Acute Appendicitis

**Definition:** Acute appendicitis is a term used to describe the inflammation of the appendix leading to various signs and symptoms. It is one of the most common causes of the acute abdomen and one of the most frequent indications for an emergent abdominal surgical procedure worldwide.

**Symptoms:**

The classic cluster of symptoms are:

- Right lower quadrant abdominal pain.
- Anorexia.
- Nausea and vomiting.

Other non-classic symptoms include:

- Generalized weakness.
- Diarrhea.
- Indigestion.
- Flatulence.
- Irregularities in bowel movement.

**Signs:**

- Low grade fever (38.3°C) that can progress to high grade fever of > 38.3°C as the patient’s condition worsens.
- Right lower quadrant tenderness, along with classical signs of peritoneal irritation (eg, rebound tenderness, guarding, rigidity, referred pain), may be present.

**Laboratory Findings:**

- Mild leukocytosis white blood cell count >10,000 cells/microL.
- Serum C-reactive protein CRP > 10 mg/L.

**Differential Diagnosis:**

The diagnosis is based on combining information from the physical examination (the initial physical examination of patients with suspected appendicitis should include a digital rectal
examination. Women should also undergo a pelvic examination. Women of reproductive age should be queried regarding the possibility of pregnancy. Laboratory findings and various imaging techniques such as Computed tomography (CT) (it is the preferred modality, the highest diagnostic accuracy and lowest rates of nondiagnostic exams), with ultrasound and magnetic resonance imaging (MRI) reserved for radiosensitive populations such as pregnant women and children.

In a minority of patients, surgical exploration may be warranted if clinical suspicion for appendicitis is high but imaging studies are either negative, nondiagnostic, or unavailable. In such patients, appendicitis can only be diagnosed intraoperatively or pathologically.

**Note:** Alvarado score calculation which is a score used to identify the patient's likelihood of having acute appendicitis and can be used to identify patients who would need further investigation using imaging techniques prior to treatment.

**Alvarado score:**

1. Migratory right lower quadrant pain (1 point)
2. Anorexia (1 point)
3. Nausea or vomiting (1 point)
4. Tenderness in the right lower quadrant (2 points)
5. Rebound tenderness in the right lower quadrant (1 point)
6. Fever >37.5°C (>99.5°F) (1 point)
7. Leukocytosis of WBC count >10 x 10^9/L (2 points)

- Patients with a score of 0 to 3 are unlikely to have appendicitis and should be evaluated for other possible diagnoses.
- Patients with a score of ≥4 should be evaluated further for appendicitis. Surgical evaluation and imaging, if readily available, should be pursued.
- **Treatment:**

- **NONPERFORATED APPENDICITIS (simple, uncomplicated appendicitis):**

  - Appendectomy is the treatment of choice for adult patients with nonperforated appendicitis.

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* Perforated appendicitis, also referred to as complicated appendicitis, is characterized by a palpable mass in the right lower quadrant on physical examination or by a phlegmon (inflammatory mass) or abscess on imaging studies. Nonperforated appendicitis, also referred to as simple or uncomplicated appendicitis, does not have any clinical or radiologic signs of perforation.

* The choice of antibiotics varies by clinical situations and is constantly evolving. Refer to related topics in UpToDate for information on antibiotic selection.

* Immediate appendectomy, as opposed to interval appendectomy, should be performed within 12 hours of decision to operate, except in the case of an unstable/septic patient or the presence of free perforation or generalized perforation, where surgery should be performed emergently.
Timely appendectomy is recommended, either open or laparoscopically. Antibiotics can be used to augment rather than to replace surgery. Although antibiotics are an option for those who are unfit for or refuse surgery.

For those who go with the nonoperative choice, initial intravenous antibiotics for one to three days, followed by oral antibiotics for up to 10 days; the choices of antibiotics are not standardized. Patients are typically admitted to the hospital during the first one to three days for close observation in case of clinical deterioration, which requires prompt rescue appendectomy. Patients who choose nonoperative treatment should be warned of a recurrence rate that is typically 15 to 25 percent but may be up to 38 percent.

**Appendectomy for nonperforated appendicitis:**

- Immediate appendectomy should be performed within 12 hours of decision to operate, except in the case of an unstable/septic patient or the presence of free perforation or generalized perforation, where surgery should be performed emergently.

- Patients should be admitted to the hospital and receive intravenous hydration, pain control, and intravenous antibiotics while awaiting surgery.

**Preoperative preparation:**

**Antibiotics:** — Prophylactic antibiotics are important for preventing wound infection and intra-abdominal abscess following appendectomy. The flora of the appendix reflects that of the colon and includes gram-negative aerobes and anaerobes.

- Patients proceeding directly from the emergency room to the operating room for appendectomy without further delay should receive prophylactic antibiotics within a 60 minute "window" before the initial incision. In general, a single preoperative antibiotic dose for surgical wound prophylaxis is adequate.

- Options include:

  - A single dose of cefoxitin (2 g IV) or cefotetan (2 g IV).

  - the combination of cefazolin (2g if<120kg or 3g if≥120kg IV) Plus metronidazole (500mg IV).

  - In patients allergic to penicillins and cephalosporins, clindamycin PLUS one of the following: ciprofloxacin, levofloxacin, gentamicin, or aztreonam.
Patients who present at night and will not undergo appendectomy until the next morning should be admitted to the hospital and started on intravenous antibiotics as soon as possible (often in the emergency room), rather than waiting until just before surgery. In this case, we suggest choosing antibiotics from the list intended for patients with perforated/complicated appendicitis to provide broad-spectrum coverage. Additional prophylactic antibiotics may be required if patients did not receive antibiotics within the 60-minute "window" before incision.
### Empirical antibiotic regimens for low-risk community-acquired intra-abdominal infections in adults

<table>
<thead>
<tr>
<th>Single-agent regimen</th>
<th>Dose</th>
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</thead>
<tbody>
<tr>
<td>Ertapenem</td>
<td>1 g IV once daily</td>
</tr>
<tr>
<td>Piperacillin-tazobactam</td>
<td>1.373 g IV every 6 hours</td>
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</table>

#### Combination regimen with metronidazole

<table>
<thead>
<tr>
<th>ONE of the following:</th>
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<tbody>
<tr>
<td>Cefazolin</td>
<td>1 to 2 g IV every 8 hours</td>
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<tr>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>Cefuroxime</td>
<td>1.5 g IV every 8 hours</td>
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<tr>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>2 g IV once daily</td>
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<tr>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>Cefotaxime</td>
<td>2 g IV every 8 hours</td>
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<tr>
<td>OR</td>
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</tr>
<tr>
<td>Ciprofloxacin</td>
<td>400 mg IV every 12 hours or</td>
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<tr>
<td>OR</td>
<td>500 mg PO every 12 hours</td>
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<tr>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>Levofoxacin</td>
<td>750 mg IV or PO once daily</td>
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<tr>
<td>PLUS:</td>
<td></td>
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<tr>
<td>Metronidazole*</td>
<td>500 mg IV or PO every 8 hours</td>
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For empirical therapy of low-risk community-acquired intra-abdominal infections, we cover streptococci, Enterobacteriaceae, and anaerobes. Low-risk community-acquired intra-abdominal infections are those that are of mild to moderate severity (including perforated appendicitis or appendiceal abscess) in the absence of risk factors for antibiotic resistance or treatment failure. Such risk factors include recent travel to areas of the world with high rates of antibiotics-resistant organisms, known colonization with such organisms, advanced age, immunocompromising conditions, or other major medical comorbidities. Refer to other UpToDate content on the antimicrobial treatment of intra-abdominal infections for further discussion of these risk factors.

The antibiotic doses listed are for adult patients with normal renal function.

**IV:** intravenously; **PO:** orally.

* For most uncomplicated biliary infections of mild to moderate severity, the addition of metronidazole is not necessary.

### Empirical antibiotic regimens for high-risk community-acquired intra-abdominal infections in adults

<table>
<thead>
<tr>
<th>Single-agent regimen</th>
<th>Dose</th>
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</thead>
<tbody>
<tr>
<td>Imipenem-cilastatin</td>
<td>500 mg IV every 6 hours</td>
</tr>
<tr>
<td>Meropenem</td>
<td>1 g IV every 8 hours</td>
</tr>
<tr>
<td>Doripenem</td>
<td>500 mg IV every 8 hours</td>
</tr>
<tr>
<td>Piperacillin-tazobactam</td>
<td>4.5 g IV every 6 hours</td>
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</table>

#### Combination regimen with metronidazole

<table>
<thead>
<tr>
<th>ONE of the following:</th>
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<tbody>
<tr>
<td>Ceftepime</td>
<td>2 g IV every 8 hours</td>
</tr>
<tr>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>Cefazolin</td>
<td>2 g IV every 8 hours</td>
</tr>
<tr>
<td>PLUS:</td>
<td></td>
</tr>
<tr>
<td>Metronidazole</td>
<td>500 mg IV or PO every 8 hours</td>
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</tbody>
</table>

High-risk community-acquired intra-abdominal infections are those that are severe or in patients at high risk for adverse outcomes or antimicrobial resistance. These include patients with recent travel to areas of the world with high rates of antibiotics-resistant organisms, known colonization with such organisms, advanced age, immunocompromising conditions, or other major medical comorbidities. Refer to the UpToDate topic on the antimicrobial treatment of intra-abdominal infections for further discussion of these risk factors.

For empirical therapy of high-risk community-acquired intra-abdominal infections, we cover streptococci, Enterobacteriaceae resistant to third-generation cephalosporins, *Pseudomonas aeruginosa*, and anaerobes. Empiric antifungal therapy is usually not warranted but is reasonable for critically ill patients with an upper gastrointestinal source.

Local rates of resistance should inform antibiotic selection (ie, agents for which there is >10 percent resistance among Enterobacteriaceae should be avoided). If the patient is at risk for infection with an extended-spectrum beta-lactamase (ESBL)-producing organism (eg, known colonization or prior infection with an ESBL-producing organism), a carbapenem should be chosen. When beta-lactams or carbapenems are chosen for patients who are critically ill or are at high risk of infection with drug-resistant pathogens, we favor a prolonged infusion dosing strategy. Refer to other UpToDate content on prolonged infusions of beta-lactam antibiotics.

The combination of vancomycin, aztreonam, and metronidazole is an alternative for those who cannot use beta-lactams or carbapenems (eg, because of severe reactions). The antibiotic doses listed are for adult patients with normal renal function.

**IV:** intravenously; **PO:** orally.
Although laparoscopic appendectomy has gained widespread acceptance, there are both benefits and limitations to the laparoscopic approach. As a result, the operative approach in patients with suspected appendicitis is best decided by the surgeon based on personal experience, institutional capabilities, and individual patient factors such as the confidence in the diagnosis; history of prior surgery; the patient's age, gender, and body habitus; and severity of disease.

Postoperative management: After either open or laparoscopic appendectomy for nonperforated appendicitis, patients may be started on a clear liquid diet and advanced as tolerated to a regular diet. Antibiotics are not required postoperatively. Most patients are discharged within 24 to 48 hours of surgery. Same-day discharge is feasible, most commonly following a laparoscopic appendectomy.

**PERFORATED APPENDICITIS:**

- The management of perforated appendicitis depends on the condition of the patient (stable versus unstable), the nature of the perforation (contained versus free perforation), and whether an abscess or phlegmon is present on imaging studies.

**Unstable patients or patients with free perforation:**

- For patients who are septic or unstable, and for those who have a free perforation of the appendix or generalized peritonitis, emergency appendectomy is required, as well as drainage and irrigation of the peritoneal cavity. Emergency appendectomy in this setting can be accomplished open or laparoscopically; the choice is determined by surgeon preference with consideration of patient condition and local resources.
**Stable patients:**

Stable patients with perforated appendicitis who have symptoms localized to the right lower quadrant can be treated with immediate appendectomy or initial nonoperative management. Both approaches are safe.

The following initial approach is recommended based on imaging findings on presentation:

- Patients with a small (≤3 cm) appendiceal abscess may undergo immediate appendectomy. Larger (>3 cm) abscesses should be treated with intravenous antibiotics and percutaneous drainage first, although immediate appendectomy is required if the abscess is not amenable to percutaneous drainage.

- Patients with a phlegmon of the right lower quadrant should be assessed for the likelihood that an appendectomy can be safely performed without the need for an ileocecal resection. If appendectomy is feasible and an ileocecal resection is not likely required, immediate appendectomy may be performed. If the contrary is true, the patient should be treated with intravenous antibiotics first.

- Patients who fail initial antibiotic therapy clinically or radiographically require rescue appendectomy, whereas those who respond to initial antibiotic therapy can be discharged with oral antibiotics to complete a 7 to 10 day course (in total) and return for follow-up in six to eight weeks.

**Initial nonoperative management:**

Stable patients with perforated appendicitis who have symptoms localized to the right lower quadrant (ie, no free perforation or generalized peritonitis) may be treated initially with antibiotics, intravenous fluids, and bowel rest, rather than immediate surgery. These patients will often have a palpable mass on physical examination; a computed tomography (CT) scan may reveal a phlegmon or abscess.

In patients with perforated appendicitis, the antibiotic regimen should consist of empiric broad spectrum therapy with activity against gram-negative rods and anaerobic organisms pending culture results. The choice of agents is based on patient and disease factors:
Most perforated appendices or appendiceal abscesses fall into the category of mild-to-moderate community-acquired intra-abdominal infections without risk factors for antibiotic resistance or treatment failure. Coverage of streptococci, non-resistant Enterobacteriaceae, and (in most cases) anaerobes is generally sufficient.

In cases of perforated appendicitis that are severe, or in patients at high risk for adverse outcomes or resistance, broader empirical coverage is warranted. We generally include an agent with gram-negative activity broad enough to cover Pseudomonas aeruginosa and Enterobacteriaceae that are resistant to non-pseudomonal cephalosporins in addition to coverage against enteric streptococci and (in most cases) anaerobes.

Although rare for appendicitis, in patients with healthcare-associated infections, the likelihood of drug resistance is high. Thus, to achieve empiric coverage of likely pathogens, in addition to coverage against streptococci and anaerobes, regimens should at least include agents with expanded spectra of activity against gram-negative bacilli (including P. aeruginosa and Enterobacteriaceae that are resistant to non-pseudomonal third generation cephalosporins and fluoroquinolones). We also usually use an empiric regimen that has anti-enterococcal activity for patients with healthcare-associated intra-abdominal infection, particularly those with postoperative infection, those who have previously received cephalosporins or other antimicrobial agents selecting for Enterococcus species, immunocompromised patients, and those with valvular heart disease or prosthetic intravascular materials.

Regardless of the initial empiric regimen, the therapeutic regimen should be revisited once culture and susceptibility results are available. Recovery of more than one organism should suggest polymicrobial infection including anaerobes, even if no anaerobes are isolated in culture. In such circumstances, anaerobic coverage should be continued.
- If imaging studies demonstrate an intra-abdominal or pelvic abscess, computed tomography- or ultrasound-guided drainage can often be performed percutaneously or transrectally.

- Follow-up after initial nonoperative management of perforated appendicitis:

- After successful nonoperative management of perforated appendicitis, patients should be seen in six to eight weeks, at which time those over 40 who have not undergone routine colonoscopic screening should be offered a colonoscopy. The risk of such patients harboring a cecal or appendiceal neoplasm can be high.

- Appendectomy may be required to treat perforated appendicitis in one of three clinical scenarios:

  1. Emergency appendectomy is required for patients with free perforation of the appendicitis, with diffuse peritonitis, or who are septic or hemodynamically unstable as a result of perforated appendicitis.

  2. Rescue appendectomy is required for patients with perforated appendicitis who fail to respond to nonoperative management with intravenous antibiotics with or without percutaneous drainage, regardless of initial imaging findings.

  3. Immediate appendectomy may be performed for perforated appendicitis associated with a small but well-contained abscess or a larger abscess not accessible to percutaneous drainage. It may also be performed in the presence of a right lower quadrant phlegmon if the surgeon judges the risk of requiring an ileocecal resection is low.

References:


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