Appendicitis, Acute

Description/Etiology
Acute appendicitis is a medical/surgical emergency involving severe inflammation of the vermiform appendix, which is a small pouch extending from the cecum (i.e., the first part of the large intestine) that has no known function. Appendicitis frequently results from appendiceal lumen obstruction. Obstruction causes vascular congestion and edema, which initiates an inflammatory process that can quickly lead to infection, thrombosis, necrosis, and increased risk for perforation. Appendiceal rupture or perforation causes the infected contents to spill into the abdominal cavity, which can result in peritonitis, one of the most common and life-threatening complications of acute appendicitis. Other potential complications include pelvic abscess, ileus, obstruction, sepsis, shock, and death.

Patients with right lower quadrant (RLQ) abdominal pain, nausea, vomiting, anorexia, and RLQ rebound tenderness should undergo prompt clinical and laboratory evaluation for acute appendicitis. Accurate diagnosis of acute appendicitis is challenging because only about half of patients have the classic signs and symptoms; atypical clinical presentation commonly leads to delayed diagnosis, which increases risk for perforation, prolonged hospitalization, and greater morbidity. Imaging studies are usually performed in cases of uncertain diagnosis.

The mainstay of treatment for acute appendicitis is appendectomy performed by an open approach or laparoscopically; benefits of laparoscopic appendectomy over an open surgical approach include reduced pain, earlier return to activity, and better cosmetic results, although laparoscopy is more expensive and associated with higher complication rates (for more information on appendectomy, see *Quick Lesson About … Appendectomy*). Supportive therapy includes correction of fluid and electrolyte imbalances and antibiotic prophylaxis. With prompt treatment, the overall prognosis is excellent.

Facts and Figures
The incidence of acute appendicitis in the United States is 10 cases per 100,000 persons; lifetime risk is 7–14%. Acute appendicitis occurs most commonly in persons who are 10–30 years of age. Appendicitis is the most common abdominal surgical emergency; 300,000 appendectomies are performed annually in the U.S. Appendicitis occurs in three males for every two affected females until the mid-20s, after which it affects males and females in equal numbers. The incidence of appendicitis has been steadily declining in the U.S. since the 1940s. Perforation occurs in ~20% of adult cases. The mortality rate is <1% in young adults who have no complications and is >10% in older adults whose appendix ruptures. In rare cases, stump appendicitis (i.e., the recurrence of appendicitis in the surgical stump after a previous appendectomy) develops; 36 cases of stump appendicitis have been reported.

Risk Factors
The most common causes of appendiceal lumen obstruction are fecaliths (i.e., hard fecal stones, which account for 30–45% of cases and are the most common cause of appendicitis in adults) and inflammation, which causes 50–60% of cases and is the most common cause of appendicitis in children. Less common causes include foreign body obstruction (e.g., by fruit seeds, parasitic worms, or calculi) and neoplasm. Some degree of familial predisposition exists. The incidence of acute appendicitis is lower in cultures with higher...
average dietary fiber intake, likely because of decreased fecal viscosity, decreased bowel transit time, and reduced formation of fecaliths associated with high intake of dietary fiber.

**Signs and Symptoms/Clinical Presentation**

Clinical presentation of acute appendicitis typically includes abdominal pain, anorexia, nausea, vomiting, constipation, diarrhea, abdominal spasms, swelling, rigidity, and tenderness. Usually patients complain of generalized or localized periumbilical or epigastric pain that migrates to the RLQ and worsens with movement.

**Assessment**

› **Physical Findings of Particular Interest**
  • Although no single sign or symptom accurately identifies appendicitis in all cases, RLQ pain on palpation is the single most important physical finding. Other common findings include low-grade fever (e.g., < 100.4 °F/38 °C) and peritoneal manifestations, including localized tenderness to palpation and guarding (i.e., abdominal muscle spasm that occurs to shield the affected abdominal area during examination); rebound tenderness (i.e., increased pain elicited by deep palpation of the tender area with subsequent sudden release of the hands from the area); RLQ flank tenderness, indicating retroperitoneal or retrocecal abscess; and maximal tenderness at McBurney’s point (i.e., a point halfway between the umbilicus and the anterior spine of the ilium)
  – Other physical signs associated with acute appendicitis include Rovsing’s sign (i.e., deep palpation of the left lower quadrant that causes increased pain in the RLQ), iliopsoas sign (i.e., increased abdominal pain on flexion and extension of the right thigh against resistance, indicating retroperitoneal or retrocecal abscess), and obturator sign (i.e., RLQ pain on internal rotation of the right thigh to stretch the obturator internus muscle, indicating an inflamed and enlarged appendix that is causing obturator internus muscle irritation)
  • Lying with right knee flexed for comfort is common in patients with acute appendicitis

› **Laboratory Tests**
  • CBC with differential shows moderate leukocytosis, WBC count > 10,500 cells/mm\(^3\) in 80–85% of patients, and a shift to the left (i.e., increased numbers of unsegmented neutrophils) in 90% of patients. **WBC count > 20,000/mm\(^3\) with a left shift strongly suggests perforation**
  • Serum chemistry will show electrolyte abnormalities if dehydration is present
  • C-reactive protein levels are commonly > 1 mg/dL in patients with appendicitis
  • Enzyme-linked immunosorbent assay testing often identifies significant elevation of the plasma markers lactoferrin and calprotectin in patients with appendicitis
  • Urinalysis shows hematuria, pyuria, infection, and/or nephrolithiasis in some cases
  • Pregnancy testing should be considered in women who are of childbearing age

› **Other Diagnostic Tests/Studies**
  • Abdominal X-ray can identify a gas-filled appendix, fecalith, and/or rupture, if present
  • Doppler ultrasonography followed by abdominal helical CT scan is more than 90% accurate in diagnosing acute appendicitis
  • Abdominal multi-detector CT scan with contrast can diagnose acute appendicitis
  • MRI can be performed to diagnose appendicitis in pregnant females if ultrasound findings are inconclusive
  • The Alvarado score, which is based on a combination of signs and symptoms, can be used to predict the presence or absence of appendicitis, but its reliability is questionable

**Treatment Goals**

› **Promote Resolution of Acute Status and Reduce Risk of Complications**
  • Monitor vital signs, assess all physiologic systems (especially gastrointestinal), and laboratory/other diagnostic study results, place in Fowler’s position, and maintain NPO status; immediately report abnormalities and provide prescribed treatment
  • Assess for pain using a facility-approved pain assessment tool and administer prescribed analgesic(s); apply ice to area of pain
  • Administer IV fluids to reduce the risk of dehydration and correct fluid/electrolyte abnormalities
  • Assess for complications of appendicitis, and administer prescribed antibiotics
    – Third-generation cephalosporins (e.g., cefOxitin, cefoTEtan) are the antibiotics of choice for patients with uncomplicated acute appendicitis
Broad-spectrum antibiotics (e.g., gentamicin, ampicillin/sulbactam) are ordered for gram-negative and anaerobic organisms associated with appendicitis that is complicated by perforation, gangrene, and/or peritonitis.

- Follow facility pre- and postsurgical protocols if patient becomes a surgical candidate (e.g., for appendectomy); reinforce pre- and postsurgical education and verify completion of facility informed consent documents

**Promote Rapid Postsurgical Recovery, Support Emotional Well-Being, and Educate**

- Closely monitor vital signs, I & O, and for pain and postsurgical complications (e.g., paralytic ileus); provide prescribed analgesic(s), and maintain fluid balance with IV fluids
- Frequently assess the surgical wound and provide wound care to prevent infection and sepsis, as ordered; encourage frequent coughing, deep breathing, and turning to prevent pulmonary complications; and assist with ambulation as soon as possible after surgery
- Insert and maintain a nasogastric tube, if ordered; provide oral and nasal care and encourage consuming a regular diet, as ordered, when bowel function returns
- Assess patient anxiety level and coping ability; provide emotional support and education regarding the prescribed postsurgical treatment regimen and expectations for recovery

**Food for Thought**

- Authors of a retrospective analysis of 361 patient records explored which diagnostic tools (e.g., imaging, physical assessment, laboratory) most accurately aided in appendicitis diagnosis. Ultrasound was unreliable in detection. Elevated leukocytes raised concern but physical assessment was found to be the best method for appendicitis diagnosis (Ozdemir et al., 2018)
- Ultrasound reliability for the detection of acute appendicitis may be operator-dependent. Researchers in Indiana conducted a prospective, observational study including 105 patients with moderate-to-high likelihood of having acute appendicitis and sonographers who received 20 minutes of instruction about appendicitis. Confident sonographers detected appendicitis reliably. Surgical consultation after positive ultrasound findings for appendicitis without additional diagnostic testing is recommended (Corson-Knoles et al., 2018)
- Although appendectomy is the standard treatment for acute appendicitis, accumulating evidence suggests that antibiotic therapy can be a safe and effective alternative in select patients with uncomplicated appendicitis
  - Researchers in Israel conducted a prospective cohort study including 362 children with appendicitis, 86% of which successfully responded to conservative antibiotic treatment, and concluded that conservative antibiotic treatment can be a safe option over surgery for children with appendicitis (Steiner et al., 2018)
  - Researchers in France reviewed data from the records of 166 children treated for uncomplicated appendicitis, all of whom received only antibiotics for seven days. Only four of the children remained in the hospital after two days. Of the four children that required surgery, none developed complicated appendicitis (Abbo et al., 2018)
  - Researchers in Taiwan studied 239,821 patients hospitalized with acute appendicitis, 12,235 (29.9%) of which were managed nonoperatively. The recurrence rate among conservatively managed patients was 7.1% at a median follow-up of 6.5 years. Risk factors for recurrence included young age, male sex, and percutaneous abscess drainage (Liang et al., 2016)
- Limited evidence exists to explain how patient outcomes relate to the timing of surgery for acute appendicitis. Authors of a systematic literature review concluded that risk of perforation is lowest in the first 24 hours after the initiation of symptoms (Cameron et al., 2018)
- Abdominal drainage is routinely used after appendectomy in patients with complicated appendicitis to reduce the risk of adverse postoperative problems. Authors of a meta-analysis found low-quality evidence supporting clinical advantages of abdominal drainage postoperatively for complicated appendicitis (Li et al., 2018)

**Red Flags**

- Parents and other care providers of children should have a high index of suspicion for acute appendicitis because it can occur in children of all ages, including neonates
- Sudden cessation of abdominal pain indicates perforation or infarction of the appendix
- Analgesics should not be administered until the diagnosis is made to avoid masking peritonitis
- Preoperative administration of cathartics or enemas or application of heat to the abdomen is contraindicated because these increase risk for rupture the appendix
- Although pregnancy is not associated with increased risk for appendicitis, anatomic changes during pregnancy can hinder diagnosis of appendicitis; pregnant patients are more likely to develop perforation, which often leads to the development of life-threatening complications, including intraperitoneal infection and fetal death
- If imaging is required in a pregnant female, strategies should be initiated to minimize radiation exposure and risk
What Do I Need to Tell the Patient/Patient’s Family?

› Emphasize the importance of ambulating as soon after surgery as possible, and educate that return to full activities is possible by 4–6 weeks after surgery in uncomplicated cases
› Educate to seek immediate medical attention for the development of postoperative anorexia, nausea, vomiting, abdominal pain, fever, and/or chills

References