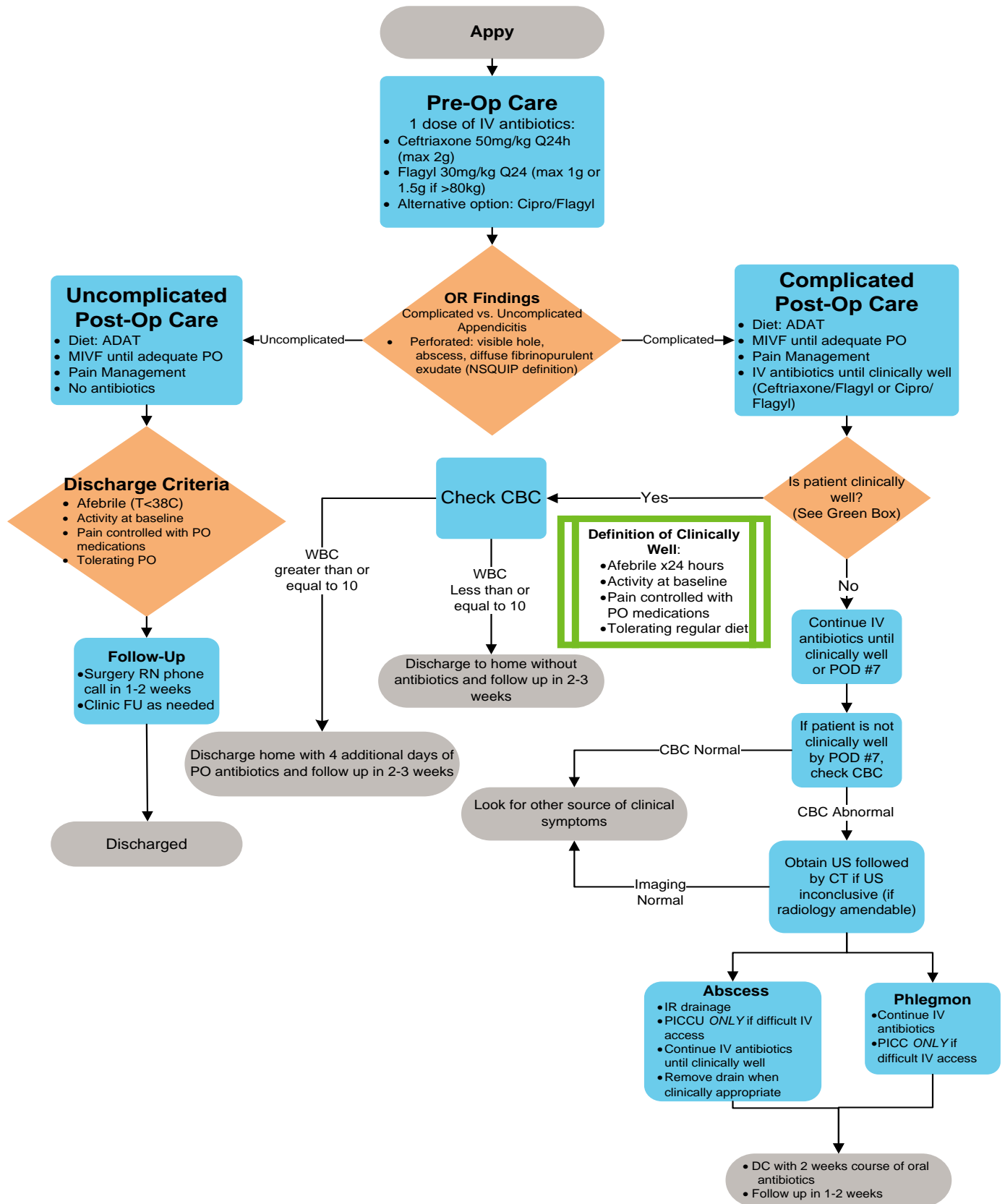
## Anschutz and Colorado Springs Hospital - Acute Appendicitis Diagnostic Algorithm



**Network of Care & South Campus - Acute Appendicitis Diagnostic Algorithm**



## Acute Appendicitis Operative Management Algorithm



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## DIAGNOSIS

### Evaluate for Fluid Status

- If dehydrated, rehydrate with IVF - IV bolus: 20mL/kg normal saline or lactated Ringer's solution (max: 1000mL/dose) as soon as possible. Do not wait for diagnostic studies/surgical evaluation. Repeat if necessary.
- Continue with MIVF

### Evaluate Pain | Nausea Status

- If in pain, don't delay analgesia. The evidence shows that giving analgesic medication prior to surgical evaluation doesn't influence outcomes<sup>6-8</sup>.
- Utilize fentanyl (recommended dose) for rapid onset, short duration pain relief **OR**
- Utilize morphine (recommended dose) for slow onset, longer duration continued pain relief
- Treat nausea with ondansetron<sup>9</sup> (recommended dose)

### Laboratory Studies | Additional Orders

- CBC (or POC CBC) – Required for completion of the Alvarado score, and WBC in conjunction with left shift can be utilized in the case of an equivocal ultrasound
- UA (or POC UA) – Abdominal pain from a urinary tract infection can mimic the pain of appendicitis. Review UA results prior to imaging
- UPT (for females of reproductive age) – Ectopic pregnancy should be ruled out. UPT screening is required prior to CT.
- NPO – Order for NPO in anticipation of surgical procedures. If you anticipate that the patient is going to NPO for an extended period of time, order maintenance IV fluids.

### Alvarado Score

- It's highly recommended to utilize the Alvarado Score (see the 'Clinical Decision Support' tab on your Epic Navigator) to determine a risk category (low, medium, or high).
- Follow the [Anschutz and Colorado Springs Hospital - Appendicitis Diagnostic Pathway Algorithm](#) **OR** the [Network of Care/South Campus - Appendicitis Diagnostic Pathway Algorithm](#).
- All imaging orders for appendicitis will require entry of a risk category.

Migration of pain	Yes(1)	No
Anorexia (decreased appetite)	Yes(1)	No
Nausea/Vomiting	Yes(1)	No
Tenderness to the RLQ	Yes(2)	No
Rebound pain	Yes(1)	No
Elevated temp (≥37.3 C)	Yes(1)	No
Leukocytosis (≥ 10,000)	Yes(2)	No
Shift to the Left (≥ 75% PMNs)	Yes(1)	No
<b>Total Score</b>	<b>/10</b>	

Risk category	Total Alvarado Score	Likelihood Ratio	Risk
Low	0-4	0.04	5%
Med	5-8	1.16	50%
High	9-10	8.47	95%

## Surgical Consultation

- Consult the surgery team according to the posted algorithms. Network of Care sites should consult attending surgeons only.
- Network of Care providers should consult the surgery attending prior to ordering imaging on any high risk patients as they may be able to avoid imaging and go directly to surgery after surgical evaluation. On moderate risk patients with equivocal or negative US imaging in the Network of Care, the surgical attending should be consulted prior to ordering any follow up CTs of abdomen.
- Expectations for surgical response to the ED/UCs are as follows:
  - Anschutz or Colorado Springs Hospital –
    - Phone response to page should be less than 5minutes
    - Arrival of the initial surgical provider to the bedside should occur within 20 minutes and check-in at the unit secretary’s desk is required. Once a plan is generated, it should be communicated back to ED staff and the patient and family (ideally within 1hour).
    - It’s critical that all members of the care team and patient/family are informed about the plan (imaging plan, surgery time slot, interval appendectomy or other procedures). Delays should also be clearly communicated without open-ended timeframes.
  - Network of Care and South Campus–
    - The interval from call response to arrival of the surgical provider to bedside at South is dependent on surgeon availability and transfer from other Network of Care sites
    - For further information about transferring appendicitis patients to South or Anschutz reference the [‘Transfer of Care’ section](#)

**Imaging Summary:**

- **Utilize US first for suspected complicated or uncomplicated appendicitis according to the diagnostic algorithm**
- **It’s highly recommended to order surgical consult before axial imaging (CT or MRI)**
- **MRI is available per the protocol below**

## Imaging

Order imaging according to the [Anschutz and Colorado Springs Hospital](#) or [Network of Care & South Campus](#) Acute Appendicitis Diagnostic Algorithm.

- US should always be utilized as a screening exam prior to CT in an effort to spare children from ionizing radiation. It’s effective at differentiating complicated vs uncomplicated appendicitis and has high positive and negative predictive values when the appendix is visualized.
- In the case of the non-visualized appendix, combine the US results with the WBC and PMN percentage. Recent research<sup>5</sup> suggests that non-visualization of the appendix (without secondary signs present) plus a WBC count of less than 9,000 and PMN% of less than 65 produces a NPV of 95%. If a confident diagnosis isn’t reached despite early testing, observation of patients (in the ED or inpatient unit) is recommended with a plan for serial exams and/or serial imaging<sup>10</sup>. The length of observation will be determined by the ED provider and surgeon (if involved).

From the Literature				
	<i>Sensitivity</i>	<i>Specificity</i>	<i>NPV</i>	<i>PPV</i>
<i>US</i> <sup>1</sup>	72.5%	97%	87.5%	92.5%
<i>CT</i> <sup>3</sup>	93%	92%	95%	89%
<i>MRI</i> <sup>4</sup>	96.8%	97.4%	98.9%	92.4%
<i>Nonvis US + lab values</i> <sup>5</sup>	N/A	N/A	95%	N/A

- If appendicitis has been ruled out, and the patient is still symptomatic, consider the following for your differential: Ovarian torsion, ovarian cyst (those more than 5cm are of clinical significance and can lead to ovarian torsion). Network of Care locations utilizing on call resources need to consider the timing of imaging orders and avoid calling in the radiology tech twice.
- If the patient comes to CHCO with an image on a CD, then order 'outside imaging – reference only' or 'outside imaging – request interpretation' and have a staff member deliver the CD to radiology for upload. If that image is usable, the patient doesn't need the image repeated, but if the image is substandard, it may need to be repeated.
  - **Parker** - For patients seen at CHCO Parker, radiology images are not available for viewing in the Epic chart initially, but are viewable in CHCO Synapse in the folder marked CHC Parker. You can still request an outside read of these images if necessary.

**CT Scan**

- Surgical consultation (in person if available or via phone) is highly recommended prior to CT scan for suspected appendicitis<sup>11</sup>.
- A surgical attending should always be consulted prior to ordering a CT scan for suspected appendicitis in Network of Care including South locations with CT. When available, US may be ordered in moderate risk patients prior to consulting with surgery. All high risk patients should have a phone consult with the surgical attending prior to ordering any imaging to determine whether they are candidates for surgical evaluation and/or surgery without any imaging.
- CT is highly accurate, but it's costly to families and delivers ionizing radiation doses according to the CT Abdomen/Appendix Radiation Dosage Chart.

<i>Age (Years)</i>	<i>Abd CT mSv Dose</i>	<i>Equivalent Denver/Boulder background radiation</i>
5	3.6	8 months
10	4.5	10 months
15+	5.4	12 months

- Patients will require rectal contrast according to the following radiology protocol except at Parker where rectal contrast isn't utilized by Parker Adventist hospital for abdominal CTs:
  - Patients 6 years and younger require rectal contrast
  - Patients 7-12 years of age with less than the 50th percentile BMI need a rectal contrast
  - Patients aged 7-12 years of age with greater than or equal to the 50th percentile BMI do not need rectal contrast
  - Patients 13 years and older do not require rectal contrast

### MRI Protocol (Anschutz or Colorado Springs Hospital)

- MRI is available at Anschutz or Colorado Springs Hospital during normal operating hours for patients 12 years old or greater with suspected appendicitis that completed ultrasonography and have negative or equivocal results.

#### Procedure:

- ED provider orders a CT abdomen/appendix with contrast and PIV
- The CT tech will call MRI during operating hours and determine if MRI is available within 20 minutes.
- If MRI is available, then the CT tech will contact the ordering ED provider and ask if the patient will tolerate MRI which will require a breath hold of 15 seconds. If so, then the CT tech will change the CT order to an MRI Abdomen and Pelvis for Appendicitis and the ED provider will communicate the plan change with ED staff.
- MRI tech will call the patient's assigned ED nurse and assign a room location and coordinate an arrival time
- ED staff complete the MRI safety checklist prior to the patient's arrival in MRI
- If a patient doesn't tolerate MRI, then the MRI tech or CT tech will change the order to CT abdomen/appendix with contrast and the patient will be brought directly to CT. If it's unsafe or if the wait for CT availability is long, then consider transferring the patient back to the ED.

## CONFIRMED APPENDICITIS

### Pre-operative Antibiotics

Pre-operative antibiotic therapy is recommended for all patients diagnosed with appendicitis (non-perforated and perforated). The following antibiotic recommendations should be initiated as soon as possible following a positive diagnosis (but not before imaging and CBC have been done):

- a. Intravenous (IV) antibiotics, all appendicitis both perforated and non-perforated, prescribe both cefTRIAxone and metroNIDAZOLE<sup>12-16</sup>:
  - CefTRIAxone: 50mg/kg/dose, maximum dose 2 grams
  - MetroNIDAZOLE: 30mg/kg/dose, recommended maximum dose 1 gram (maximum dose 1.5 grams per day if greater than 80 kg)
  - If the patient goes to the operating room 12 hours or more after cefTRIAxone dosing, repeat dose prior to surgery. If the patient goes to the operating room 24 hours or more after metroNIDAZOLE dosing, repeat dose prior surgery<sup>17</sup>
- b. In cephalosporin allergic patients (confirm and document type of allergy), prescribe both IV ciprofloxacin\* and IV metroNIDAZOLE:
  - Ciprofloxacin 10mg/kg/dose, maximum dose 400mg
  - MetroNIDAZOLE: Dose as above
  - \*NOTE: If patient is less than 1 year of age, must weigh risks and nature of allergy vs. use of fluoroquinolone in that age group and consider alternatives

#### **OR**

- c. In metroNIDAZOLE allergic patients, prescribe both IV cefTRIAxone and IV clindamycin:
  - CefTRIAxone: Dose as above
  - Clindamycin: 10 to 13 mg/kg/dose maximum dose 900 mg



## Interval Appendectomy

If the surgeon determines that a patient will benefit from an interval appendectomy, then they may require abscess drainage in interventional radiology and/or a PICC line for pre-operative antibiotics. Either way, the patient needs to be NPO.

## TRANSFER OF CARE

### Within Anschutz, Colorado Springs Hospital or South campus:

- Utilize standard transfer of care procedures per policy for transfer to observation, the inpatient unit, the operating room, or the ICU.
- If the OR cannot admit the patient for appendectomy from the ED within 3 hours, then the patient may go to the inpatient unit to wait for surgery. Patient safety is the first concern when making this decision, but resource utilization should be taken into consideration and the transfer center should coordinate with all parties involved.

### Between ED/UC sites:

- Utilize the transfer policy to aid in the decision to transfer by private car, BLS, ALS, CCT, or Children's team CCT
- For patients with a definitive appendicitis diagnosis, an OR time scheduled greater than 3 hours in the future or no OR time scheduled), **and** are stable for inpatient admission, can be admit directly to the inpatient unit
- Transfer to South campus will be determined by the Anschutz attending surgeon on call

## OPERATIVE CLINICAL MANAGEMENT

### Surgical Technique

- Approach with either limited laparotomy or laparoscopy<sup>18</sup>
- Local anesthetic if there is no gross contamination of tissues
- Irrigation of abdominal cavity with sterile saline solution for patients with perforated appendix
- Consider drain placement if focal abscess cavity is present
- Close skin at incision site unless massive contamination is present
- Consider interventional radiology-directed drainage of a well-formed abscess followed by interval appendectomy in 6 to 8 weeks.

### Laboratory Studies | Imaging

- Cultures of abdominal fluid are not recommended

### Therapeutics

- Antiemetics
  - Ondansetron 0.1 mg/kg (Max: 4 mg) IV should be given at the end of the surgical procedure<sup>9</sup>

## POST-OPERATIVE CLINICAL MANAGEMENT

### Clinical Assessment and Monitoring

- Vital signs per provider order
- Cardio-respiratory monitoring & pulse oximetry use during the first 24 hours post-op and for patients receiving morphine sulfate

- Pain assessment/reassessment per local pain assessment & management procedure
- Assess surgical incision(s) for signs of infection once per shift

### Laboratory Studies | Imaging

- CBC prior to discharge for patients with perforated appendicitis is recommended

### Fluids, Electrolytes, Nutrition

- Dextrose containing IV maintenance fluids until patient is taking sufficient oral intake
- For patients with non-perforated appendicitis: clear liquids and advance as tolerated
- NPO if postoperative ileus is expected in patients with perforated appendicitis
- If patient is expected to be NPO for longer than 3 days, consider PICC line placement and TPN administration. Also consider keeping indwelling urinary catheter in place for 24 to 48 hours.

### Therapeutics

#### Pain Management<sup>8</sup>

##### For patients with non-perforated appendicitis:

- Morphine sulfate 0.05 to 0.1 mg/kg/dose IV every 2 hours as needed for pain (Max dose: 4 mg)
- Acetaminophen orally or rectally per pharmacy dose standardization protocol every 4 hours as needed for pain or fever

##### For patients with perforated appendicitis:

- Morphine sulfate 0.05 to 0.1 mg/kg/dose IV every 2 hours as needed for pain (Max dose: 4 mg) or Morphine sulfate via PCA if patient is 7 years old or older
- Acetaminophen orally or rectally per pharmacy dose standardization protocol every 4 hours as needed for pain or fever
- Ketorolac 0.5 mg/kg/dose IV every 6 hours as needed for pain (Max dose: 30 mg, Max duration: 48 hours)

#### Post-operative Antibiotics

- Post-operative antibiotic therapy is only recommended in perforated appendicitis patients. A one-time pre-operative dose of IV antibiotics for non-perforated appendicitis is sufficient. The following antibiotic recommendations should be followed for patients with perforated appendicitis:
  - a. Recommended antibiotic regimen:
    - Prescribe both IV cefTRIAxone and metroNIDAZOLE:
      - CefTRIAxone: 50 mg/kg/dose Q24 hours, maximum dose 2 grams
      - MetroNIDAZOLE: 30 mg/kg/dose Q24 hours, recommended maximum dose 1 gm (max dose 1.5 gram per day if greater than 80 kg)
    - In cephalosporin allergic patients (confirm and document type of allergy), prescribe both IV ciprofloxacin and IV metroNIDAZOLE:
      - Ciprofloxacin 10-15 mg/kg/dose Q12 hours, maximum dose 400mg
      - MetroNIDAZOLE: Dose as above.

**\*Note: If patient is less than 1 year of age, must weigh risks and nature of allergy vs. use of fluoroquinolone in that age group and consider alternatives OR**

- In metroNIDAZOLE allergic patients, prescribe both IV cefTRIAxone and IV clindamycin:

- CefTRIAxone: Dose as above.
  - Clindamycin: 10 to 13 mg/kg/dose Q8 hours, maximum dose 900mg
- b. Continue IV antibiotic therapy for at least 72 hours. Once patients are clinically well (afebrile greater than 24 hours, activity at baseline, tolerating regular diet, pain controlled with PO medications then a CBC will be ordered. If CBC normal then may DC without oral antibiotics. If CBC abnormal then may be discharged with 4 days of oral (PO) antibiotics. PO antibiotic options include:
- Amoxicillin/clavulanate (Augmentin)
    - Amoxicillin/clavulanic acid ES [ratio 14:1] (600mg-42.9mg/5mL): 90mg/kg/day divided BID or TID. TID has increased coverage for more resistant organisms based on pharmacokinetics. Maximum 3-4 grams per day.
  - Penicillin-allergic patients, prescribe both PO ciprofloxacin and metroNIDAZOLE:
    - Ciprofloxacin: 10 to 15 mg/kg/dose (max 750 mg per dose) given twice daily (avoid antacids and calcium-containing products within 2 hours of the dose)
    - MetroNIDAZOLE: 10 to 15 mg/kg/dose (max 500 mg per dose) given two or three times daily
- c. If patient does not meet clinical criteria at 72 hours, IV antibiotic therapy should be continued until clinically well or on post-operative day 7, whichever comes first. If not clinically well by POD 6-7 then will obtain a CBC and CT to determine development of post-operative abscess.
- d. PO antibiotics after 5 to 7 days of IV therapy is controversial, and decision to start and length of therapy needed are unknown. Prolonged antibiotics may be indicated in patients in whom adequate drainage was not achievable<sup>19,20</sup>
- e. Amoxicillin/clavulanate (Augmentin):
- Preferred: Amoxicillin/clavulanic acid ES [ratio 14:1] (600mg/42.9mg), 90mg/kg/day divided BID or TID (On formulary at CHCO). TID has increased coverage for more resistant organisms based on pharmacokinetics. Maximum 3 grams per day.
  - Amoxicillin/clavulanic acid XR [ratio 16:1] (1gm: 62.5mg), 2 to 4 grams per day, divided BID; only comes in 1 gram tablets so only for use in children over 22 kg (not on CHCO formulary).
- f. **In penicillin allergic patients**, prescribe both ciprofloxacin and metroNIDAZOLE:
- Ciprofloxacin: 10 to 15 mg/kg/dose (max 750 mg per dose) given twice daily
  - MetroNIDAZOLE: 10 to 15 mg/kg/dose (max 500 mg per dose or 30 mg/kg/day) given two or three times daily
- OR** Trimethoprim/sulfamethoxazole and metroNIDAZOLE (metroNIDAZOLE dosing as above):
- Trimethoprim/sulfamethoxazole: 4 to 16 mg (TMP component)/kg/dose (max 160 mg [TMP component] per dose) given twice daily
- OR** In metroNIDAZOLE allergic or intolerant patients, prescribe both clindamycin and ciprofloxacin:
- Clindamycin: 10 to 13 mg/kg/dose (max 600 mg per dose) given three times daily
  - Ciprofloxacin: 10 to 15 mg/kg/dose (max 750 mg per dose) given twice daily

## Respiratory Care

- Incentive spirometry is recommended for patients who are able perform this treatment during the first 48 hours post-operatively or until patient is ambulating without supplemental oxygen.
  - Incentive spirometry every 1 hour while awake
  - Incentive spirometry every 4 hours while sleeping

## PARENT | CAREGIVER EDUCATION

- Expected clinical course for appendicitis
- Importance of early ambulation
- Monitoring wound for signs of infection and when to call Surgical Services
- Wound Care: Keep the incision(s) dry for 2 days
- Pain control with Tylenol and ibuprofen at home. Determination for a narcotic prescription made on a case to case basis.

## DISCHARGE (D/C) HOME

- Begin discharge planning on admission
- Taking adequate oral intake
- Ambulatory
- Adequate pain management with oral analgesics or narcotics
- For patients with perforated appendicitis:
  - Afebrile for 24 hours
- Home resources are adequate to support the use of all necessary home therapies.
- Standard Discharge Order Form fully completed before discharge
- PCP notified of discharge plan
- Outpatient Surgery Clinic Appointment made prior to discharge

## Follow-up

- For non-perforated appendicitis
  - Call the Surgery RN in 7 days for a phone check-up and determination for need of follow up in clinic
- For perforated appendicitis
  - Follow up in the Outpatient Surgery Clinic in 2-3 weeks post discharge with the operating surgeon.
- No heavy lifting or strenuous athletics for first 2 weeks post op

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**CLINICAL IMPROVEMENT TEAM MEMBERS**

**Kevin Carney**, MD | Emergency Medicine  
**Lalit Bajaj**, MD | Emergency Medicine | Clinical Effectiveness  
**Joni Mackenzie**, PNP | Emergency Medicine  
**Jennifer Bruny**, MD | Pediatric General Surgery  
**John Strain**, MD | Radiology  
**Lorna Browne**, MD | Radiology  
**Amanda Hurst**, PharmD | Clinical Pharmacist  
**Jesse Herrgott** | Clinical Effectiveness

**Michael Distefano**, MD | Emergency Medicine  
**Angelique Ferayorni**, MD | Emergency Medicine  
**Amy Lewis**, RN MSN | South Campus Nursing Director  
**Derrek Massanari**, MD | Emergency Medicine  
**Catherine Orendac**, MD | Emergency Medicine  
**Jay Santos**, MD | Emergency Medicine  
**Summer Smith**, MD | Emergency Medicine  
**Irina Topoz**, MD | Emergency Medicine

**APPROVED BY**

Guideline and Measures Review Committee – October 11, 2016  
 Medication Safety Committee – Not Applicable  
 Antimicrobial Stewardship Committee – October 6, 2016  
 Pharmacy & Therapeutics Committee – October 6, 2016

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<b>COLORADO SPRINGS REVIEW BY</b>	 Michael DiStefano, MD Chief Medical Officer, Children’s Hospital Colorado – Colorado Springs
<b>APPROVED BY</b>	 Lalit Bajaj, MD, MPH Medical Director, Clinical Effectiveness

**REVIEW/REVISION SCHEDULE**

Scheduled for full review on October 11, 2020

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You can also file a civil rights complaint with the U.S. Department of Health and Human Services, Office for Civil Rights, electronically through the Office for Civil Rights Complaint Portal, available at [ocrportal.hhs.gov/ocr/portal/lobby.jsf](http://ocrportal.hhs.gov/ocr/portal/lobby.jsf), or by mail or phone at: U.S. Department of Health and Human Services 200 Independence Avenue, SW Room 509F, HHH Building Washington, D.C. 20201 1-800-368-1019, 800-537-7697 (TDD) Complaint forms are available at [www.hhs.gov/ocr/office/file/index.html](http://www.hhs.gov/ocr/office/file/index.html).

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ATENCIÓN: si habla español, tiene a su disposición servicios gratuitos de asistencia lingüística. Llame al 1-720-777-9800.

CHÚ Ý: Nếu bạn nói Tiếng Việt, có các dịch vụ hỗ trợ ngôn ngữ miễn phí dành cho bạn. Gọi số 1-720-777-9800.

주의: 한국어를 사용하시는 경우, 언어 지원 서비스를 무료로 이용하실 수 있습니다. 1-720-777-9800 번으로 전화해 주십시오.

注意: 如果您使用繁體中文, 您可以免費獲得語言援助服務。請致電1-720-777-9800。

ВНИМАНИЕ: Если вы говорите на русском языке, то вам доступны бесплатные услуги перевода. Звоните 1-720-777-9800.

ማስታወሻ: የሚናገሩት ቋንቋ አማርኛ ከሆነ የትርጉም አርዳታ ድርጅቶቹ: በነጻ ሊያገዝዎት ተዘጋጅተዋል: ወደ ሚከተለው ቁጥር ይደውሉ 1-720-777-9800 (መስማት ለተሳናቸው).

ملحوظة: إذا كنت تتحدث اذكر اللغة، فإن خدمات المساعدة اللغوية تتوافر لك بالمجان. اتصل برقم 720-777-9800-1 (رقم).

ACHTUNG: Wenn Sie Deutsch sprechen, stehen Ihnen kostenlos sprachliche Hilfsdienstleistungen zur Verfügung. Rufnummer: 1-720-777-9800.

ATTENTION : Si vous parlez français, des services d'aide linguistique vous sont proposés gratuitement. Appelez le 1-720-777-9800.

ध्यान दनु होसतपाइले नेपाल बोलनहनछ भन तपाइको निम्त भाषा सहायता सवाहदून:शलक रूपमा उपलब्ध छ । फोन गनु होसरू 1-720-777-9800 ।

PAUNAWA: Kung nagsasalita ka ng Tagalog, maaari kang gumamit ng mga serbisyo ng tulong sa wika nang walang bayad. Tumawag sa 1-720-777-9800.

注意事項: 日本語を話される場合、無料の言語支援をご利用いただけます。1-720-777-9800 まで、お電話にてご連絡ください。

Nti: O buru na asu lbo, asusu aka oasụ n'efu, defu, aka. Call 1-720-777-9800.