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INTRODUCTION — This topic will discuss the epidemiology, clinical features, and evaluation of children with suspected appendicitis. Detailed discussions of diagnostic imaging and treatment for pediatric appendicitis are found elsewhere. (See "Acute appendicitis in children: Diagnostic imaging" and "Acute appendicitis in children: Management".)

ANATOMY — The appendix arises from the cecum, which is located in the right lower quadrant of the abdomen in the majority of children. It may lie in the upper abdomen or on the left side in children with congenital abnormalities of intestinal position (eg, uncorrected malrotation), situs inversus totalis, and after repair of diaphragmatic hernia, gastroschisis, and omphalocele [1].

Some anatomic features of the appendix may play a role in the incidence and presentation of appendicitis throughout childhood. These include the following [2]:

- In the first year of life, the appendix is funnel-shaped, perhaps making it less likely to become obstructed.
- Lymphoid follicles are interspersed in the colonic epithelium that lines the appendix and may obstruct it. These follicles reach their maximal size during adolescence, the age group in which the peak incidence of appendicitis occurs.
- The omentum is underdeveloped in young children and often cannot contain purulent material, perhaps accounting, in part, for the diffuse peritonitis that typically follows perforation in young children.

PATHOPHYSIOLOGY — Most commonly, appendicitis is caused by nonspecific obstruction of the appendiceal lumen [2,3]. Fecal material, undigested food, other foreign material, an enlarged lymphoid follicle in the epithelial lining, or a bend or twist of the organ itself may all be responsible. The obstruction causes colic, which in turn produces the poorly localized periumbilical abdominal pain typical of early appendicitis. It also causes the appendiceal lumen to dilate and its wall to thicken.

Intraluminal bacterial overgrowth follows appendiceal obstruction with breakdown of the mucosal barrier, bacterial invasion of the wall, inflammation, ischemia, and gangrene, eventually leading to perforation [2,3]. The bacteria include the usual fecal flora, mainly aerobic and anaerobic Gram negative rods. The most common are *Escherichia coli*, Peptostreptococcus species, *Bacteroides fragilis*, and Pseudomonas species [4].

Inflammation of the wall of the appendix causes peritonitis, which produces localized abdominal pain and tenderness, the cardinal clinical signs of acute appendicitis [2]. Perforation releases bacteria into the peritoneal cavity. Perforation occurs rarely in the first 12 hours of symptoms but is more likely with time thereafter, becoming common after 72 hours. Generalized peritonitis develops if the infection is not contained by bowel loops and omentum.

Less commonly, enteric pathogens may directly infect the appendix or cause localized appendiceal lymphoid hyperplasia with obstruction [5]. Specific organisms include adenovirus (in combination with intussusception) [6], rubeola virus (measles) [7], Epstein-Barr virus [8], *Actinomyces israeli* (Actinomycosis) [9], *Enterobius vermicularis* (pinworms) [10], and *Ascaris lumbricoides* (roundworms) [11].

Rarely, pediatric appendicitis arises from other conditions such as Crohn's disease (granulomatous inflammation of the appendix) [12], appendiceal carcinoid tumor [13], Burkitt lymphoma [14], appendiceal duplication (often in association with other duplications of the gastrointestinal and genitourinary tract in children) [15], or cystic fibrosis (inspissated mucous obstruction of the appendiceal lumen). (See "Cystic fibrosis: Overview of gastrointestinal disease", section on 'Appendiceal disease'.)

EPIDEMIOLOGY — Appendicitis is the most common indication for emergent abdominal surgery in childhood and is diagnosed in 1 to 8 percent of children evaluated urgently for abdominal pain [16,17]. The incidence increases from an annual rate of one to six per 10,000 children between birth and four years of age to 19 to 28 per 10,000 children younger than 14 years [18-20]. It presents most frequently in the second decade of life. Fewer than 5 percent of patients diagnosed with appendicitis are five years of age or less [21]. Boys are more commonly affected than girls (lifetime risk 9 and 7 percent, respectively).

Advanced disease is common in children younger than six years of age, occurring in up to 57 percent of cases [22]. This finding is explained by the frequency of nonspecific symptoms in young children with appendicitis. (See 'Clinical manifestations' below.)

Traditionally, success in achieving the goal of timely and accurate diagnosis for appendicitis has been reflected, in part, by the balance between perforation rates and rates of negative appendectomy. Perforation correlates strongly with duration of symptoms [23]. The reported rates vary significantly by age as follows:

- Neonates – 83 percent [24]
- Young children (<5 years) – 51 to 100 percent [25-30]
- School-age (5 to 12 years) – 11 to 32 percent [27,29]
- Adolescents (>12 years) – 10 to 20 percent [18,22,31]

Similarly, negative appendectomy rates vary by age but are also impacted by gender. The highest frequency is reported in children younger than five years of age (up to 17 percent) and in postmenarchal females (up to 5 percent) while rates of 1 to 2 percent are described in school-age children and adolescent males [32]. Furthermore, increased rates of diagnostic imaging are associated with a lower negative appendectomy rate.

Thus, the accurate diagnosis of appendicitis is particularly challenging in children less than five years of age and adolescent females.

CLINICAL MANIFESTATIONS — The classic presentation of appendicitis includes the following clinical findings [2]:

- Anorexia
- Periumbilical pain (early)
- Migration of pain to the right lower quadrant (often within 24 hours of onset of symptoms)
- Pain with movement: walking or shifting position in bed or on stretcher
- Vomiting (typically occurring after the onset of pain)
- Fever (commonly occurring 24 to 48 hours after onset of symptoms)
- Right lower quadrant tenderness
- Signs of localized or generalized peritoneal irritation such as:
    - Involuntary muscle guarding with abdominal palpation

- Positive Rovsing sign (pain in the right lower quadrant with palpation of the left side)
- Obturator sign (pain on flexion and internal rotation of the right hip, which is seen when the inflamed appendix lies in the pelvis and causes irritation of the obturator internus muscle)
- Iliopsoas sign (pain on extension of the right hip, which is found in retrocecal appendicitis)
- Rebound tenderness (elicited by the examiner placing steady pressure with his or her hand in the right lower quadrant for 10 to 15 seconds and then suddenly releasing the pressure; a positive finding consists of increased pain with removal of pressure)

The Rovsing, obturator, and iliopsoas signs may be difficult to elicit in young children. In addition, as with adults, their accuracy has not been well defined [2,33]. The absence of the classic signs of appendicitis should not cause the clinician to exclude the diagnosis of appendicitis [27]. However, when present in children 3 to 12 years of age, these signs have high specificity for acute appendicitis (86 to 98 percent, depending upon age).

Although this classic pattern of clinical findings does occur in school-age children and adolescents, it is less common overall in pediatric patients with appendicitis than in adults. (See 'School-age (5 to 12 years)' below and 'Adolescent' below and "Acute appendicitis in adults: Clinical manifestations and differential diagnosis", section on 'Clinical manifestations'.)

In infants and young children, this pattern may not occur at all, perhaps because of differences in the pathophysiology of the disease and in the child's ability to relate information regarding signs and symptoms. (See 'Neonates (0 to 30 days)' below and 'Young children (<5 years)' below.)

Furthermore, among children, the absence of classic clinical features of appendicitis (such as fever, anorexia, migration of pain to the right lower quadrant, and rebound tenderness) are neither sensitive nor specific for excluding appendicitis, especially in younger patients [2]. This was demonstrated in a prospective series describing children evaluated in an emergency department (ED) for suspected appendicitis in whom the following features were noted among the patients with appendicitis [34]:

- Lack of migration of pain to right lower quadrant in 50 percent
- Absence of anorexia in 40 percent
- No rebound tenderness in 52 percent

Thus, diagnosing appendicitis among children is frequently challenging because typical symptoms and signs are often not present, specific findings of appendicitis are difficult to elicit in this patient population, and clinical findings frequently overlap with other conditions. (See 'Differential diagnosis' below.)

Clinical features by age

Neonates (0 to 30 days) — Appendicitis in neonates is rare [24]. The low frequency of appendicitis in these patients is attributed to anatomic differences in the appendix (more funnel-shaped than tubular), soft diet, infrequent diarrheal illnesses, and recumbent positioning [35]. Mortality from neonatal appendicitis approaches 28 percent and reflects the difficulty in establishing the diagnosis prior to advanced disease with bowel perforation and sepsis [36].

Case reports indicate that abdominal distension, vomiting, and decreased feeding are the most commonly reported findings in neonates with appendicitis [24]. Temperature instability and septic shock may also develop. The frequency of clinical features in these patients as illustrated by a case review of 33 neonates is as follows [24]:

- Abdominal distension – 75 percent

- Vomiting – 42 percent
- Decreased oral intake – 40 percent
- Abdominal tenderness – 38 percent
- Sepsis – 38 percent
- Temperature instability – 33 percent
- Lethargy or irritability – 24 percent
- Abdominal wall cellulitis – 24 percent
- Respiratory distress – 15 percent
- Abdominal mass – 12 percent
- Hematochezia (possibly representing necrotizing enterocolitis of the appendix) – 10 percent

Thus, findings of neonatal appendicitis are nonspecific and overlap with other more common neonatal surgical diseases, especially volvulus and necrotizing enterocolitis. (See "Clinical features and diagnosis of necrotizing enterocolitis in newborns", section on 'Clinical presentation' and "Intestinal malrotation in children", section on 'Clinical presentation'.)

Young children (<5 years) — Appendicitis is uncommon in infants and pre-school children. Fever and diffuse abdominal tenderness with rebound or guarding are the predominant physical findings although irritability, grunting respirations, difficulty with or refusal to ambulate, and right hip complaints may also be present. Localized right lower quadrant tenderness occurs in less than 50 percent of patients. The high frequency of rebound or diffuse tenderness and guarding reflects the high prevalence of perforation and peritonitis in this age group.

Typical findings on history are nonspecific such as fever, vomiting, and abdominal pain, all of which can also occur with other surgical diagnoses, such as intussusception. Diarrhea is also relatively common making appendicitis difficult to differentiate from acute gastroenteritis, a much more common condition in these patients [25,26,28]. (See 'Differential diagnosis' below.)

Based upon observational studies, the relative frequency and variability of clinical findings in infants and children younger than five years is as follows [25,26,28]:

- Abdominal pain – 72 to 94 percent
- Fever – 62 to 90 percent
- Vomiting – 80 to 83 percent
- Anorexia – 42 to 74 percent
- Rebound tenderness – 81 percent
- Guarding – 62 to 72 percent
- Diffuse tenderness – 56 percent
- Localized tenderness – 38 percent
- Abdominal distension – 35 percent
- Diarrhea (frequent, low volume, with or without mucus) – 32 to 46 percent

School-age (5 to 12 years) — Appendicitis is more frequent in this age group when compared to younger children. Abdominal pain and vomiting are commonly present in school-age children; although the typical migration of periumbilical pain to the right lower quadrant may not occur. On physical examination, right lower quadrant tenderness is noted in the majority of patients. Involuntary guarding and rebound tenderness indicate perforation. Other prominent symptoms include fever, anorexia, and pain with movement [37]. Diarrhea, constipation, and dysuria (abdominal pain with voiding not urethral pain which is typical of a urinary tract infection [UTI]) are less frequent, but occur enough to potentially confuse the diagnosis.

The relative frequency of these findings is illustrated in an observational study of 379 children 3 to 12 years (84 children under five years of age) [27]:

- Anorexia – 75 percent
- Vomiting – 66 percent
- Fever – 47 percent
- Diarrhea – 16 percent
- Nausea – 79 percent
- Maximum abdominal tenderness in the right lower quadrant – 82 percent
- Difficulty walking – 82 percent
- Pain with percussion, hopping, or coughing – 79 percent

Adolescent — The clinical features of appendicitis in this age group are similar to those in adults and often include the classic findings of fever, anorexia, periumbilical abdominal pain that migrates to the right lower quadrant, and vomiting. Involuntary guarding and rebound tenderness are present more often with perforation. The onset of pain typically occurs before vomiting, and is a sensitive indicator of appendicitis. (See 'Clinical manifestations' above and "Acute appendicitis in adults: Clinical manifestations and differential diagnosis", section on 'Clinical manifestations'.)

Information regarding menstrual history and sexual activity can be helpful in distinguishing gynecologic disorders from appendicitis in postmenarchal girls. Common conditions include mittelschmerz, ovarian cysts, ectopic pregnancy, or pelvic inflammatory disease. (See 'Other nonsurgical diagnoses' below.)

Abdominal examination

Approach and analgesia — Despite its limitations, a careful abdominal examination is key to the diagnosis of pediatric appendicitis. A reliable examination requires that the child be quiet and cooperative. To accomplish this, the clinician needs to gain the trust of the child which often requires significant patience. It is also helpful to spend time taking the history, sitting down if possible, and to examine the abdomen before more invasive portions of the examination, such as looking in the ears or pharynx [2]. Similarly, the child can be initially examined in the position in which he or she is most comfortable, such as a caretaker's lap, prior to a standard evaluation.

In some patients, the degree of pain makes physical examination of the abdomen challenging. We recommend that children with suspected appendicitis receive analgesia commensurate with the degree of pain, including intravenous opioid medications if necessary. In the past, analgesia for patients with appendicitis was discouraged in the mistaken belief that pain control would mask symptoms and cause clinicians to miss definitive signs of disease. However, trials in children indicate that diagnosis of appendicitis is not significantly impacted when they receive intravenous opioid medications for pain control as follows:

- In a trial performed in 108 children (age 5 to 16 years) with suspected appendicitis who received intravenous morphine or normal saline while undergoing evaluation in a children's hospital ED, morphine administrations was **not** associated with perforation, negative appendectomy, or admission for observation after surgical assessment when compared to intravenous normal saline [38]. Missed appendicitis occurred in one patient who received normal saline. Morphine administration was associated with clinically significant greater pain relief.

- In a trial of 90 children (age 8 to 18 years) with right lower quadrant pain evaluated in a children's hospital ED, morphine in a dose of 0.1 mg/kg did not delay surgical decision-making when compared to normal saline administration (median time to decision 269 versus 307 minutes, respectively) [39]. Approximately three-quarters of patients in both groups underwent laparoscopy or laparotomy with appendicitis diagnosed in 29 patients in both groups. Morphine administration was not associated with increased risk of perforation. Appendicitis was missed in one patient who received normal saline. However, morphine in a dose of 0.1 mg/kg did **not** decrease pain more than placebo in this study.

Although both of these studies may not have had enough patients to truly identify significant differences in the impact of analgesia on the diagnosis of appendicitis, neither trial detected significant adverse effects on surgical management of these patients [40]. Thus, they support prompt treatment of abdominal pain in school-aged children and older with suspected appendicitis.

No studies have evaluated the use of analgesia in patients younger than five years of age undergoing examination for appendicitis. However, our experience suggests that infants and young children with significant abdominal pain warrant appropriate analgesia.

Physical findings — Local tenderness with some rigidity of the abdominal wall at or near McBurney's point (located approximately one-third of the distance along a line from the anterior superior iliac spine to the umbilicus) is the most reliable clinical sign of acute appendicitis. This finding may be less obvious when the appendix is in the retrocecal, retroileal, or pelvic position.

However, abdominal examination findings of appendicitis in children vary significantly by age and frequently fall outside of the classic disease presentation. (See 'Clinical features by age' above and 'Clinical manifestations' above.)

The following features may also be noted on abdominal examination [2]:

- Children with appendicitis prefer to lie still, often with one or both hips flexed. They are generally not too uncomfortable as long as they are not disturbed.

- Peritoneal inflammation causes splinting, which reduces movement of the anterior abdominal wall during normal breathing.

- Generalized abdominal tenderness with some rigidity of the abdominal wall occurs in most patients with diffuse peritonitis due to acute appendicitis and perforation.

- Abdominal pain can also be elicited by asking the child to cough or to hop. Patients whose appendix is in the retrocecal, retroileal, or pelvic position may have less obvious discomfort with these maneuvers.

Although rebound tenderness is also a reliable sign of peritoneal irritation, many pediatric surgeons feel that testing for it is often unnecessary, since it is painful in children who have appendicitis and may be falsely positive in those who do not.

Other findings — The following findings are sometimes present in children with appendicitis but, with the exception of low-grade fever, are less helpful for establishing the diagnosis:

- Low grade fever (38 to 38.5°C [100.2 to 101°F]), or in neonates, temperature instability

- Limp or right hip pain

- Difficulty ambulating, especially among children with advanced appendicitis
- Lethargy or irritability (neonates and young infants)
- Right sided pelvic pain or mass on abdominal palpation or digital rectal examination

Based upon a systematic review of five articles, the sensitivity and specificity for diagnosing acute appendicitis using digital rectal examination are low in both adults and children (44 to 55 percent and 44 to 75 percent, respectively) [41]. Furthermore, in one observational study, the diagnostic accuracy for appendicitis in 33 children undergoing digital rectal examination was not different from 64 children in whom it was omitted (75 versus 90 percent, respectively) [42]. Thus, digital rectal examination is **not** necessary in most children with suspected appendicitis and typically does **not** need to be performed to make the diagnosis of appendicitis. In our experience, it may be helpful in equivocal cases when performed by an experienced examiner.

Laboratory testing — Although limited in their ability to differentiate appendicitis from other causes of abdominal pain, the following studies are typically obtained in children suspected to have appendicitis:

- White blood cell count (WBC)
- Differential with calculation of the absolute neutrophil count (ANC)
- C-reactive protein (CRP)
- Urinalysis

The clinician should also obtain a pregnancy test (urine beta-human chorionic gonadotropin) in postmenarchal females to aid in the diagnosis of ectopic pregnancy and to guide imaging decisions in patients who have a moderate to high risk of appendicitis.

Although not widely available, addition of procalcitonin (PCT) and calprotectin (CP) to the above studies may significantly improve diagnostic discrimination. As an example, in a single-center, prospective observational study of 185 children presenting to the ED with abdominal pain (prevalence of appendicitis 48 percent), a PCT <0.1 ng/mL and CP <0.5 ng/mL (expressed as a negative commercial fluoroimmunoassay result), when combined with ANC <7500 was able to identify children without appendicitis with 100 percent sensitivity (95% CI 96 to 100 percent) and a negative predictive value of 100 percent (95% CI 90 to 100 percent) [43]. However, further study in larger and more diverse populations is needed before PCT and CP can be routinely recommended in the laboratory evaluation of pediatric appendicitis.

Laboratory tests should **not** be used in isolation to make or exclude the diagnosis of appendicitis. However, in some children, a combination of characteristic clinical findings and elevations in WBC, ANC, or CRP is sufficient to diagnose appendicitis [44]. Based upon observational studies, up to 50 percent of children with appendicitis can undergo surgery using clinical and laboratory findings and avoid diagnostic imaging [45-47]. Negative appendectomy rates of 5 to 6 percent have been reported with this approach.

Similarly, normal values for WBC or ANC in children undergoing evaluation for appendicitis have been used to predict a low risk of appendicitis as a component of validated clinical scoring systems [48-51]. (See 'Clinical scoring systems' below.)

Elevations in the peripheral WBC count, ANC, and CRP levels have been noted in children with appendicitis. However, these findings are variable and nonspecific as indicated by the following evidence:

- **WBC and ANC** – Either the WBC or the ANC is elevated in up to 96 percent of children with appendicitis [22]. This finding, however, is nonspecific because many other diseases that mimic appendicitis (eg, streptococcal pharyngitis, pneumonia, pelvic inflammatory disease, or gastroenteritis) also cause such elevations [2,37,52,53]. Thus, the ability of these tests to discriminate appendicitis from other causes is limited. As an example, in an observational study of 280 children (age 3 to 18

years) evaluated for appendicitis who had symptoms less than 24 hours, a WBC >14,600/mm^3 and an ANC >11,000/mm^3 had sensitivities of 68 and 69 percent, respectively and specificities of 96 and 75 percent, respectively [54]. In another observational report describing 772 children (1 to 19 years of age) with nontraumatic abdominal pain who were evaluated in an ED, those patients with either increased WBC (greater than upper limit of normal for age) or elevated neutrophil count (>80 percent mature or immature neutrophils), had an overall sensitivity of 79 percent and specificity of 80 percent [55].

By contrast, in children undergoing appendectomy, a normal WBC or ANC prior to surgery is associated with a negative appendectomy. As an example, in a retrospective observational study of 847 children who underwent appendectomy, a WBC <9000/microliter or <8000/microliter prior to surgery had sensitivities of 92 and 95 percent, respectively for a normal appendix [56].

- **CRP** – Elevation of CRP (>0.6 to 1 mg/dL [6 to 10 mg/L]) has been reported in children with appendicitis, but sensitivities and specificities range widely (sensitivity 58 to 93 percent, specificity 28 to 82 percent) [2,37,54]. CRP appears to be less sensitive in patients who have had symptoms for less than 24 hours but more sensitive than WBC for patients with symptoms for 24 to 48 hours [54,57]. Small observational studies also suggest that an elevated CRP may be more helpful in identifying both a gangrenous appendix (>1 mg/dL [10 mg/L] in 83 percent of patients) and appendiceal perforation (sensitivity and specificity for perforation 76 and 82 percent, respectively at a CRP >5 mg/dL [50 mg/L]) [57,58]. When both CRP and WBC are elevated, specificity for appendicitis is approximately 90 percent, although sensitivity remains low at approximately 40 percent [59].

- **Procalcitonin** – In one prospective study of 209 children (1 to 18 years of age), semiquantitative procalcitonin levels (PCT) were higher in patients with definitive appendicitis than in those without definitive appendicitis [59]. However, either WBC or CRP was better able to identify patients with appendicitis than PCT. Thus, PCT should **not** be routinely used to diagnose appendicitis in children.

  Among patients with appendicitis, elevation in PCT does suggest perforation. As an example, among 111 children with appendicitis a PCT level >0.18 ng/mL identified children with peritonitis with a sensitivity of 97 percent, specificity 80 percent, and a positive predictive value of 72 percent [60].

A urinalysis is usually performed in children with suspected appendicitis to identify alternative conditions such as a UTI or nephrolithiasis. However, between 7 and 25 percent of patients with appendicitis may have pyuria [23], although bacteria are not typically present in a clean-catch specimen. Less commonly, hematuria may also occur due to appendiceal irritation of the ureter or bladder [61,62]. Thus, the presence of pyuria or hematuria on urinalysis should **not** be used as the sole information to exclude the diagnosis of appendicitis.

EVALUATION AND DIAGNOSIS

Clinical suspicion — The diagnosis of appendicitis is made clinically and should be considered in all children with a history of abdominal pain and abdominal tenderness on physical examination. The diagnosis may be straightforward when the classic findings associated with appendicitis are present. However, the variations in presentation by age in children can pose a significant challenge. (See 'Clinical manifestations' above and 'Clinical features by age' above.)

In some children with abdominal pain a clear alternative diagnosis is present (eg, streptococcal pharyngitis, pneumonia, pelvic inflammatory disease). These patients should receive specific treatment for the underlying condition rather than undergoing a diagnostic evaluation for appendicitis. (See 'Differential diagnosis' below.)

For patients without a clear etiology for their abdominal pain in whom appendicitis is suspected, we suggest a diagnostic approach guided by the clinical impression of risk (low, moderate, or high) derived from history, physical examination, and selected laboratory studies as follows (algorithm 1):

- **Low risk** – These patients have few signs or symptoms of appendicitis (eg, afebrile, no history of vomiting or anorexia, minimal diffuse abdominal tenderness with a soft abdomen on palpation, or no right lower quadrant tenderness). If obtained, white blood cell (WBC) count, absolute neutrophil count (ANC), and C-reactive protein (CRP) are typically normal.

  Alternatively, patients can be determined to be low risk by a Pediatric Appendicitis Score (PAS) ≤2 (table 1) or according to the refined Low-Risk Appendicitis Rule (ANC <6750/mm^3 AND either maximal abdominal tenderness **not** in the right lower quadrant or right lower quadrant tenderness but no abdominal pain with walking, jumping, or coughing) [48-51]. (See 'Clinical scoring systems' below.)

  - **Further evaluation** – Children with a clear alternative diagnosis should undergo specific treatment for the identified condition and no further evaluation for appendicitis is indicated.

    Patients without an obvious alternative diagnosis may still have appendicitis, especially if signs or symptoms are of a short duration (<24 hours). For example, up to 2 percent of patients categorized as low risk by the PAS and up to 7 percent of patients identified as low risk by the refined Low-Risk Appendicitis Rule ultimately have appendicitis [48-51]. However, the risk of appendicitis in these patients is low enough to make close follow-up the most appropriate approach.

    Children **without** right lower quadrant pain or tenderness may be discharged home with clear instructions to the caregivers to return if pain increases or becomes localized to the right lower quadrant. The clinician should ensure that the caregivers are reliable and understand that a specific diagnosis for their child's abdominal pain has not been made and appendicitis is still possible.

    Patients **with** right lower quadrant pain or tenderness should undergo assured reevaluation within 12 to 24 hours. Some clinicians may choose to admit children with right lower quadrant tenderness to the hospital for serial examination.

- **Moderate risk** – Children with a moderate risk for appendicitis have some signs or symptoms of appendicitis (eg, low-grade fever, vomiting or anorexia, right lower quadrant tenderness, or abdominal pain with walking, jumping, or coughing). The WBC, ANC, or CRP can be normal or elevated.

  Alternatively, a PAS of 3 to 6 (table 1) suggests an intermediate risk of appendicitis that ranges from 8 to 48 percent. Patients who are not low risk by the refined Low-Risk Appendicitis Rule (ANC >6750/mm^3 OR right lower quadrant tenderness with pain on walking, jumping, or coughing) have an estimated risk of appendicitis between 12 and approximately 50 percent. (See 'Clinical scoring systems' below.)

  - **Further evaluation** – The best approach for these patients is not clear and depends upon local resources. Options include surgical consultation, diagnostic imaging, hospital admission with serial abdominal examinations by a surgeon with pediatric expertise, or a combination of these approaches.

- **High risk –** Children at high risk for appendicitis have classic findings of appendicitis, especially recent onset (one to two days) of abdominal pain that over time has migrated from the periumbilical region to the right lower quadrant followed by low-grade fever, vomiting, and anorexia and associated with right lower quadrant tenderness on physical examination. WBC, ANC, and/or CRP are typically elevated.

  A PAS score ≥7 (table 1) indicates a high risk of appendicitis (50 to 60 percent). (See 'Clinical scoring systems' below.)

  - **Further evaluation** – These children warrant prompt evaluation by a surgeon with pediatric expertise prior to urgent imaging to determine the need for appendectomy. If the patient requires transfer to a different hospital for pediatric surgical evaluation, then deferral of diagnostic imaging

(eg, ultrasound, computed tomography [CT], or magnetic resonance imaging [MRI]) is suggested if it will delay transfer or is likely **not** to be definitive.

- **Prior treatment with antibiotics** – Prior treatment with antibiotics before surgical evaluation may modify the clinical findings or change decision making regarding surgical care in children with appendicitis as indicated by the following observational studies:

  - In a retrospective study of 311 children treated for appendicitis, the 45 children who received antibiotics prior to evaluation had decreased tenderness on abdominal examination and had a higher degree of fever and elevated CRP prior to surgery than those not treated with antibiotics [63].

  - In another study of 151 children, history of receiving antibiotics (50 patients) was strongly associated with a delay of 48 hours or longer in the diagnosis of appendicitis (odds ratio [OR] 5.8, 95% CI 2.3-15.5) despite comparable physical findings suggestive of appendicitis (eg, right lower quadrant tenderness or peritoneal findings) in children who did or did not receive antibiotics.

    Thus, prior treatment with antibiotics tends to lower the confidence regarding the clinical examination and diagnosis of appendicitis by the surgeon and may cause a delay in definitive diagnosis. Diagnostic imaging is usually warranted to supplement other clinical findings in these patients.

Clinical scoring systems — Several clinical scoring systems have been devised for the diagnosis of appendicitis [2]. Among these, the Pediatric Appendicitis Score (PAS) (table 1), the refined Low-Risk Appendicitis Score, and the Alvarado (or MANTRELS) score have been prospectively studied in children [2,64-67]. The utility of these scores lies in their ability to categorize patients into groups that are at low, moderate, and high risk of appendicitis. However, they have limited ability to identify patients who warrant appendectomy. Furthermore, no studies have evaluated the ability of such scoring systems to improve diagnostic outcomes (ie, reduction in perforation and/or negative appendectomy rate) when compared to assessment by experienced clinicians. Nevertheless, these scores may have utility in identifying children who may benefit from diagnostic imaging and/or surgical consultation by providing a standard approach. The specific components of these scores are provided below.

Interobserver reliability of historical and physical examination findings commonly used in these scores shows significant variation. As an example, in a prospective multicenter study of 811 children (age 3 to 18 years) with possible appendicitis who underwent independent evaluations by clinicians with variable experience and training, agreement beyond chance for items commonly used in clinical scores was high only for the history of emesis and was moderate for the following clinical features [68]:

- Anorexia
- Duration of pain
- Presence of right lower quadrant pain
- Migration of pain to the right lower quadrant
- Maximal tenderness in the right lower quadrant
- Abdominal pain with walking, jumping, or coughing

These findings may, in part, explain why diagnostic accuracy for clinical scoring systems can be inconsistent.

Limited evidence is available to determine which score is best. In one systematic review of 11 prospective studies that evaluated the use of the PAS in 2170 children and the Alvarado score in 1589 children, the Alvarado score appeared to be better than the PAS for identifying children at low risk for appendicitis [69].

However, the analysis showed marked heterogeneity among the reviewed studies including significant variation in the percent of patients with appendicitis (15 to 71 percent) [70].

Pediatric appendicitis score — The Pediatric Appendicitis Score (PAS) is a tool that utilizes history, physical examination, and laboratory results to categorize the risk of appendicitis in children with abdominal pain on a 10 point scale (table 1) [48,64]. An algorithm that incorporates the PAS for clinical decision-making is provided (algorithm 1).

In several prospective observational studies, the mean PAS was significantly higher in children with appendicitis than in children without appendicitis (7 to 7.5 versus 2 to 5, respectively) [48-50,71]. The frequency of appendicitis in these studies varies by PAS as follows:

- PAS ≤2 to 3 – 0 to 2 percent
- PAS 3 to 6 – 8 to 48 percent
- PAS ≥7 – 78 to 96 percent

In one prospective observational study of 101 children with abdominal pain, a PAS of ≤3 excluded the diagnosis of appendicitis with a sensitivity of 100 percent (95% CI 98 to 100 percent) and a negative predictive value of 100 percent (95% CI 96 to 100 percent, prevalence of appendicitis: 28 percent) [71]. A PAS ≥8 had relatively high specificity (93 percent) but low sensitivity (57 percent). By contrast, a systematic review of six prospective studies with a total of 2170 patients found that a cutoff of <4 for low risk of disease was not sufficiently accurate for excluding appendicitis although the analysis showed significant heterogeneity among the pooled studies and, for most studies, a relatively high prevalence of appendicitis [69]. This review also found that a PAS ≥8 was not accurate enough to diagnose appendicitis.

Taken together, these studies indicate the following [48-50,69,71] (see 'Clinical suspicion' above):

- A PAS ≤2 or 3 suggests a low risk for appendicitis. Children with a PAS score in this range may be discharged home as long as their caretakers understand that persistent pain or additional symptoms warrant repeat evaluation.
- A PAS ≥7 or 8 indicates a high risk for appendicitis. Children with a PAS score in this range warrant surgical consultation or urgent imaging depending upon local guidelines. It is unclear if the PAS alone can be used to determine the need for appendectomy, because the number of patients with high scores who do **not** have appendicitis varies widely. This variation may be due, in part, to differences in inclusion and exclusion criteria in the studies discussed above.
- A PAS of 3 to 6 or 7 is indeterminate for appendicitis and the best approach is not clear. Options include surgical consultation, diagnostic imaging, serial abdominal examinations while being observed in the hospital, or a combination of these approaches depending upon local resources
- In isolation, the PAS may be inadequate to stratify risk among children with abdominal pain, especially among patients with a high prevalence of appendicitis.

Clinical pathways that utilize the PAS have the potential to achieve acceptable diagnostic accuracy and low utilization of CT. As an example, in a prospective observational study of 196 children with abdominal pain who were evaluated using a clinical pathway based upon the PAS to determine discharge (PAS ≤3), emergency ultrasonography (PAS 4 to 7), or surgery consult (PAS 8 to 10) in a children's hospital emergency department, the sensitivity and specificity of the pathway for appendicitis was 92 and 95 percent, respectively [72]. Perforated appendicitis occurred in 15 percent of patients and the negative appendectomy rate among the 68 children undergoing operation was 4.4 percent. CT of the abdomen was performed in 7 percent of patients. No child with a PAS ≤3 had appendicitis.

Refined Low-Risk Appendicitis Score — The Refined Low-Risk Appendicitis Score consists of the following low-risk items [51]:

- Absence of maximal tenderness in the right lower quadrant OR right lower quadrant tenderness without pain on walking, jumping, or coughing
- A less than 6750/mm^3

In a prospective cohort of 2625 children evaluated at multiple centers, these criteria had a sensitivity of 98 percent, specificity of 24 percent, and negative predictive value of 95 percent in identifying children **without** appendicitis [51].

Alvarado score — The Alvarado score (also called the MANTRELS score) is a 10-point score derived from eight components:

- Migratory right iliac fossa pain (1 point)
- Anorexia (1 point)
- Nausea/vomiting (1 point)
- Tenderness in the right iliac fossa (2 points)
- Rebound tenderness in the right iliac fossa (1 point)
- Elevated temperature >37.5°C (1 point)
- Leukocytosis (2 points)
- Shift of the WBC count (1 point)

The Alvarado score does **not** have adequate accuracy for the diagnosis of appendicitis in children. In a systematic review of the diagnostic accuracy of the Alvarado score which included 1075 children, a score of ≥5 for admission and ≥7 for surgery had pooled sensitivities of 99 percent and 76 percent among pediatric patients, respectively [73]. However, the Alvarado score had a significant tendency to exaggerate the probability of appendicitis in intermediate (score 5 or 6) and high (score 7 to 10) risk children. Furthermore, analysis suggested that the diagnostic accuracy of the score was inconsistent in children. In a separate systematic review of six prospective studies (1589 patients), no Alvarado score had an acceptable performance for ruling in appendicitis [69]. For example, using a score of ≥9 for the performance of surgery in children with a 40 percent pretest probability of appendicitis would have resulted in a 19 percent frequency of negative appendectomy [70]. On the other hand, this review also found that an Alvarado score <5 in children with a pretest probability for appendicitis up to 40 percent reduced the likelihood of appendicitis to <3 percent and which for some clinicians would permit the safe discharge of such patients to home observation. However, this risk of appendicitis is still greater than what is found for a Pediatric Appendicitis Score of 2 to 3. (See 'Pediatric appendicitis score' above.)

The use of the Alvarado score for the diagnosis and management of appendicitis in adults is discussed separately. (See "Acute appendicitis in adults: Diagnostic evaluation", section on 'Alvarado score calculation'.)

Imaging — For children who do not have a typical presentation for appendicitis or in whom appendicitis cannot be excluded clinically, imaging can be helpful to establish or exclude the diagnosis. Ultrasonography and CT, separately or in combination, are the modalities used most frequently; although evidence suggests that MRI instead of CT can provide similar diagnostic accuracy in a timely manner without radiation exposure. (See "Acute appendicitis in children: Diagnostic imaging", section on 'Imaging approach'.)

We suggest the following approach to the use of imaging studies for children with suspected appendicitis (see 'Clinical suspicion' above and "Acute appendicitis in children: Diagnostic imaging", section on 'Imaging decision'):

- Children with a typical clinical presentation for acute appendicitis are likely to have appendicitis. For these patients at high risk for appendicitis, we suggest clinicians consult a surgeon with pediatric experience prior to obtaining urgent imaging studies.
- Children who have a low risk for appendicitis based upon the clinical examination and, when indicated, laboratory studies may be managed without imaging at the initial evaluation. These patients warrant clear instructions regarding signs of appendicitis that should prompt reevaluation, or, if right lower quadrant pain or tenderness is present, assured reevaluation within 12 to 24 hours.
- Children with atypical or equivocal clinical findings of appendicitis suggesting a moderate likelihood for appendicitis warrant diagnostic imaging.

The Pediatric Appendicitis Score (PAS) or the Refined Low-Risk Appendicitis Score may be useful in establishing the level of risk in children with appendicitis. (See 'Pediatric appendicitis score' above and 'Refined Low-Risk Appendicitis Score' above.)

Chronic or recurrent appendicitis — Chronic appendicitis refers to the pathologic finding of chronic inflammation or fibrosis of the appendix found in a subset of patients undergoing appendectomy. Chronic appendicitis is a rare finding in children. These patients are clinically characterized by prolonged (>7 days) right lower quadrant pain that may be intermittent and a normal WBC count. Most patients have resolution of pain with appendectomy. Crohn's disease is a consideration in patients who have persistent pain after surgery. (See "Management of acute appendicitis in adults".)

Recurrent appendicitis can occur but is also rare in children; such cases may be caused by a retained foreign body (eg, fecalith) in the lumen of the appendix. Stump appendicitis is a form of recurrent appendicitis that is related to incomplete appendectomy that leaves an excessively long stump after open or laparoscopic surgery. (See "Acute appendicitis in children: Management", section on 'Late'.)

DIFFERENTIAL DIAGNOSIS — Appendicitis often presents with characteristic clinical features that make the evaluation and diagnosis straightforward. However, many diseases can mimic acute appendicitis in children (table 2). (See "Causes of acute abdominal pain in children and adolescents".)

Emergent surgical diagnoses — Although conditions other than appendicitis may also require operative management, the urgency and surgical approach may vary depending upon the diagnosis.

- **Bowel obstruction** – Bowel obstruction must always be considered in the child who has had abdominal surgery and presents with vomiting and abdominal pain. Vomiting may be bilious. In addition, plain films of the abdomen often show distended loops of bowel with air-fluid levels or pneumoperitoneum.
- **Intestinal malrotation** – Although most children with malrotation present in infancy with abdominal distension and bilious vomiting, a small percentage are diagnosed outside of infancy with abdominal pain and a variety of nonspecific clinical findings. Patients with volvulus often have pain out of proportion to physical examination findings. In patients with signs of obstruction, plain abdominal radiographs should be performed to exclude signs of perforation. The diagnosis of malrotation is confirmed by a limited upper gastrointestinal series or computed tomography (CT) of the abdomen with intravenous contrast. Prompt surgical intervention is required in patients with volvulus. (See "Intestinal malrotation in children", section on 'Diagnosis'.)
- **Intussusception** – Intussusception describes invagination of a part of the intestine into itself. Patients typically have an abrupt onset of intermittent episodic abdominal pain with vomiting, blood in the stool, and less commonly, lethargy or a palpable sausage-shaped abdominal mass in the right upper

quadrant. In the hands of an experienced ultrasonographer, the sensitivity and specificity of ultrasound for establishing the diagnosis of intussusception approach 100 percent. The diagnosis can also be made with a contrast enema (air or barium), which may reduce the intussusceptum, thereby avoiding an operation. (See "Intussusception in children", section on 'Evaluation'.)

- **Ovarian torsion** – Although ovarian torsion does not occur commonly in children, the presentation is nonspecific and easily confused with appendicitis. Features include acute onset of moderate to severe abdominal pain, vomiting, and an adnexal mass. The character of the pain may be sharp, stabbing, colicky, or crampy, and may radiate to the flank, back, or groin. Infants with ovarian torsion present with feeding intolerance, vomiting, abdominal distension, and fussiness or irritability. Most infants have previously diagnosed ovarian cysts on prenatal ultrasounds. Salvage of the ovary is often not possible but is maximized by expeditious surgery. Ovarian torsion is typically diagnosed with Doppler flow ultrasound of the ovaries. (See "Ovarian and fallopian tube torsion", section on 'Clinical presentation' and "Ovarian and fallopian tube torsion", section on 'Imaging studies'.)

- **Ectopic pregnancy** – Ectopic pregnancy can be a life-threatening emergency typically occurring six to eight weeks after the last normal menstrual period. Classic symptoms include abdominal pain, vaginal bleeding, and amenorrhea. Normal signs of pregnancy such as breast tenderness, frequent urination, and nausea may also be present. Clinical findings, a positive urine pregnancy test, and visualization of a pregnancy outside of the uterus are the key diagnostic findings. (See "Ectopic pregnancy: Clinical manifestations and diagnosis", section on 'Clinical presentation' and "Ectopic pregnancy: Clinical manifestations and diagnosis", section on 'Diagnosis'.)

- **Testicular torsion** – Although testicular torsion can cause abdominal pain, symptoms and physical findings in the scrotum will also be present. (See "Causes of scrotal pain in children and adolescents", section on 'Testicular torsion'.)

- **Torsion of the omentum** – Omental torsion may cause localized right-sided abdominal pain and tenderness [74,75]. Fever and vomiting are less prominent than in acute appendicitis. Obesity appears to be a risk factor. Ultrasound or CT can aid in diagnosis by identifying an ovoid mass with adherence to the anterior abdominal wall [75]. The signs and symptoms will often resolve with intravenous fluids and analgesia. If this diagnosis is recognized by ultrasound or CT before surgery, operation is not necessary. When diagnosed intraoperatively, treatment consists of partial omentectomy. Omental torsion coexisting with appendicitis has been described [74].

Emergent nonsurgical diagnoses — Most emergent nonsurgical diagnoses that may be confused with appendicitis can usually be detected early in the evaluation of children with acute abdominal pain. Failure to do so, however, could delay emergent treatment.

- **Hemolytic uremic syndrome** – Children with hemolytic uremic syndrome often have vomiting and abdominal pain with a prodrome of diarrhea. The characteristic triad of microangiopathic hemolytic anemia, thrombocytopenia, and acute renal failure is also typically present, leading to a prompt diagnosis. (See "Clinical manifestations and diagnosis of Shiga toxin-producing Escherichia coli (STEC) hemolytic uremic syndrome (HUS) in children".)

- **Diabetic ketoacidosis** – Children with diabetic ketoacidosis usually have classic symptoms such as polyphagia, polydipsia, and polyuria. Once insulin deficiency and ketoacidosis become significant, anorexia, vomiting, and abdominal pain develop in association with hyperglycemia, metabolic acidosis, glycosuria, and ketonuria. (See "Clinical features and diagnosis of diabetic ketoacidosis in children and adolescents".)

- **Primary peritonitis** – Primary peritonitis usually occurs in children with ascites and chronic conditions such as nephrotic syndrome, systemic lupus erythematosus, or liver disease although cases caused by *Streptococcus pyogenes* have been described in healthy children [76]. In patients with ascites, the diagnosis is made by paracentesis with isolation of a single organism by culture in association with an

ascitic fluid neutrophil count ≥250 cells/mm^3. Differentiation of primary peritonitis from secondary peritonitis caused by a surgical condition as described in the algorithm (algorithm 2) is a critical aspect of care and is discussed in greater detail separately. (See "Spontaneous bacterial peritonitis in adults: Diagnosis", section on 'Distinguishing spontaneous from secondary bacterial peritonitis'.)

Other nonsurgical diagnoses — Nonsurgical diagnoses that present in a similar manner to appendicitis often have some distinguishing features. Others, such as pneumonia, streptococcal pharyngitis, and urinary tract infections (UTIs), may not be evident unless specific tests are performed.

- **Nephrolithiasis** – Kidney stones are less common than appendicitis in children. In children, intermittent colicky flank pain with radiation to the abdomen and groin is a common manifestation which may be accompanied by gross or microscopic hematuria. Diagnosis can be confirmed by helical CT of the abdomen and pelvis or by ultrasound. (See "Clinical features and diagnosis of nephrolithiasis in children", section on 'Clinical presentation' and "Clinical features and diagnosis of nephrolithiasis in children", section on 'Diagnosis'.)

- **Sickle cell disease** – Abdominal pain as a result of infarction of abdominal and retroperitoneal organs can occur in children with sickle cell disease. Although vasoocclusive crises occur more commonly than appendicitis, the symptoms may be indistinguishable [77,78]. A surgical diagnosis should be considered in patients with an unusual pattern of pain or who do not respond promptly to hydration and analgesia. (See "Overview of the clinical manifestations of sickle cell disease".)

- **Immunoglobulin A vasculitis (IgAV; Henoch-Schönlein purpura [HSP])** – IgAV (HSP) is a systemic vasculitis that includes a characteristic purpuric rash, typically distributed symmetrically over the upper legs and buttocks (picture 1). Abdominal pain is usually colicky and may be associated with vomiting. Intussusception is a rare surgical complication. (See 'Emergent surgical diagnoses' above and "IgA vasculitis (Henoch-Schönlein purpura): Clinical manifestations and diagnosis".)

- **Pelvic inflammatory disease (PID)** – Although PID usually causes diffuse lower abdominal pain, focal right lower quadrant abdominal pain does occur. Patients may often be febrile. Findings on pelvic bimanual examination of a purulent endocervical discharge and/or acute cervical motion and adnexal tenderness distinguish PID from appendicitis. (See "Pelvic inflammatory disease: Clinical manifestations and diagnosis".)

- **Ovarian cyst** – Ovarian cysts commonly occur in postmenarchal adolescent females and may cause right lower quadrant pain, which can be severe if the cyst has ruptured. Findings of anorexia and vomiting are less common unless ovarian torsion has occurred. Plain and Doppler ultrasounds of the pelvis and abdomen that demonstrate an ovarian cyst and a normal appendix are diagnostic. (See "Ovarian cysts and neoplasms in infants, children, and adolescents", section on 'Clinical features'.)

- **Mittelschmerz** – This ovulatory event causes recurrent midcycle pain in females with regular ovulatory cycles. This pain is caused by normal follicular enlargement just prior to ovulation or to normal follicular bleeding at ovulation. The pain is typically mild and unilateral; it occurs midway between menstrual periods and lasts for a few hours to a couple of days. The onset of pain midcycle and a history of recurrence help to differentiate mittelschmerz from appendicitis. (See "Evaluation of acute pelvic pain in the adolescent female", section on 'Mittelschmerz'.)

- **Pneumonia** – An infiltrate in the lower lobes of the lungs may irritate the diaphragm and cause abdominal pain that can mimic findings of appendicitis in children. Cough, fever, tachypnea, rales on auscultation, and/or decreased oxygen saturation help to distinguish pneumonia from appendicitis. In many children, pneumonia can be diagnosed based upon clinical findings alone. The presence of infiltrates on chest radiograph, which may be subtle on presentation, confirms the diagnosis of pneumonia in children with compatible clinical findings. However, pneumonia can be difficult to identify when respiratory signs and symptoms are subtle [79]. Because of the overlap in clinical presentation, some children may warrant chest radiographs and abdominal imaging. (See "Community-acquired

pneumonia in children: Clinical features and diagnosis", section on 'Clinical presentation' and "Fever without a source in children 3 to 36 months of age", section on 'Pneumonia' and "Community-acquired pneumonia in children: Clinical features and diagnosis", section on 'Diagnosis'.)

- **Urinary tract infection** – UTIs may cause abdominal pain and vomiting, particularly in young children. Although white blood cells (WBCs) may also be seen on urinalysis in patients with appendicitis, children with UTIs will generally have bacteria on microscopic examination and a dipstick positive for leukocyte esterase and/or nitrites. (See "Urinary tract infections in infants and children older than one month: Clinical features and diagnosis", section on 'Rapidly available tests'.)

- **Streptococcal pharyngitis** – Young children with streptococcal pharyngitis may have vomiting and abdominal pain in addition to a sore throat. Suggestive clinical findings include sore throat, tender anterior cervical nodes, and exudative pharyngitis. Rapid antigen detection can quickly diagnose group A streptococcal disease in most cases. (See "Group A streptococcal tonsillopharyngitis in children and adolescents: Clinical features and diagnosis", section on 'Diagnosis'.)

- **Gastroenteritis** – Gastroenteritis occurs commonly in children younger than two years. In resource-rich countries, a viral etiology is most common, and the presence and quantity of diarrhea can be variable. Diarrhea may also occur in children with appendicitis, especially patients younger than five years of age. In most instances, children with gastroenteritis have diffuse abdominal tenderness without guarding or rebound. The diagnosis of gastroenteritis should be made cautiously in children with abdominal pain and vomiting who do not have diarrhea. In one retrospective review of cases of missed appendicitis, 42 percent of children were initially diagnosed with gastroenteritis [23]. (See "Acute viral gastroenteritis in children in resource-rich countries: Clinical features and diagnosis", section on 'Clinical presentation'.)

  Yersinia enterocolitica gastroenteritis can cause focal abdominal pain that is clinically indistinguishable from appendicitis. (See "Clinical manifestations and diagnosis of Yersinia infections", section on 'Pseudoappendicitis'.)

- **Mesenteric lymphadenitis** – Children with abdominal pain who undergo ultrasound demonstrate mesenteric lymphadenitis in 9 to 32 percent of cases [80,81]. This radiologic finding is a nonspecific indicator of infection, inflammation, and rarely, malignancy. Etiologies of mesenteric lymphadenitis include viral and bacterial gastroenteritis, inflammatory bowel disease, and lymphoma. (See "Causes of acute abdominal pain in children and adolescents", section on 'Gastrointestinal'.)

  Compared to patients with acute appendicitis, children with mesenteric adenitis tend to have longer duration of symptoms prior to presentation, fewer findings of appendicitis (ie, vomiting, migration of pain, percussion tenderness, rebound tenderness, or Rovsing sign), higher fever (when present), and normal WBC counts and C-reactive protein levels [82]. However, patients with mesenteric adenitis can have clinical findings that are difficult to distinguish from acute appendicitis [83]. Ultrasound is typically warranted to make the diagnosis and to exclude appendicitis.

SOCIETY GUIDELINE LINKS — Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Appendicitis in children".)

INFORMATION FOR PATIENTS — UpToDate offers two types of patient education materials, "The Basics" and "Beyond the Basics." The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword(s) of interest.)

- Basics topics (see "Patient education: Appendicitis in adults (The Basics)" and "Patient education: Appendicitis in children (The Basics)")

SUMMARY AND RECOMMENDATIONS

- The classic presentation of appendicitis includes the following historical and physical examination findings (see 'Clinical manifestations' above):
  - Anorexia
  - Periumbilical pain (early)
  - Migration of pain to the right lower quadrant (often within 24 hours of onset of symptoms)
  - Pain with movement: walking or shifting position in bed or on stretcher
  - Vomiting (typically occurring after the onset of pain)
  - Fever (commonly occurring 24 to 48 hours after onset of symptoms)
  - Right lower quadrant tenderness
  - Signs of localized or generalized peritoneal irritation
- Although this classic pattern of clinical findings does occur in school-age children and adolescents, it is less common overall in pediatric patients with appendicitis than in adults and may not occur at all in children younger than five years of age. (See 'Clinical features by age' above.)
- Despite its limitations, a reliable abdominal examination is key to demonstrating the physical findings of appendicitis and requires that the child be quiet and cooperative. We recommend that children with suspected appendicitis receive analgesia commensurate with the degree of pain, including intravenous opioid medications (**Grade 1B**). (See 'Approach and analgesia' above and 'Physical findings' above.)
- Although limited in their ability to differentiate appendicitis from other causes of abdominal pain, the following laboratory tests are typically obtained in children undergoing evaluation for appendicitis (see 'Laboratory testing' above):
  - White blood cell (WBC) count
  - Differential with calculation of the absolute neutrophil count (ANC)
  - C-reactive protein (CRP)
  - Urinalysis
  - Urine pregnancy test in postmenarchal females
- We suggest a diagnostic approach guided by the clinical impression of risk (low, moderate, or high) derived from history, physical examination, and selected laboratory studies to determine next steps in evaluation and treatment of children with possible pediatric appendicitis (algorithm 1). Validated clinical scoring systems have been developed to assist in this process. (See 'Clinical suspicion' above and 'Clinical scoring systems' above.)
- We suggest the following approach to the use of imaging studies for children with suspected appendicitis (see 'Clinical suspicion' above and "Acute appendicitis in children: Diagnostic imaging",

section on 'Imaging decision'):

- Children with a typical clinical presentation for acute appendicitis are likely to have appendicitis. For these patients at high risk for appendicitis, we suggest clinicians consult a surgeon with pediatric experience prior to obtaining urgent imaging studies.
- Children who have a low risk for appendicitis based upon the clinical examination and, when indicated, laboratory studies may be managed without imaging at the initial evaluation. These patients warrant clear instructions regarding signs of appendicitis that should prompt reevaluation, or, if right lower quadrant pain or tenderness is present, assured reevaluation within 12 to 24 hours.
- Children with atypical or equivocal clinical findings of appendicitis suggesting a moderate likelihood for appendicitis warrant diagnostic imaging. Ultrasonography is the recommended initial imaging test.

- Children with a clear alternative diagnosis should undergo specific treatment for the identified condition and no further evaluation for appendicitis is indicated. (See 'Differential diagnosis' above.)

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