Acute appendicitis

The right clinical information, right where it's needed
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Summary

- Acute inflammation of the vermiform appendix.
- Typically presents as acute abdominal pain starting in the mid-abdomen and later localizing to the right lower quadrant.
- Associated with fever, anorexia, nausea, vomiting, and elevation of the neutrophil count.
- Diagnosis is usually made clinically. If investigation is required, CT scan or ultrasonography may show dilatation of the appendix outer diameter to more than 6 mm.
- Definitive treatment is surgical appendectomy.
Definition

Acute appendicitis is an acute inflammation of the vermiform appendix,[1] most likely due to obstruction of the lumen of the appendix (by fecalith, normal stool, infective agents, or lymphoid hyperplasia).[2]

Epidemiology

Acute appendicitis is one of the most common acute surgical abdominal emergencies.[4] More than 250,000 appendectomies are performed each year in the US,[5] however, the incidence is lower in populations where a high-fiber diet is consumed.[6] The overall lifetime risk of developing acute appendicitis is 8.6% for males and 6.7% for females; lifetime risk of appendectomy is around 12% in males and 23% in females.[7] [8] The rate of appendectomy is around 10 per 10,000 cases per year in the US.[9] This condition is most commonly seen in patients aged between early teens and late 40s. There is a slight male to female predominance (1.3:1).

Etiology

Obstruction of the lumen of the appendix is the main cause of acute appendicitis. Fecalith (a hard mass of fecal matter), normal stool, or lymphoid hyperplasia are the main causes for obstruction. Fecalith alone causes simple appendicitis in 40%, gangrenous nonperforated appendicitis in 65%, and perforated appendicitis in 90% of cases.[10]

There is evidence suggesting a neuroimmune etiology in some cases, but this is still being investigated.[11]

Pathophysiology

The lumen distal to the obstruction starts to fill with mucus and acts as a closed-loop obstruction. This leads to distension and an increase in intraluminal and intramural pressure. As the condition progresses, the resident bacteria in the appendix rapidly multiply. The most common bacteria in the appendix are Bacteroides fragilis and Escherichia coli.[12]

Distension of the lumen of the appendix causes reflex anorexia, nausea and vomiting, and visceral pain.

As the pressure of the lumen exceeds the venous pressure, the small venules and capillaries become thrombosed but arterioles remain open, which leads to engorgement and congestion of the appendix. The inflammatory process soon involves the serosa of the appendix, hence the parietal peritoneum in the region, which causes classical right lower quadrant pain.

Once the small arterioles are thrombosed, the area at the antimesenteric border becomes ischemic, and infarction and perforation ensue. Bacteria leak out through the dying walls and pus forms (suppuration) within and around the appendix. Perforations are usually seen just beyond the obstruction rather than at the tip of the appendix.[10]
Acute appendicitis

Diagnosis

Case history

Case history #1

A 22-year-old male presents to the emergency room with abdominal pain, anorexia, nausea, and low-grade fever. Pain started in the mid-abdominal region 6 hours ago and is now in the right lower quadrant of the abdomen. The pain was steady in nature and aggravated by coughing. Physical examination reveals a low-grade fever (100.5°F; 38°C), pain on palpation at right lower quadrant (McBurney sign), and leukocytosis (12,000/microliter) with 85% neutrophils.

Case history #2

A 12-year-old girl presents with sudden-onset severe generalized abdominal pain associated with nausea, vomiting, and diarrhea. On exam she appears ill and has a temperature of 104°F (40°C). Her abdomen is tense with generalized tenderness and guarding. No bowel sounds are present.

Other presentations

Atypical appendiceal anatomy, such as retrocecal or long appendix, may present with back, hip, or left-sided abdominal pain that is confused with an alternate intra-abdominal diagnosis. Older patients are less likely to have classical symptoms and may present with nonspecific abdominal pain without associated features, or confusion. The delay in presentation or diagnosis in this group results in increased risk of morbidity and mortality. The diagnosis of acute appendicitis during pregnancy is often delayed, as the location of the pain is affected by displacement of the appendix by the uterus, and symptoms such as nausea and vomiting are frequently associated with pregnancy itself.[3]

Step-by-step diagnostic approach

Typical history and physical examination are usually sufficient to reach the diagnosis of acute appendicitis.[2] It has, however, become common practice, especially in the US, for any patient presenting to the emergency department with abdominal pain suggestive of appendicitis, to have CT scan of the abdomen and pelvis, unless the patient is pregnant.

Atypical presentations that do not have the classical symptoms of central abdominal pain that shifts to the right iliac fossa or associated features of anorexia and vomiting should also have either an ultrasound or a CT scan. Women of childbearing age should have a pelvic examination to rule out other pelvic pathology. Pregnant women presenting with right-sided abdominal pain, with nausea and vomiting, pose an even greater challenge and should proceed to ultrasound examination, followed by MRI or CT scan if needed.[21]

History

Abdominal pain is the main presenting complaint. Pain typically starts at mid-abdominal region and later (1 to 12 hours) shifts to the right lower quadrant. Pain is usually constant in nature and with intermittent abdominal cramps and is usually worse on movement and coughing.

Location of the pain may vary depending upon the position of the appendix:
Acute appendicitis diagnoses include:

- Retrocecal appendix may cause flank or back pain
- Retroileal appendix may cause testicular pain due to irritation of the spermatic artery or ureter
- Pelvic appendix may cause suprapubic pain
- A long appendix with tip inflammation in the left lower quadrant may cause pain to that region.

Anorexia is another important symptom almost always associated with acute appendicitis. Without anorexia, the diagnosis of acute appendicitis is in question. Nausea and vomiting are also present in 75% of patients. Vomiting usually occurs only once or twice. Absolute constipation is a late feature.

The sequence of presentation in 95% of the patients with acute appendicitis usually starts with anorexia, followed by abdominal pain and then vomiting (seen only in 75% of patients). However, in pregnant patients, the only features shown to be significantly associated with a diagnosis of appendicitis are nausea, vomiting, and local peritonitis.

Complicated appendicitis (perforation or intra-abdominal abscess) is more likely the greater the duration of symptoms and in older patients (>50 years).

**Physical exam**

Usually, there are no significant changes in vital signs. Body temperature may be slightly increased (by an average of 1.8°F). In patients presenting with a high-grade fever, another diagnosis should be considered. Tachycardia and fetor may also be present.

A classic sign is right lower quadrant abdominal tenderness (McBurney sign) and localized rebound tenderness, if appendix is anterior. There may also be pain in the right lower quadrant after compressing the left lower quadrant (Rovsing sign).

Pain may be elicited with the patient lying on their left side and slowly extending the right thigh to cause a stretch in the iliopectos muscle (psoas sign) or by internal rotation of the flexed right thigh (obturator sign).

Bowel sounds may be reduced, particularly on the right side compared with on the left.

Classical abdominal findings may not be present if the appendix is in an atypical position.

Patients with perforation may present acutely ill with hypotension, tachycardia, and a tense, distended abdomen with generalized guarding and absent bowel sounds.

A palpable mass may be felt if the appendiceal perforation has been contained by the omentum, resulting in a periappendiceal abscess.

**Investigation**

All patients with abdominal discomfort should have a CBC taken. Mild leukocytosis (10,000 to 18,000/ microliter) with increased neutrophils is usually present.

If clinical findings suggest acute appendicitis, further investigations should not delay proceeding to surgical management. In the US, most nonpregnant patients presenting to the emergency department with abdominal pain suggestive of appendicitis will have a CT scan of the abdomen and pelvis.

Patients with a palpable abdominal mass should also have either an ultrasound or a CT abdomen.

In patients with equivocal clinical findings, imaging by ultrasound or CT scan of the abdomen is indicated. Women and children, in particular, may benefit from preoperative imaging.
Acute appendicitis

Although CT scan has greater sensitivity and specificity than ultrasound in diagnosing appendicitis,[33] [34] the latter has the advantage of being readily available, rapid, and able to be performed at the bedside.[35] In children, ultrasound may be preferred over CT scan in order to limit radiation exposure.[32] If, on ultrasound, a normal appendix is visualized in its full length, then acute appendicitis can be excluded. However, this is rarely the case, and the greatest utility for ultrasound is to detect alternative causes of abdominal pain.[36]

Appendiceal CT scan is increasingly used as the initial diagnostic test for acute appendicitis, and it is routine practice in the US to request a CT for patients presenting to the ED with features of acute appendicitis.[31] There is some opinion that CT scan should be used selectively for patients with atypical presentations, as delay in surgery increases the rate of appendiceal perforation.[28] Intravenous contrast-enhanced CT scan with or without oral contrast has 100% sensitivity compared with 92% sensitivity in non-intravenous contrast-enhanced CT scan.[37] [38] [Fig-2]

In pregnant women presenting with features of appendicitis, an abdominal sonogram should be performed to identify the appendix. If the sonogram examination is inconclusive, either an abdominal MRI (particularly in early pregnancy) or a CT scan should be performed.[21]

Tests to exclude other causes

A urinalysis should be performed to exclude possible urinary tract infection or renal colic. Sexually active women of childbearing age should have a urinary pregnancy test.

[VIDEO: Venepuncture and phlebotomy: animated demonstration ]

Risk factors

Weak

<6 months of breastfeeding

- Affects immunologic responses to certain microbial organisms. Children who received <6 months of breastfeeding had a higher incidence of acute appendicitis compared with those who received >6 months of breastfeeding.[13] [14]

low dietary fiber

- Known to cause constipation. Children with appendectomies have low fiber in their diet compared with controls.[6] [15] However, this theory is controversial.[16]

improved personal hygiene

- A higher incidence of acute appendicitis in Western society may be related to the living conditions and improved personal hygiene.[17]

- A balance of gastrointestinal microbial flora is important for prevention of infection, for digestion, and providing important nutrients.[18] Frequent use of antibiotics and improved hygienic conditions lead to decreased exposure and/or imbalance of gastrointestinal microbial flora that may eventually lead to a modified response to viral infection and thereby trigger appendicitis.[19]
smoking

- Children exposed to passive smoking have significantly increased incidence of acute appendicitis.[20] There is also an increased incidence of acute appendicitis in adult patients who smoke every day compared with adults who never smoked.[20]

History & examination factors

Key diagnostic factors

abdominal pain (common)

- Constant mid-abdominal pain which later shifts to right lower quadrant. Usually worse on movement.

anorexia (common)

- An important symptom almost always associated with acute appendicitis.[22] Without anorexia the diagnosis of acute appendicitis is in question.

right lower quadrant tenderness (common)

- A classic sign is right lower quadrant abdominal tenderness (McBurney sign). There may be localized rebound tenderness, especially if the appendix is anterior. Compressing the left lower quadrant may also elicit pain in the right lower quadrant (Rovsing sign). Pain may also be elicited with the patient lying on their left side and slowly extending the right thigh to cause a stretch in the iliopsoas muscle (psoas sign) or by internal rotation of the flexed right thigh (obturator sign).

Other diagnostic factors

adolescence or early adulthood (common)

- May occur at any age but is most commonly seen in early teens to late 40s.

nausea (common)

- Nausea and vomiting are also present in 75% of patients.[22]

fever (common)

- Low-grade, usually 1.8°F (1°C) increase in body temperature.

diminished bowel sounds (common)

- Bowel sounds may be reduced, particularly on the right side compared with on the left.

tachycardia (common)

- Tachycardia may be present, particularly in patients with perforation.[27]

fetor (common)

- Fetor may be present.[27]

vomiting (uncommon)

- Nausea and vomiting are also present in 75% of patients.[22] Vomiting usually occurs only once or twice.
### Rovsing sign (uncommon)
- Pressing the left side of the abdominal cavity and eliciting pain in right lower quadrant.

### Psoas sign (uncommon)
- Extending the right thigh on left lateral position elicits pain in right lower quadrant.

### Obturator sign (uncommon)
- Pain is elicited at right lower quadrant of abdomen by internal rotation of the flexed right thigh.

## Diagnostic tests

### 1st test to order

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBC</td>
<td>Increased polymorphonuclear leukocytes (&gt;75%). High discriminatory</td>
</tr>
<tr>
<td></td>
<td>power when combined with history.[39]</td>
</tr>
<tr>
<td>abdominal and pelvic CT scan</td>
<td>Wall thickening, wall enhancement, and inflammatory changes in the</td>
</tr>
<tr>
<td></td>
<td>surrounding tissues are additional findings seen in a CT scan of</td>
</tr>
<tr>
<td></td>
<td>abdomen and pelvis.[40]</td>
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<tr>
<td></td>
<td>[Fig-2]</td>
</tr>
<tr>
<td></td>
<td>It has become common practice, especially in the US, for any patient</td>
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<tr>
<td></td>
<td>presenting to the emergency department with abdominal pain suggestive</td>
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<tr>
<td></td>
<td>of appendicitis, to have CT scan of the abdomen and pelvis, unless</td>
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<tr>
<td></td>
<td>the patient is pregnant. A CT is also indicated in atypical</td>
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<tr>
<td></td>
<td>presentations.</td>
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<tr>
<td></td>
<td>The sensitivity and specificity of CT scan in detecting acute</td>
</tr>
<tr>
<td></td>
<td>appendicitis have been reported to be 94% and 95%, respectively.[33]</td>
</tr>
<tr>
<td></td>
<td>In pregnant women presenting with features of appendicitis, an</td>
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<tr>
<td></td>
<td>abdominal sonogram should be performed to identify the appendix.</td>
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<tr>
<td></td>
<td>If the sonogram examination is inconclusive, either an abdominal</td>
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<tr>
<td></td>
<td>MRI (particularly in early pregnancy) or a CT scan should be</td>
</tr>
<tr>
<td></td>
<td>performed.[21]</td>
</tr>
<tr>
<td>urinary pregnancy test</td>
<td>If positive, the possibility of ectopic pregnancy should be</td>
</tr>
<tr>
<td></td>
<td>considered.</td>
</tr>
</tbody>
</table>
Other tests to consider

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>abdominal ultrasound</td>
<td>aperistaltic or noncompressible structure with outer diameter &gt;6 mm</td>
</tr>
<tr>
<td>• Operator-dependent.</td>
<td></td>
</tr>
<tr>
<td>• Indicated in atypical presentations. May be preferred in children in order to limit radiation exposure with CT scan.[32]</td>
<td></td>
</tr>
<tr>
<td>• The sensitivity and specificity of ultrasound in detecting acute appendicitis have been reported to be 86% and 81%, respectively.[33]</td>
<td></td>
</tr>
<tr>
<td>urinalysis</td>
<td>negative</td>
</tr>
<tr>
<td>• If positive for red cells, white cells, or nitrates, an alternative diagnosis such as renal colic or UTI should be considered.</td>
<td></td>
</tr>
<tr>
<td>abdominal and pelvic MRI in pregnancy</td>
<td>abnormal appendix (diameter &gt;6 mm) identified and evidence of periappendical inflammatory changes</td>
</tr>
<tr>
<td>• MRI can be used as an alternative to CT scan in pregnancy, particularly in early pregnancy. Its results are comparable to CT scan in pregnant patients for whom sonographic findings are equivocal for the diagnosis of acute appendicitis.[41] [21]</td>
<td></td>
</tr>
</tbody>
</table>
# Differential diagnosis

<table>
<thead>
<tr>
<th>Condition</th>
<th>Differentiating signs / symptoms</th>
<th>Differentiating tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute mesenteric adenitis</td>
<td>• Usually presents in children with a recent history of upper respiratory infection.</td>
<td>• There is no specific test to confirm the diagnosis.</td>
</tr>
<tr>
<td></td>
<td>• Pain in the abdomen is usually diffuse with tenderness not localized to the right lower quadrant.</td>
<td>• Relative lymphocytosis in WBC differential counts is suggestive.</td>
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<tr>
<td></td>
<td>• Guarding may be present, but rigidity is usually absent.</td>
<td>• Negative ultrasound or CT findings help exclude other diagnoses.</td>
</tr>
<tr>
<td></td>
<td>• Generalized lymphadenopathy may be noted.</td>
<td></td>
</tr>
<tr>
<td>Viral gastroenteritis</td>
<td>• Common in children; caused by viruses, bacteria, or toxin.</td>
<td>• No specific test unless due to typhoid (Salmonella typhi from stool or blood will confirm the diagnosis).</td>
</tr>
<tr>
<td></td>
<td>• Characterized by profuse watery diarrhea, nausea, and vomiting.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Crampy abdominal pain often precedes the diarrhea, and no localizing signs are present.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• If caused by typhoid fever, intestinal perforation may cause localized abdominal pain and/or generalized and rebound tenderness. In this scenario, associated maculopapular rash, inappropriate bradycardia, and leukopenia will differentiate from appendicitis.</td>
<td></td>
</tr>
<tr>
<td>Meckel diverticulitis</td>
<td>• Usually asymptomatic.</td>
<td>• Technetium pertechnetate scan may show the enhancement of diverticulum if gastric mucosa is present.</td>
</tr>
<tr>
<td></td>
<td>• Only 20% of the patients present with diverticulitis, and 50% of this group are age &lt;10 years.[42]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Clinical presentation of diverticulitis is similar to acute appendicitis.</td>
<td></td>
</tr>
<tr>
<td>Intussusception</td>
<td>• Occurs in young children (age &lt;2 years).</td>
<td>• Barium enema may demonstrate the intussusception with a coil-spring sign at the point of bowel invagination.</td>
</tr>
<tr>
<td></td>
<td>• Sudden onset of colicky pain; between episodes of pain the child is calm.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• A sausage-shaped mass may be palpable in the right lower quadrant.</td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td>Differentiating signs / symptoms</td>
<td>Differentiating tests</td>
</tr>
<tr>
<td>----------------------------</td>
<td>-----------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Crohn disease</td>
<td>• Young adult with fever, nausea, vomiting, diarrhea, right lower quadrant pain, and localized tenderness.</td>
<td>• CT scan may show intra-abdominal abscess. • Contrast study of the small bowel and colon may show stricture or a series of ulcers and fissures (cobblestone appearance) of mucosa.</td>
</tr>
<tr>
<td>Peptic ulcer disease</td>
<td>• May or may not have a history of peptic ulcer disease. • Pain is abrupt, severe in intensity, and may be localized to right lower quadrant.</td>
<td>• Erect CXR and abdominal x-ray may show free air under the diaphragm</td>
</tr>
<tr>
<td>Right-sided ureteric stone</td>
<td>• Pain is usually colicky in nature and severe in intensity. May be referred to the labia, scrotum, or penis and associated with hematuria. • Fever usually absent.</td>
<td>• Urinalysis positive for blood. • Leukocytosis usually absent. • Abdominal x-rays or tomogram may show calcified stone. • Pyelography and CT scan without oral and intravenous contrast confirm the diagnosis.</td>
</tr>
<tr>
<td>Cholecystitis</td>
<td>• Pain and tenderness are usually in the right upper quadrant. In one third of patients the gallbladder can be palpable.[43]</td>
<td>• Abdominal ultrasound shows thick wall with pericholecystic collection, and tenderness is present over gallbladder area (Murphy sign). • Hepatobiliary iminodiacetic acid (HIDA) scan will show nonvisualization of gallbladder at &gt;4 hours.</td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>• Pain and tenderness is usually in suprapubic area associated with burning micturition. • Acute right-sided pyelonephritis may present with fever, chills, and tenderness at the right costovertebral angle.</td>
<td>• Urine microscopy and culture confirm presence of bacteria.</td>
</tr>
<tr>
<td>Primary peritonitis</td>
<td>• Most patients present with abrupt abdominal pain, fever, distension, and rebound tenderness. • History of advanced cirrhosis or nephrosis.</td>
<td>• CT scan may show fluid in the abdomen. • Peritoneal fluid shows &gt;500/microliter count and &gt;25% polymorphonuclear leukocytosis.</td>
</tr>
</tbody>
</table>
### Condition | Differentiating signs / symptoms | Differentiating tests
--- | --- | ---
**Pelvic inflammatory disease** | • Occurs in females usually aged between 20 and 40 years.  
• Presents with bilateral lower quadrant tenderness, usually within 5 days of the last menstrual period.  
• Purulent discharge from cervical os. | • Endocervical swab may confirm the pelvic inflammatory disease due to *Chlamydia trachomatis*. [44]

**Ruptured Graafian follicle (mittelschmerz)** | • Midmenstrual cycle, brief period of lower abdominal pain not usually associated with nausea and vomiting and fever.  
• Tenderness is usually diffused not localized. | • Clinical diagnosis. No investigation indicated.

**Ectopic pregnancy** | • Female within childbearing age presents with missed menstrual period, right lower quadrant pain, or pelvic pain with some degree of vaginal bleeding or spotting. Cervical motion tenderness may be present on pelvic examination. | • HCG hormone level is high in serum and in urine.  
• Ultrasound reveals presence of mass in fallopian tubes.

**Ovarian torsion** | • Female with right lower quadrant pain. Occasionally presents with mass in the right lower quadrant. | • Ultrasonography shows ovarian cyst and decreased blood flow.

### Diagnostic criteria

**Alvarado (MANTRELS) score** [45]

Score is based on clinical characteristics of the patients. The higher the score out of a possible total of 10, the greater the chance of having acute appendicitis.

- **M**: Migration of pain to right lower quadrant = 1 point
- **A**: Anorexia = 1 point
- **N**: Nausea and vomiting = 1 point
- **T**: Tenderness in right lower quadrant = 2 points
- **R**: Rebound tenderness = 1 point
- **E**: Elevated temperature = 1 point
- **L**: Leukocytosis = 2 points
Acute appendicitis

**Diagnosis**

S: Shift of WBC count to left = 1 point

**Acute Physiology and Chronic Health Evaluation II (APACHE II) score[46]**

The APACHE score is commonly used to establish illness severity in the ICU and predict the risk of death.

[VIDEO: APACHE II scoring system ]

There is a high risk of death if the score is 25 or above.

There are several other models that have been developed for use in the ICU, including APACHE III, Mortality in Emergency Department Sepsis score, Simplified Acute Physiology Score, Sepsis-related Organ Failure Assessment, and Mortality Probability Model II.[47] [48] [49]
Step-by-step treatment approach

The goal of treatment is to remove the infected appendix.

Uncomplicated presentation

Once the diagnosis of acute appendicitis is made, patients should be given nothing by mouth.

Intravenous fluids, such as lactated Ringer solution, should be started. Use of prophylactic intravenous antibiotics postoperatively is controversial; however, the use of cefoxitin (one dose preoperatively and 2 doses postoperatively) is recommended for uncomplicated appendicitis to reduce the risk of wound infection.[55] Appendectomy should be performed without delay.

Complicated presentation

Complications of acute appendicitis occur in 4% to 6% of patients and include gangrene with subsequent perforation or intra-abdominal abscess.[10]

Initial management includes keeping the patient nothing by mouth and starting intravenous fluids. Patients who are in shock should be given a bolus of intravenous fluid, such as lactated Ringer solution, in order to maintain a stable pulse rate and BP.[56] [57]

Intravenous antibiotics (e.g., cefoxitin or piperacillin/tazobactam) should be started immediately and continued until the patient becomes afebrile and the leukocytosis is corrected. For more severe infections, a carbapenem antibiotic may be used as a single agent. Combination antibiotic regimens may also be used based on local sensitivities and protocols.[10]

In patients with acute peritonitis, appendectomy should be performed without delay.

Patients presenting with right lower quadrant abscess should be managed with intravenous antibiotics and drainage either by interventional radiology (CT-guided drainage) or by operative drainage. If there is clinical improvement and the signs and symptoms are completely resolved, then there is no need for interval appendectomy.[58] [59] [60] Interval appendectomy is performed after 6 weeks if the symptoms are not completely resolved.[61] There is evidence to suggest that laparoscopic appendectomy may be a feasible first-line option over conservative treatment for appendiceal abscess in adults; however, this is not currently recommended.[62]

Surgical options

There are 2 operative options for appendectomy: open and laparoscopic.

In adults, the choice of appendectomy generally depends upon the experience of the surgeon. Studies have shown laparoscopic appendectomy to have better cosmetic results, shorter length of hospital stay, reduced postoperative pain, and reduced risk of wound infection, when compared with open appendectomy. Laparoscopic appendectomy is recommended for uncomplicated appendicitis,[37] as well as complicated and perforated appendicitis.[63] It is also considered the safest approach in obese patients.[64] However, open appendectomy is considered to be the safest approach in pregnant women.[65]
In children, laparoscopic appendectomy decreases the incidence of overall postoperative complications, including wound infection and duration of total hospital stay, but does not reduce the postoperative pain compared with open appendectomy.[66] [67] However, another study has shown no significant difference.[68]

**[VIDEO: Peripheral venous cannulation: animated demonstration ]**  
**[VIDEO: Practical suturing techniques: animated demonstrations ]**

### Treatment details overview

Please note that formulations/routes and doses may differ between drug names and brands, drug formularies, or locations. Treatment recommendations are specific to patient groups: see disclaimer

<table>
<thead>
<tr>
<th>Acute</th>
<th>( summary )</th>
</tr>
</thead>
</table>
| uncomplicated acute appendicitis | 1st appendectomy + supportive care  
adjunct intravenous antibiotic therapy |
| ill with perforation or abscess | 1st intravenous antibiotic therapy + supportive care  
perforation plus appendectomy  
abscess plus drainage ± interval appendectomy |
Treatment options

Please note that formulations/routes and doses may differ between drug names and brands, drug formularies, or locations. Treatment recommendations are specific to patient groups: see disclaimer.
<table>
<thead>
<tr>
<th>Acute appendicitis</th>
<th>Treatment</th>
</tr>
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</table>

**Acute uncomplicated acute appendicitis**

1st **appendectomy + supportive care**

- Once the diagnosis of acute appendicitis is made, patients should be given nothing by mouth.
- Intravenous fluids, such as lactated Ringer solution, should be started.
- Appendectomy should be performed without delay, as early appendectomy reduces the chances of perforation and intra-abdominal abscess.

*Fig-1*

- There are 2 operative options for appendectomy: open and laparoscopic. In adults, the choice of appendectomy generally depends upon the experience of the surgeon.
- Studies have shown laparoscopic appendectomy to have better cosmetic results, shorter length of hospital stay, reduced postoperative pain, and reduced risk of wound infection, when compared with open appendectomy.
- Laparoscopic appendectomy is recommended for uncomplicated appendicitis.[37] It is also considered the safest approach in obese patients.[64] However, open appendectomy is considered to be the safest approach in pregnant women.[65]

- Intra-abdominal abscesses have previously been noted to be more common in adult patients who undergo laparoscopic appendectomy,[70] but other factors such as the level of contamination, possible stump leak, use of preoperative antibiotic, and the patient’s own immune response to infection may be involved. However, one study suggests that intra-abdominal abscess is less frequent in patients undergoing laparoscopic surgery.[37]

- Patients with higher APACHE (Acute Physiology and Chronic Health Evaluation) scores seem to be at higher risk of development of postoperative complication.

*[VIDEO: APACHE II scoring system]*

The APACHE score is commonly used to establish illness severity in the ICU and predict the risk of death. In this context, there is a high risk of death if the score is 25 or above.
### Acute Appendicitis

**Adjunct Intravenous Antibiotic Therapy**

Treatment recommended for SOME patients in selected patient group

**Primary Options**

- **Cefoxitin:** 1-2 g intravenously as a single dose before surgery, followed by 1-2 g every 8 hours for 2 doses postsurgery
  
  Given for 24 hours for uncomplicated appendicitis.

*Patients ill with perforation or abscess*

**1st Intravenous Antibiotic Therapy + Supportive Care**

**Primary Options**

- **Cefoxitin:** 1-2 g intravenously every 8 hours
  
  OR
  
  **Piperacillin/Tazobactam:** 3.375 g intravenously every 6 hours
  
  Dose consists of 3 g piperacillin plus 0.375 g tazobactam.
  
  OR
  
  **Meropenem:** 1 g intravenously every 8 hours

  These patients have evidence of perforation, mass, or abscess.

  Initial management includes keeping the patient nothing by mouth and starting intravenous fluids. Patients who are in shock should be given a bolus of intravenous fluid, such as lactated Ringer solution, in order to maintain a stable pulse rate and BP. Following on, maintenance intravenous fluids should be given until the condition of the patient improves and an oral diet can be tolerated.

  Intraoperative antibiotics (e.g., cefoxitin or piperacillin/tazobactam) should be started immediately. For more severe infections, a carbapenem antibiotic may be used as a single agent. Combination antibiotic regimens may also be used based on local sensitivities and protocols.

  Antibiotics should be continued until the patient becomes afebrile and leukocytosis is corrected.
**Acute**

- **perforation** plus **appendectomy**

   Treatment recommended for ALL patients in selected patient group

   - There are 2 operative options for appendectomy: open and laparoscopic. In adults, the choice of appendectomy generally depends upon the experience of the surgeon.

   - Studies have shown laparoscopic appendectomy to have better cosmetic results, shorter length of hospital stay, reduced postoperative pain, and reduced risk of wound infection, when compared with open appendectomy.

   - Laparoscopic appendectomy is recommended for complicated and perforated appendicitis.[63] It is also considered the safest approach in obese patients.[64] However, open appendectomy is considered to be the safest approach in pregnant women.[65]

   - In children, laparoscopic appendectomy decreases the incidence of overall postoperative complications, including wound infection and duration of total hospital stay, but does not reduce the postoperative pain compared with open appendectomy.[66] [67] However, another study has shown no significant difference.[68]

- **abscess** plus **drainage ± interval appendectomy**

   Treatment recommended for ALL patients in selected patient group

   - Abscess usually occurs as a progression of the disease process, particularly after perforation.

   - Presents with tender right lower quadrant mass, swinging fever, and leukocytosis. Ultrasonography or CT scan will show the abscess.

   - Initial treatment includes intravenous antibiotics and CT-guided or operative drainage of the abscess.

   - If there is clinical improvement and the signs and symptoms are completely resolved, then there is no need for interval appendectomy.[58] [59] [60] Interval appendectomy is performed
| Acute |  | after 6 weeks if the symptoms are not completely resolved. [61] |
Emerging

Antibiotic-only therapy

Studies have investigated the management of uncomplicated appendicitis with antibiotics only compared with surgical appendectomy.[71] [72] [73] [74] [75] [76] Most studies have reported on small sample sizes, and have included only highly selected patients with no signs of sepsis, perforation, or abscess formation. In most of these studies, intravenous antibiotics were given for 48 to 72 hours followed by 7 to 10 days of oral antibiotics. Serial clinical examinations were performed every 6 to 12 hours while patients were being given intravenous antibiotics. Patients underwent surgery if any signs of sepsis, peritonitis, or shock developed during inpatient observation. Findings from these studies have not shown antibiotic-only therapy to be as effective as surgery for managing uncomplicated appendicitis, but they have shown that some patients can be managed successfully with antibiotics only.[71] [72] Several systematic reviews have concluded that although surgery is more effective than antibiotics at reducing treatment failure in uncomplicated appendicitis, the risk of complications is higher with surgery.[74] [75] [76] However, the evidence base is generally weak and confounded by factors such as lack of consistency with results, diagnostic protocol, outcomes measured, and the type of surgical procedure performed. At this time, treatment with antibiotics only would not be recommended as a first choice for acute appendicitis. Nevertheless, some patients with uncomplicated appendicitis may benefit from primary antibiotic therapy.[71] [72] Further large trials are required.[77]
Recommendations

Monitoring

Patients are usually discharged from hospital 1 day after the operation for uncomplicated appendicitis. Complicated appendicitis may require a longer hospital stay depending on the response to treatment. In some countries, patients are followed up postoperatively regardless of complicated or uncomplicated appendicitis; for example, 1 week after discharge, with further follow-up visits arranged as needed.

Patient instructions

Patients can be started on a clear liquid diet on the same day as the operation if there is no nausea or vomiting and can start a regular diet the next day. Patients are usually given at least 1 week off work or school. Future level of activity, driving, or return to work should be determined at the follow-up appointment.
Complications

<table>
<thead>
<tr>
<th>Complications</th>
<th>Timeframe</th>
<th>Likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>perforation</td>
<td>short term</td>
<td>low</td>
</tr>
<tr>
<td>May occur after &gt;12 hours of progressive appendiceal inflammation.</td>
<td></td>
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<tr>
<td>Usually a consequence of a delay in seeking medical treatment.</td>
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<tr>
<td>Presents with more severe abdominal pain, high fever (&gt;101°F [38.3°C]), localized tenderness, and decreased bowel sounds.</td>
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<tr>
<td>Appendectomy should be performed in all cases. Procedure can be done open or laparoscopically.</td>
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</tbody>
</table>

| generalized peritonitis     | short term| low        |
| Large perforation of acutely inflamed appendix results in generalized peritonitis. |
| Presents with an acute abdomen (high fever, diffuse abdominal pain, generalized tenderness, and absent bowel sounds). |
| If the diagnosis is suspected as acute appendicitis, appendectomy can be performed. If diagnosis is in doubt, exploratory laparotomy should be performed through midline incision, and the inflamed appendix needs to be removed. |

| appendicular mass           | short term| low        |
| Usually due to delay in medical treatment. |
| Presents with tender right lower quadrant mass. Ultrasonography or CT scan will show a mass. |
| If the patient appears otherwise well, the initial management is conservative treatment with intravenous fluids and broad-spectrum antibiotics. If there is clinical improvement and the signs and symptoms are completely resolved, then there is no need for interval appendectomy.[58] [59] [60] Interval appendectomy is performed after 6 weeks if the symptoms are not completely resolved.[61] |
| In older patients, carcinoma should be excluded. |

| appendicular abscess        | short term| low        |
| Usually occurs as a progression of the disease process, particularly after perforation. |
| Presents with tender right lower quadrant mass, swinging fever, and leukocytosis. |
| Ultrasonography or CT scan will show the abscess. |
| Initial treatment includes intravenous antibiotics and CT-guided drainage of abscess. |
| If there is clinical improvement and the signs and symptoms are completely resolved, then there is no need for interval appendectomy.[58] [59] [60] Interval appendectomy is performed after 6 weeks if the symptoms are not completely resolved.[61] There is evidence to suggest that laparoscopic appendectomy may be a feasible first-line option over conservative treatment for appendiceal abscess in adults; however, this is not recommended.[62] |
**Complications**

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<tr>
<td>surgical wound infection</td>
<td>short term</td>
<td>low</td>
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Decreased incidence if laparoscopic approach and prophylactic antibiotic used.[55]

**Prognosis**

If patients are treated in a timely fashion, the prognosis is good. Wound infection and intra-abdominal abscess are potential complications associated with appendectomy. Laparoscopic appendectomy has been shown to decrease the incidence of overall complications.[37]
## Diagnostic guidelines

### International

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<tr>
<td>ACR Appropriateness Criteria: acute (nonlocalized) abdominal pain and fever or suspected abdominal abscess [52]</td>
<td>American College of Radiology</td>
<td>2012</td>
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<tr>
<td>Critical issues: evaluation and management of emergency department patients with suspected appendicitis [53]</td>
<td>American College of Emergency Physicians</td>
<td>2010</td>
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## Treatment guidelines

### International

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Key articles


References

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<td>27.</td>
<td>Humes DJ, Simpson J. Acute appendicitis. BMJ. 2006;333:530-534. <a href="#">Full text</a> <a href="#">Abstract</a></td>
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Acute appendicitis


Figure 1: Acute appendicitis - intraoperative specimen.

Nasim Ahmed, MBBS, FACS; used with permission
Figure 2: CT abdomen - thickened appendix.

Nasim Ahmed, MBBS, FACS; used with permission
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