JAMA | Review

Diverticulitis
A Review

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IMPORTANCE Diverticulosis is defined by the presence of multiple outpouchings (diverticula) originating from the intestinal lumen. Diverticulitis is defined as inflammation of these diverticula. The annual incidence of diverticulitis in the US is approximately 180 per 100 000 people, resulting in approximately 200 000 hospital admissions annually and an estimated health care expenditure of more than $6.3 billion/year.

OBSERVATIONS Risk factors for diverticular disease include age older than 65 years, genetic factors such as variant in the tumor necrosis factor superfamily member 15 (*TNFSF15*) gene; connective tissue diseases such as polycystic kidney disease, Marfan syndrome, or Ehlers-Danlos syndrome; body mass index 30 or greater; use of opioids, steroids, and nonsteroidal anti-inflammatory medications; hypertension; and type 2 diabetes. Approximately 1% to 4% of patients with diverticulosis will develop acute diverticulitis in their lifetime, which typically presents as left lower quadrant pain associated with nausea, vomiting, fever, and leukocytosis. A contrast-enhanced abdominal and pelvic computed tomography scan is the recommended diagnostic test and has a sensitivity of 98% to 99% and specificity of 99% to 100%. Approximately 85% of people with acute diverticulitis have uncomplicated diverticulitis (absence of abscess, colon strictures, colon perforation, or fistula formation). Management of patients with uncomplicated diverticulitis consists of observation with pain management (typically acetaminophen) and dietary modification with a clear liquid diet. Antibiotics should be reserved for patients with systemic symptoms such as persistent fever or chills, those with increasing leukocytosis, those older than 80 years, those who are pregnant, those who are immunocompromised (receiving chemotherapy, or high-dose steroids, or have received an organ transplant), and those with chronic medical conditions (such as cirrhosis, chronic kidney disease, heart failure, or poorly controlled diabetes). First-line antibiotics consist of oral amoxicillin/clavulanic acid or cefalexin with metronidazole. For patients who cannot tolerate oral intake, intravenous antibiotic therapy (ie, cefuroxime or ceftriaxone plus metronidazole or ampicillin/sulbactam) is appropriate. Complicated diverticulitis is managed with intravenous antibiotics such as ceftriaxone plus metronidazole or piperacillin-tazobactam and additional invasive management as indicated (ie, percutaneous drainage of associated intra-abdominal abscess or colon resection). Patients with generalized peritonitis should undergo emergent laparotomy with colonic resection. Postoperative mortality for diverticulitis managed electively or emergently is 0.5% for elective colon resection and 10.6% for emergent colon resection.

CONCLUSIONS AND RELEVANCE In the US, diverticulitis affects approximately 180 per 100 000 people annually. For uncomplicated diverticulitis, first-line therapy is observation and pain control, and antibiotics should be initiated for patients with persistent fevers, increasing leukocytosis, sepsis or septic shock, advanced age, pregnancy, immunocompromise, and certain chronic medical conditions. Treatment of complicated diverticulitis includes intravenous antibiotics, such as ceftriaxone plus metronidazole or piperacillin-tazobactam, and, if indicated, percutaneous drainage of abscess or resection of diseased segment of colon.

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Diverticula of the gastrointestinal tract consist of small outpouchings that open into the intestinal lumen in the colon or small bowel and most commonly affect the descending and sigmoid colon. Diverticulitis is defined by inflammation of these diverticula. The prevalence of diverticulosis in adults is approximately 2.3%.[1] The prevalence of diverticulosis increases with age, from less than 20% at age 40 years to 60% at age 60 years.[2] Approximately 1% to 4% of patients with diverticulosis develop acute diverticulitis.[3,4] The incidence of acute diverticulitis in the US is 180 per 100 000 persons per year.[1] Eighty-five percent of episodes of acute diverticulitis are uncomplicated, defined as the absence of abscess, bowel obstruction, perforation, or fistula formation. Fifteen percent to 30% of patients who develop acute diverticulitis experience a recurrence.[5]

Diverticulitis results in approximately 200 000 hospitalizations annually in the US,[6] with an estimated health care expenditure of more than $6.3 billion annually.[7] This review summarizes current evidence regarding the diagnosis and treatment of diverticulitis (**Box**).

Box. Frequently Asked Questions About Acute Diverticulitis

What Is the Optimal Diagnostic Test for Acute Diverticulitis?
A contrast-enhanced computed tomography scan of the abdomen and pelvis is the recommended test to diagnose acute diverticulitis. It has the highest sensitivity and specificity and can help identify severity of the condition, differentiating uncomplicated and complicated diverticulitis which determines appropriate treatment.

When Should Antibiotics Be Used to Treat Acute Diverticulitis?
For patients with uncomplicated diverticulitis, first-line therapy is observation and pain control. However, antibiotics are recommended for uncomplicated diverticulitis in patients with comorbidities (such as liver cirrhosis, chronic kidney disease, heart failure, or poorly controlled diabetes), those who are pregnant, immunosuppressed, or older than age 80 years. All patients with complicated diverticulitis (eg, abscess, perforation, or fistula) should be treated with intravenous antibiotics.

What Are the Most Optimal Antibiotics for the Management of Acute Diverticulitis?
When antibiotics are indicated, appropriate outpatient oral treatment includes amoxicillin-clavulanate, cefalexin + metronidazole, ciprofloxacin + metronidazole, or trimethoprim-sulfamethoxazole + metronidazole. For inpatient management, intravenous ceftriaxone + metronidazole, imipenem-cilastatin, meropenem, or piperacillin-tazobactam are recommended.

Methods

PubMed and Cochrane databases were searched for English-language reports on acute diverticulitis, including studies on risk factors, pathogenesis, diagnosis, and treatment published between January 1, 2000, and April 30, 2025. Major high-quality studies published before 2000 were included when relevant to the review and when more recent data were unavailable.

A total of 2529 studies were identified. We prioritized randomized clinical trials, meta-analyses, systematic reviews, national or international guidelines, and population-based longitudinal and observational studies. A total of 85 studies were included, consisting of 6 randomized clinical trials, 7 meta-analyses, 20 systematic reviews, 10 US and European national guidelines, 5 population-based longitudinal studies, 8 population-based observational studies, and 29 observational (cross-sectional) studies.

Pathogenesis

Colonic diverticula are false diverticula, defined as diverticula that involve only the mucosal and muscularis mucosal layers of the colon. In contrast, a true diverticulum includes all 4 layers of the intestinal wall—mucosa, submucosa, muscularis, and serosa.

Diverticula develop at sites of reduced colonic wall integrity where vasa recta, a network of capillaries, penetrate the stratum musculare circulare coli (circular muscle layer) to deliver blood to the colonic mucosa. According to the law of LaPlace, pressure is directly proportional to wall tension and inversely proportional to the radius of the bowel. Therefore, the sigmoid colon is the most frequent site of diverticular disease because it has the smallest colonic diameter.[8]

Although the pathophysiology of diverticulitis (inflammation of diverticula) is incompletely understood, there are several potential hypotheses. First, fecal matter may become trapped in the diverticula, transporting fecal microbiota to the lamina propria and causing acute mucosal inflammation, typically at the apex of the diverticulum.[9] Second, a microperforation at the diverticular fundus due to increased intraluminal pressure from obstruction of the diverticula may stimulate an inflammatory response and diverticulitis.[10] Third, diverticulitis may be initiated by changes in the gut microbiome composition and function, such as decreases in short-chain fatty acids in the colon, increases in the invasive pathogenic colonic microbiome such as the Enterobacteriaceae family of gram-negative bacteria, and altered bile acids such as ursodeoxycholic acid, leading to adverse alterations in mucosal barrier and immune function, with subsequent mucosal inflammation (**Figure 1**).[11]

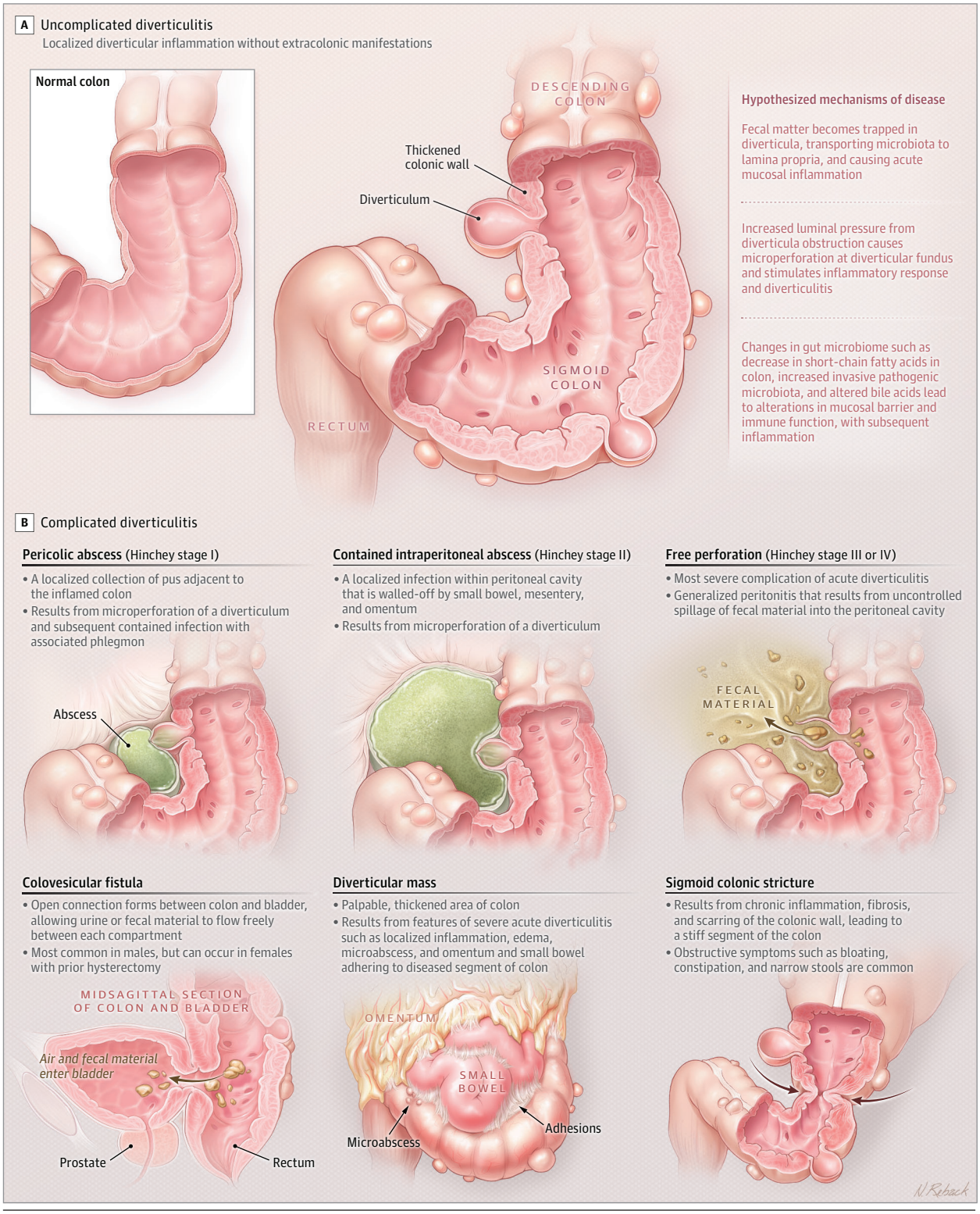
Etiology of Diverticulosis

Older people have a higher prevalence of diverticulosis compared with younger people. Peery et al[12] reported that more than 63% of people aged 70 to 79 years have diverticula, based on data from 191 patients in North Carolina. Older age is associated with loss of myenteric plexus neurons, resulting in uncoordinated colonic contractions and high intestinal pressure, producing colonic wall outpouchings.[13,14] The role of fiber intake in the pathogenesis of diverticulosis is unclear. Although comparisons between Western and African populations previously reported a significantly higher prevalence of diverticulosis associated with the low-fiber Western diet,[15] a colonoscopy-based study in the US that included 2104 patients did not find differences in dietary fiber scores between patients with and without diverticulosis assessed by the Mini Dietary Assessment index.[12]

A nationwide Danish patient registry that included 1.2 million people identified 142 143 incident cases of diverticular diseases (mean age, 61.4 years) diagnosed at hospitalization or outpatient hospital visits over a 34-year period, including cases in 10 420 index siblings. The incidence of hospital admission or visit for diverticular disease in the study was 0.81 per 1000 person-years compared with

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Figure 1. Pathophysiology, Progression, and Complications of Acute Diverticulitis



2.1 per 1000 person-years in siblings of index cases, consistent with a familial etiology.[16] The absolute rate of diverticular disease in siblings of index cases was 10.3 per 1000 person-years, compared with 3.5 per 1000 person-years in the general population (risk ratio, 2.92 [95% CI, 2.50-3.39]).

A genome-wide association study in Iceland and Denmark identified that gene variants (*ARHGAP15*, *COLQ*, and *FAM155A*) were associated with diverticular disease.[17] These gene variants are associated with colonic neuromuscular function and tissue properties, such as the ability of the colonic muscle to generate force/power and

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collagen fiber structure, which may influence development of diverticular disease (the generation of more forceful contractions increases intraluminal pressure; in the presence of weakness in tissue properties, repeated high pressure waves leads to more diverticula).[18] Inherited connective tissue disorders such as autosomal dominant polycystic kidneys, Marfan syndrome, and Ehlers-Danlos syndrome are associated with a higher prevalence of colonic diverticula.[19]

Epidemiology

The prevalence of diverticulosis is similar between men and women. Among people with diverticula, 65% have diverticula limited to the sigmoid colon, 25% have diverticula in the sigmoid colon and other colon locations, and 4% have colonic diverticula that are all proximal to the sigmoid colon.[20] In Asia, diverticula primarily involve the right colon. The prevalence of diverticulosis among Asian adults older than 60 years ranges from 13% to 25% of all Asian people with diverticula, with right-sided diverticulosis in 22.3%.[21,22]

Hospitalization rates for diverticulitis are increasing because of a disproportionately greater increase in the prevalence of diverticulitis in individuals younger than 50 years. Hospitalization is particularly increasing among men with complicated diverticulitis requiring hospitalization.[23] People who are immunocompromised, such as those with leukemia or lymphoma, patients receiving chemotherapy or high-dose steroids, and people who have received an organ transplant, have higher rates of diverticulitis. In addition, among people with diverticulitis, those who are immunocompromised have a higher incidence of severe sepsis, compared with people with diverticulitis who are immunocompetent (24.3% vs 10%).[24]

Conditions Associated With Diverticulitis

A body mass index (BMI) 30 or greater (calculated as weight in kilograms divided by square of height in meters) has been associated with diverticulitis. In a prospective study of 47 228 men, 801 incident cases of diverticulitis were documented during a mean follow-up of 18 years. The prevalence of diverticulitis was 1.04 in men with BMI less than 21 and 3.06% in men with BMI 30 or greater.[25]

There is no established evidence that red meat consumption,[11] alcohol,[26] smoking,[27] specific intestinal microbiota,[28,29] or consuming seeds and nuts are associated with the development of diverticula.[30] In addition, no interventions or behaviors have been definitively shown to prevent diverticula or diverticulitis. However, physical activity such as running may be associated with a lower rate of diverticular disease. In the Health Professionals Follow-up Study cohort that included 47 228 US males aged 40 to 75 years without diverticular disease, gastrointestinal cancer, or inflammatory bowel disease at baseline, the rate of diverticulitis among men in the highest quintile of total activity (≥57.4 metabolic equivalent hours per week) was 124 per 153 792, compared with 152 per 129 642 among men in the lowest quintile (≤8.2 metabolic equivalent hours per week) at 18-year follow-up after adjusting for BMI (adjusted risk ratio, 0.75 [95% CI, 0.58-0.95]).[31] Furthermore, weight loss to achieve a BMI less than 25.0 may reduce diverticulitis incidence.[32]

Classification of Diverticulitis

Diverticulitis is classified as uncomplicated and complicated. Approximately 85% of people with acute diverticulitis have uncomplicated diverticulitis (absence of abscess, colon strictures, colon perforation, or fistula formation). Uncomplicated diverticulitis is defined by localized diverticular inflammation without extracolonic manifestations. A contained perforation is characterized by an intestinal perforation walled off with omentum and intestines and sequestered from the rest of the peritoneal cavity. A free perforation is defined by a perforation accompanied by the free flow of colonic content (feces) into the peritoneal cavity. Complicated diverticulitis occurs when uncomplicated diverticulitis progresses and includes phlegmon, abscess formation, fistula to adjacent organs, or bowel strictures resulting in a large bowel obstruction. The modified Hinchey classification, which can be used to classify diverticulitis and guide the selection of treatment,[33] has 5 stages (0: localized inflammation in the colon; I: localized abscess formation; II: larger or distant abscesses; III: purulent peritonitis; IV: fecal peritonitis).

Clinical Presentation and Diagnosis

Approximately 70% of patients with acute diverticulitis present with a gradual onset of left lower quadrant pain. People with right colonic diverticulitis or a large redundant sigmoid colon, defined as an abnormally elongated sigmoid colon projecting into the suprapubic or right lower quadrant of the abdomen, may have suprapubic or right-sided abdominal pain. Diverticulitis pain may be constant or intermittent and is associated with nausea and vomiting in approximately 30% of patients.[34] Fever (temperature >38 °C [100.4 °F]) occurs in approximately 33% of patients with diverticulitis, and tachycardia occurs in approximately 27%.[35,36] Typical physical examination findings consist of left lower quadrant tenderness with localized guarding. Complicated diverticulitis with perforation, a medical emergency, is characterized by abdominal guarding and signs of shock such as tachycardia, hypotension, and cool and clammy extremities (although fever cannot aid in distinguishing between uncomplicated and complicated diverticulitis). In approximately 20% of patients with complicated diverticulitis, a mass may be palpable in the left lower abdominal quadrant, consisting of a thickened sigmoid colon with associated phlegmon or abscess surrounded by omentum and small intestine. Rectal examination may elicit tenderness in the presence of a pelvic abscess. Laboratory testing to evaluate a possible diagnosis of acute diverticulitis includes a complete blood cell count with differential and blood cultures. Leukocytosis is present in approximately 55% of febrile patients with acute diverticulitis.[37]

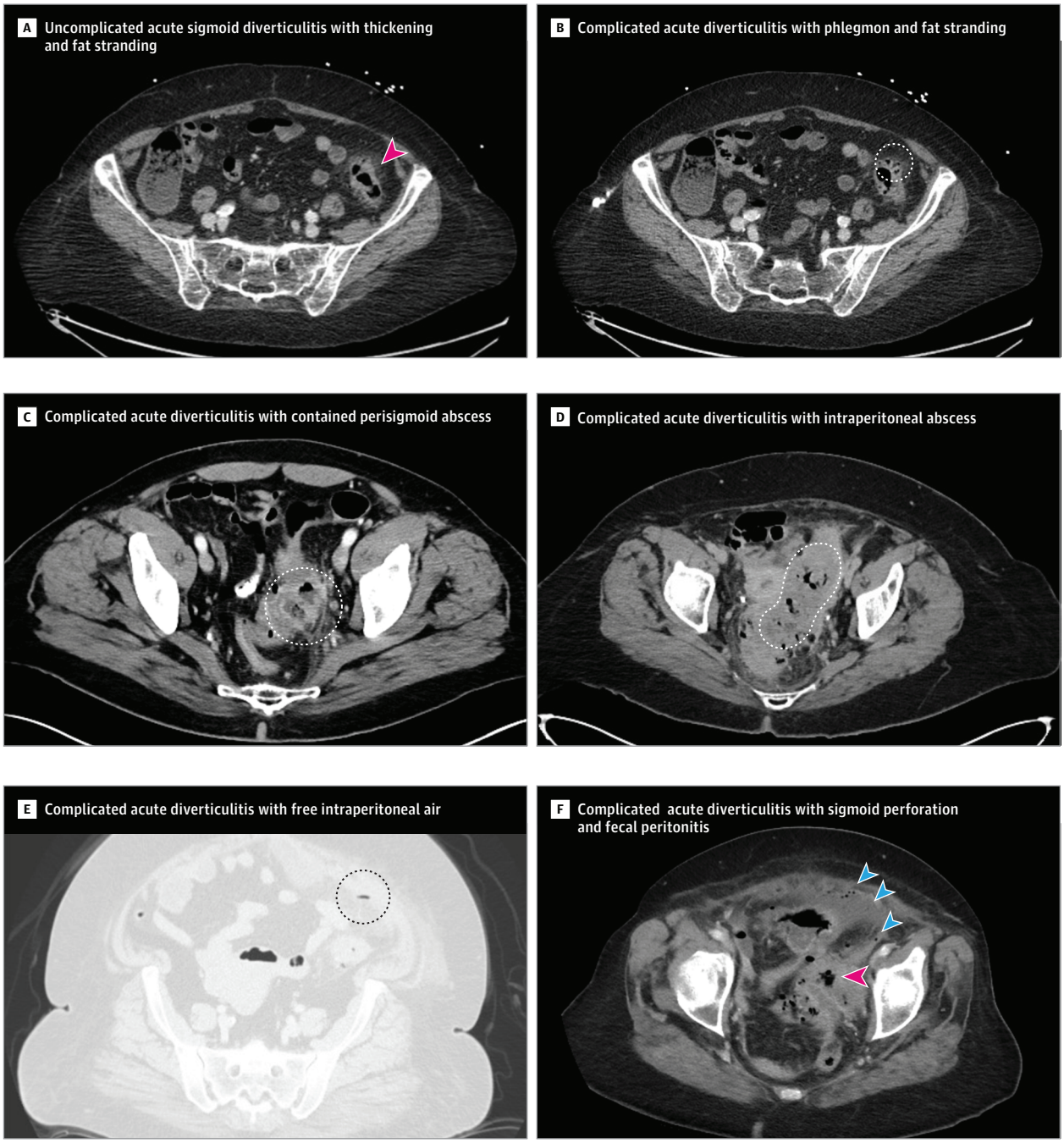
Diagnostic Studies

Computed tomography (CT) of the abdomen and pelvis with intravenous iodinated contrast is the recommended test for diagnosing acute diverticulitis and has a sensitivity of 98% to 99% and specificity of 99% to 100%.[38,39] Characteristic CT findings for patients with uncomplicated acute diverticulitis include pericolic fat inflammation around the inflamed colon, multiple diverticula, and colonic wall thickening. For patients with complicated acute diverticulitis, CT scan characteristics may include peridiverticular abscess, colonic obstruction, perforation, fistula, extraluminal fluid, or free air (**Figure 2**).[40]

Abdominal ultrasound performed by a radiologist has a sensitivity of 77% to 98% and specificity of 80% to 99% for diagnosing acute diverticulitis.[41] Point-of-care ultrasound, a portable ultrasound technology, can be helpful for the initial diagnosis of diverticulitis and allows for rapid assessment and expedited initiation of

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Figure 2. Computed Tomography Scan Images Showing Stages of Acute Diverticulitis Based on Modified Hinchey Classification



The modified Hinchey classification, which can be used to classify diverticulitis and guide the selection of treatment,[33] has 5 stages (0: localized inflammation in the colon; I: localized abscess formation; II: larger or distant abscesses; III: purulent peritonitis; IV: fecal peritonitis). A, Arrowhead indicates colonic wall thickening and surrounding fat stranding. B-E, Dotted regions indicate phlegmon and fat stranding (panel B), contained perisigmoid abscess (panel C), intraperitoneal abscess (panel D), and free intraperitoneal air (panel E). F, Blue arrowheads indicate liquid stool and air in the peritoneal cavity (fecal peritonitis); purple arrowhead indicates site of sigmoid perforation.

treatment. An observational study conducted in 4 emergency departments that included 393 patients with possible diverticulitis evaluated point-of-care ultrasound assessment by emergency medicine physicians for diagnosing diverticulitis. Among 393 enrolled patients, 218 (55.5%) were diagnosed with diverticulitis. Compared with CT scans, the clinical-sonographic assessment had a sensitivity of 92.7% and specificity of 90.9% for diverticulitis.[42] Abdominal and pelvic ultrasound can also help exclude alternative causes of abdominal pain, such as ovarian cysts, torsion, or tubo-ovarian abscesses, and may prevent the need for further evaluation with CT. Magnetic resonance imaging has a sensitivity of 86% to 94% and a specificity of 88% to 92%[43] for acute diverticulitis compared with

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Table 1. Diagnostic Tests for Acute Diverticulitis (Populations With Possible Diverticulitis Who Are Well Suited for Testing)

Diagnostic test	Computed tomography	Magnetic resonance imaging	Abdominal ultrasonography
Typical findings of acute diverticulitis	Inflammation of the pericolic fat Single or multiple diverticula Colonic wall thickening is characteristic Peridiverticular abscess may be seen Localized pericolic or free intraperitoneal air may be detected	Presence of diverticula Pericolic exudation is seen Pericolonic fat stranding is detectable Thickening and edema of the colonic wall and mesenteric infiltration are characteristic	Focal inflammation of the colon is visualized The presence of a thickened area of hyperechoic, inflamed pericolic fat can be identified Scattered diverticula containing air are evident
Diagnostic accuracy, %	Sensitivity: 98-99 Specificity: 99	Sensitivity: 86-94 Specificity: 88-92	Sensitivity: 77-98 Specificity: 88-92
Criterion standard for sensitivity and specificity	Surgical findings	Computed tomography	Computed tomography
Advantages of the diagnostic test	Able to evaluate for other causes of abdominal pain	No radiation exposure Ideal in pregnancy Useful in detecting and characterizing fistulae associated with diverticulitis	Less expensive than other available tests Readily available No radiation exposure Can prevent the need for further workup Ideal in pregnancy
Limitations of the test	Ionizing radiation Patient weight >204.12 kg (450 lb) exceeds scanner limit Difficulty in distinguishing diverticulitis from colon cancer	Expensive Increased time to obtain images (45-60 min) compared with computed tomography scan (10 min) Limited availability compared with computed tomography scans in the emergency department, community hospitals, and rural areas Not compatible with metallic medical implants or foreign bodies Patients with claustrophobia may not tolerate the test	High-quality images require an experienced and expert technician

CT scans. Magnetic resonance imaging is useful for evaluating patients during pregnancy to avoid radiation exposure from CT scans and for detecting and characterizing fistulae associated with diverticulitis (**Table 1**).

Contrast enema should not be used to evaluate patients with possible acute diverticulitis, because it may cause colonic perforation.[44] Plain radiography films have limited utility in diagnosing diverticulitis. However, a plain abdominal radiograph series with supine and upright films can identify bowel obstruction, ileus, or free air, indicating a perforated viscus.

Colonoscopy should not be used to diagnose acute diverticulitis because it increases the risk of colonic perforation. According to the American Gastrointestinal Association guidelines, the decision to perform a colonoscopy after an episode of diverticulitis should be guided by the patient's history, current colorectal cancer screening adherence, and disease severity. For patients with uncomplicated diverticulitis, a follow-up colonoscopy is not always required but should be performed if the patient is due for colorectal cancer screening. A colonoscopy is recommended to assess for colon cancer after an episode of complicated diverticulitis managed nonoperatively, because perforated colon cancers can present similarly to acute diverticulitis. In patients who require a colonoscopy after diverticulitis, colonoscopy should be performed 6 to 8 weeks after resolution of symptoms.[45,46]

Differential Diagnosis

The differential diagnosis of diverticulitis includes uncomplicated constipation, irritable bowel syndrome, inflammatory bowel disease (ie, ulcerative colitis or Crohn disease), appendicitis, colorectal cancer, kidney stones, urinary tract infection, bowel obstruction, and gynecologic conditions such as pelvic inflammatory disease, tubo-ovarian torsion, or abscess.

Management of Acute Diverticulitis

Uncomplicated Diverticulitis

Therapeutic goals for uncomplicated diverticulitis include improving symptoms and preventing recurrence and complications. Standard management has traditionally included antibiotic treatment. However, observation without antibiotics is appropriate for immunocompetent patients with uncomplicated diverticulitis who do not have systemic symptoms such as fever and chills.[47]

In 2021, a noninferiority clinical trial randomized 480 nonhospitalized patients with mild diverticulitis to oral treatment with amoxicillin-clavulanic acid (typical treatment) or ibuprofen and acetaminophen (symptomatic treatment) for 7 days. The primary outcome was hospitalization, and the noninferiority margin was a 10% difference in hospitalization rates between the nonantibiotic and antibiotic treatment groups. Hospitalization rates were 14/238 (5.8%) in patients randomized to antibiotics and 8/242 (3.3%) in patients

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Table 2. Oral Antibiotic Regimens for the Treatment of Uncomplicated Acute Diverticulitis[a,b,c]

	Amoxicillin-clavulanate	Cefalexin + metronidazole	Ciprofloxacin + metronidazole	Trimethoprim-sulfamethoxazole + metronidazole
Dose	875 mg/125 mg twice daily	1 g 3 times daily + 500 mg 3 times daily	500 mg twice daily + 500 mg 3 times daily	160 mg/800 mg double-strength tablet twice daily + 500 mg 3 times daily
Adverse effect, %	Nausea (16), diarrhea (10), rash (5-8), liver enzyme elevation (0.04)	Nausea (2-3), diarrhea (2-7), stomach pain (rare), rash (1.5)	GI upset (4.8), taste disturbance (15.5), tendinitis (0.14-0.4), neuropathy (3) rash (1.8)	GI upset (3.7), rash (7.3), hypersensitivity (3-6), photosensitivity (1-5)
Efficacy, %	86-89	75-100	74-94	Limited data

Abbreviation: GI, gastrointestinal.

[a] Broad-spectrum oral antibiotic regimens for treatment of acute diverticulitis against gram-negative rods and anaerobic bacteria. When possible, the selection of antibiotics should be guided by local resistance patterns and patient allergies. For all antibiotics, consult local formulary for appropriate use and dosing in specific populations—for example, hepatic impairment, kidney impairment, pregnancy and breastfeeding, and administering intravenous antibiotics. A longer course may be needed based on clinical assessment. For intravenous antibiotics: Duration of antibiotics depends on improvement in symptoms. Review within 48 hours or after scanning and consider de-escalating to oral antibiotics where possible.

[b] In uncomplicated diverticulitis, antibiotics can be withheld in immunocompetent and stable patients. Antibiotics are indicated in unstable patients with uncomplicated diverticulitis and patients with complicated diverticulitis.

[c] Appropriate for patients who are stable and can tolerate oral intake. If intolerant, proceed to intravenous antibiotics. For all regimens, treatment should be 4 to 7 days' duration.

randomized to symptomatic treatment (mean difference, 2.58% [95% CI, 1.17% to 6.32%]; *P* = .18), consistent with noninferiority of symptomatic treatment (upper CI was below the conservative margin but *P* value did not reach significance due to conservative statistical thresholds).[48] These data were consistent with findings from the Swedish AVOD (2013)[49] and Dutch DIABOLO (2018)[50] noninferiority randomized clinical trials. The Dutch DIABOLO clinical trial randomized 528 patients, with 266 allocated to antibiotic therapy with amoxicillin-clavulanic acid and metronidazole or an observation group (pain management and fluids). There was no significant difference over the 6-month follow-up in time to recovery (12 days [IQR, 7-35] for the group that received antibiotic vs 14 days [IQR, 7-30] for the observation group, *P* = .30) or complications (abscess, perforation, need for sigmoid resection or death) (6.5% vs 5.8% [95% CI, −4.2% to 5.7%]).[50] The disease recurrence rate within 2 years (15.4% vs 14.6%, *P* = .81) was not significantly different. A 2022 Cochrane review that included 5 randomized clinical trials and 1329 participants concluded that antibiotics for uncomplicated acute diverticulitis was not superior to management without antibiotics.[51]

For patients with uncomplicated acute diverticulitis who require antibiotics, broad-spectrum antibiotics against gram-negative bacilli and anaerobic bacteria should be administered for 4 to 7 days. First-line oral antibiotics are amoxicillin/clavulanic acid or an oral cephalosporin such as cefalexin plus metronidazole (**Table 2**).[52] Patients with uncomplicated acute diverticulitis who are able to tolerate oral fluids can be treated in the outpatient setting. Patients treated with oral antibiotics should be reevaluated within 7 days for resolution of symptoms, particularly abdominal pain. Outpatient treatment is effective for 95% of patients with uncomplicated acute diverticulitis.[53]

Antibiotics remain the standard of care for patients with uncomplicated diverticulitis who have comorbidities such as liver cirrhosis, chronic kidney disease, heart failure, or poorly controlled diabetes; who are older than 80 years; or who have immunosuppression (eg, those receiving high-dose steroids or chemotherapy, history of organ transplantation).[54] Furthermore, pregnant patients and those with worsening abdominal pain and rebound or percussion tenderness, persistent fever greater than 38.5 °C (101.3 °F), and rising leukocytosis or signs of severe sepsis or septic shock, should be treated with antibiotics and hospitalized.[1,55]

Intravenous antibiotics such as ceftriaxone plus metronidazole are first-line therapies for patients requiring hospitalization for diverticulitis (**Table 3**). Alternatively, ampicillin/sulbactam is appropriate.[56] For patients with uncomplicated diverticulitis, symptoms typically improve within 48 to 72 hours of treatment, with complete resolution usually within 1 to 2 weeks, depending on diverticulitis severity. For patients with uncomplicated diverticulitis, repeat imaging may be considered in those with persistent or worsening symptoms, such as increased abdominal pain, new-onset fever, or persistent nausea and vomiting. A repeat CT scan is indicated if new complications are suspected, such as abscess or perforation, or if a patient does not improve after 3 to 5 days of treatment.[57] Although no high-quality evidence supports dietary restrictions in patients with acute uncomplicated diverticulitis, a clear-liquid diet is recommended during the first 1 to 2 days after diagnosis of uncomplicated diverticulitis. The diet should be advanced when symptoms resolve.[58,59]

Pain Management

In the outpatient setting, acetaminophen is the preferred treatment for mild to moderate abdominal pain associated with acute diverticulitis. Nonsteroidal anti-inflammatory drugs should be avoided because they may increase the risk of diverticular bleeding.[60] For moderate to severe pain, oral opioids may be prescribed for 3 to 5 days (although opioids are highly discouraged in patients with a history of chronic opioid use or dependency, respiratory depression, or severe kidney/hepatic impairment because of risk of metabolite accumulation). Patients hospitalized with diverticulitis may be treated with oral or intravenous opioids (such as morphine or hydromorphone) for pain control. Concomitant use of stool softeners such as docusate or bulk-forming medications such as psyllium or methylcellulose is recommended for patients requiring opioid analgesia.

Recurrent Diverticulitis

The recurrence risk following an acute diverticulitis episode is 13% to 23% in patients with uncomplicated diverticulitis and up to 40%

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Table 3. Intravenous Antibiotic Regimens for the Treatment of Complicated Acute Diverticulitis[a,b]

	Ceftriaxone + metronidazole	Imipenem-cilastatin	Meropenem	Piperacillin-tazobactam
Dose	1-2 g once daily + 500 mg 3 times daily	500 mg every 6 h	1 g every 8 h	3.375-4.5 g every 6 h
Duration of treatment, d	7-14	7-14	7-14	7-14
Adverse effects, %[c]	GI upset (1-5), neutropenia (2), diarrhea (2-10), infusion reactions (0.5-2.5)	GI upset (2-10), seizures (1.5), rash (0.3-3.7)	Seizures (<1), nausea (1-4), hypersensitivity (1-2), *Clostridioides difficile* risk (1-6)	GI upset (0.9), allergic reactions (1.3), *C difficile* risk (3-10), GI upset (2-10), seizures (1.5), rash (0.3-3.7)
Disease severity[b]	Complicated (clinically stable)	Complicated (clinically unstable)	Complicated (clinically unstable)	Complicated (clinically unstable)
Efficacy, %	75-100	81	70-96	86-89

Abbreviation: GI, gastrointestinal.

[a] Broad-spectrum intravenous antibiotic regimens for treatment of acute diverticulitis against gram-negative rods and anaerobic bacteria. When possible, the selection of antibiotics should be guided by local resistance patterns and patient allergies. For all antibiotics, consult local formulary for appropriate use and dosing in specific populations—for example, hepatic impairment, kidney impairment, pregnancy and breastfeeding, and administering intravenous antibiotics. A longer course may be needed based on clinical assessment. For intravenous antibiotics, duration of antibiotics depends on improvement in symptoms. Review within 48 hours or after scanning and consider de-escalating to oral antibiotics when possible.

[b] Uncomplicated diverticulitis is defined as the presence of inflammation of colonic diverticula only. Complicated diverticulitis is inflammation of colonic diverticula that is associated with one or more of the following: perforation, abscess formation, fistula (eg, colovesical, colovaginal), or bowel obstruction.

[c] Incidence of adverse drug reaction obtained from the World Health Organization at https://vigiaccess.org/.

in patients with complicated diverticulitis.[61] Two recent randomized clinical trials studied the effects of surgery on quality of life in patients with recurrent, complicated, or persistent diverticulitis. The DIRECT trial[62] randomized 109 adults with confirmed recurrent uncomplicated diverticulitis (>3 episodes within 2 years) or persistent abdominal pain or changes in bowel habits (>3 months) to conservative management (diet, pain control, and antibiotics if needed) or laparoscopic sigmoid resection. Surgical intervention significantly improved the Gastrointestinal Quality of Life Index (GIQLI, a survey consisting of 36 questions on gastrointestinal symptoms, with scores ranging from 0-144; the typical score of 125-130 is seen in asymptomatic individuals) at 6-month follow-up. Forty-seven of 53 patients (89%) received surgical intervention, and 43 of 56 patients (77%) received conservative management. The GIQLI score at 6-month follow-up was significantly higher in patients who received surgical intervention (mean, 114.4 [SD, 22.3] points) than conservative management (100.4 [SD 22.7] points) (mean difference, 14.2 [95% CI, 7.2-21.1] points; P <. 001).

Complicated Diverticulitis

Perforation | Of the approximately 12% to 15% of patients who present with complicated acute diverticulitis, 15% to 20% develop a phlegmon or abscess, which is caused by colon perforation.[63,64] Initial nonoperative management of complicated diverticulitis with abscess includes antibiotics and/or percutaneous drainage of a diverticular abscess. These treatments cure approximately 80% of patients. Percutaneous drainage reduces abscess recurrence and is considered standard treatment for diverticular abscesses when feasible.[65] However, antibiotic therapy alone is a reasonable alternative when abscess drainage is technically challenging or may injure adjacent organs. Intravenous antibiotic regimens for diverticular abscess include piperacillin/tazobactam or ciprofloxacin plus metronidazole. However, antibiotic therapy alone, especially in people with abscesses larger than 4 cm, is associated with treatment failure rates of 25% to 28%.[66,67] Failure of treatment is defined as a lack of improvement in the patient's clinical condition within 48 hours following percutaneous intervention or administration of intravenous broad-spectrum antibiotics and should result in urgent surgery.[68]

Elective colectomy should be considered 4 to 6 weeks after successful nonoperative management of diverticular abscess due to the risk of complicated recurrences such as stricture, bowel obstruction, or fistula formation. Approximately 4% of patients require a stoma following elective colonic resection.[69] Patients who do not improve or worsen with antibiotics and pain management, and those with diffuse purulent or feculent peritonitis or septic shock, should undergo urgent or emergency surgery.

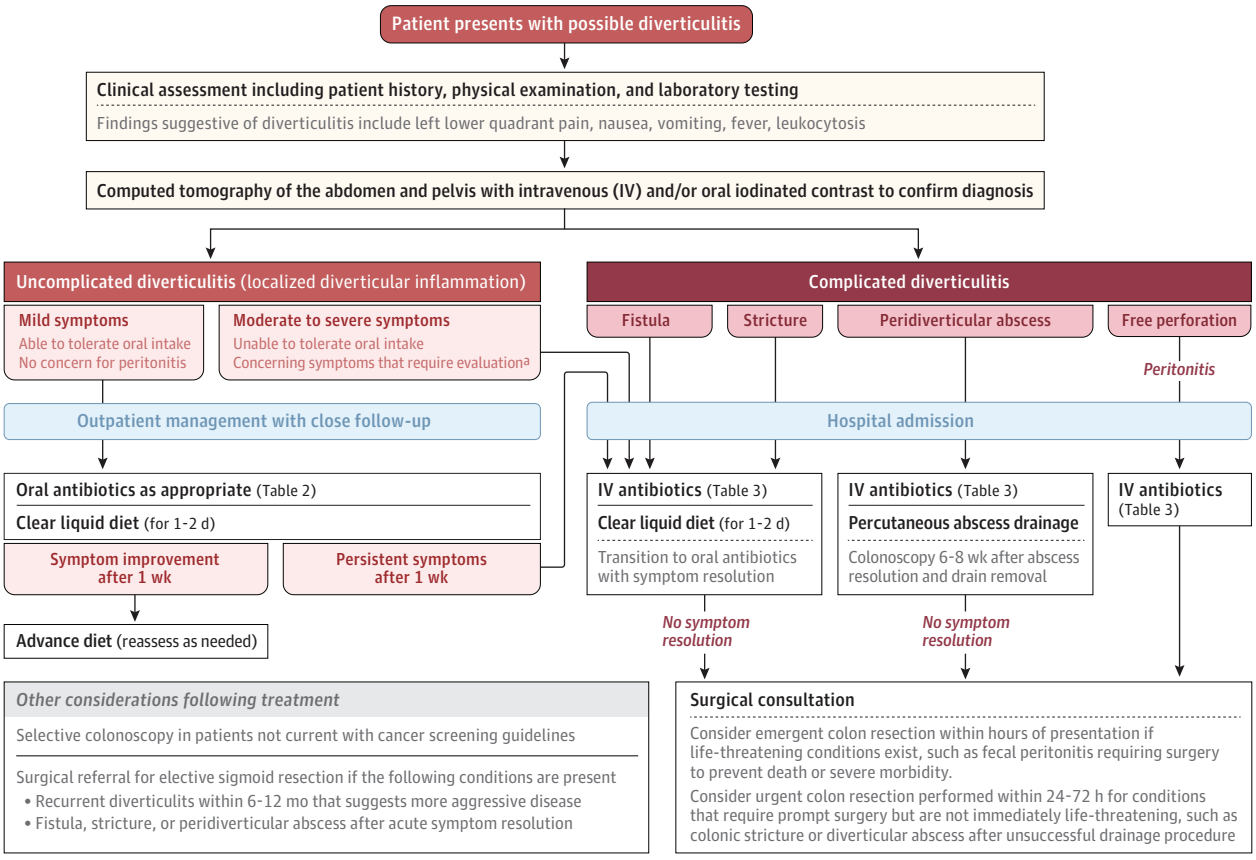
Colon Resection With Primary Anastomosis vs End Colostomy | Surgical management for diverticular disease typically consists of removing the diseased segment of the colon and repairing the resultant discontinuous colon, either by creating an end colostomy (Hartmann procedure) or primary anastomosis. A Hartmann procedure is resection of the diseased colon with exteriorization of the proximal colon through the abdominal wall (creation of end colostomy) and closure of the rectum (Hartmann stump). A primary anastomosis is the reconnection of the proximal and distal intestine following a bowel resection to achieve intestinal continuity (in surgery for sigmoid diverticulitis, this consists of joining the colon to the rectum). A diverting ileostomy exteriorizes the ileum, proximal to the primary anastomosis, to divert the fecal stream from the healing anastomosis and decrease septic complications associated with an anastomotic leak.

The 2019 DIVA (Perforated Diverticulitis With or Without Anastomosis)[70] study group of the LADIES trial randomized 130 patients with perforated diverticulitis who met specific inclusion criteria (age <85 years, hemodynamically stable, nonimmunocompromised state) with purulent or feculent peritonitis to undergo resection of sigmoid colon with end colostomy-Hartmann procedure (68 patients) or primary anastomosis with or without diverting ostomy (65 patients). The 12-month stoma-free survival was significantly higher among patients undergoing primary anastomosis compared with resection of sigmoid colon with end colostomy (94.6% [95% CI, 88.7%-100%] vs 71.7% [95% CI, 60.1%-83.3%]; hazard ratio, 2.79 [95% CI, 1.86-4.18]; log-rank P < 001).

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Figure 3. Management Algorithm for Complicated and Uncomplicated Diverticulitis



This algorithm has not been validated.

[a]Concerning symptoms include persistent or worsening abdominal pain, moderate fever (38.3 °C to 38.9 °C [100.94 °F to 102.02 °F]), increased abdominal tenderness with guarding, and worsening leukocytosis.

Stricture, Large Bowel Obstruction, or Fistula | Approximately 0.09% of patients with diverticular disease experience recurrent episodes of diverticulitis that result in colonic stricture. Approximately 3.6% of large bowel obstructions are due to recurrent diverticulitis.[71] Colonic resection is indicated for patients who present with large bowel obstruction due to diverticulitis and colon stricture, but proximal colonic dilation can preclude primary anastomosis during the index surgery.[72] Based on the high risk of complications such as pain, bleeding, perforation, and stent migration, routine colonic stenting for benign colonic stricture is not recommended.

Fistulae occur in approximately 5% of patients with acute diverticulitis on initial presentation and account for 17% to 27% of surgically treated cases of diverticular disease. Fistula typically occurs in nearby pelvic organs and includes colovesicular (65%), colovaginal (25%), colocutaneous/complex multiorgan fistulas (10%), coloenteric (7%), and colouterine (3%) fistulas.[73] Patients with complicated diverticulitis and associated fistula should be considered for elective colon resection (**Figure 3**).[55]

Postoperative Mortality

Among 200 600 US adults with diverticulitis in 2016, elective colectomy rates were 3.1 per 100 000, and emergency colectomy rates were 1.5 per 100 000.[74] A systematic review and meta-analysis that included 4 longitudinal studies of 692 patients with diverticulitis reported that emergent colectomy was associated with a mortality rate of 10.6% (95% CI, 7.95%-14.11%), and elective colectomy was associated with a mortality rate of 0.50% (95% CI, 0.46%-0.54%).[75]

Diverticulitis in Young Adult Patients | Among patients admitted for complicated diverticulitis, the proportion of patients younger than 50 years increased from 18.5% in 2005 to 28.2% in 2020 (<.001).[76] A retrospective review of the Nationwide Inpatient Sample of 5 239 735 patients nonelectively admitted with acute diverticulitis between 2005 and 2020 showed that compared with patients 50 years or older, patients younger than 50 years were more frequently male (59.7% vs 40.7%, $P < .001$), had a higher prevalence of obesity (20.8% vs 11.7%, $P < .001$), and had higher rates of complicated diverticulitis (24.9% vs 14.3%, $P < .001$). Similarly, a prospective study of 220 patients with acute diverticulitis reported that, compared with patients 50 or older, those younger than 50 years showed a higher recurrence, hospitalization, and surgical intervention rates. Early surgery should be considered in patients younger than 50 years with complicated or recurrent diverticulitis.[77]

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Diverticulitis in Older Patients

Older patients are less likely to have typical signs and symptoms of diverticulitis. In an observational study of 1139 patients with acute diverticulitis, patients older than 80 years had lower rates of fever (21.4% vs 35.2%; $P < .001$) and abdominal pain (47.8% vs 65.6%; $P < .001$) and leukocytosis than patients younger than 80 years.[78,79] No clinical trials testing the efficacy of treating people with diverticulitis without antibiotics have included people older than 80 years.[50,80] The selection and duration of antibiotics for elderly patients should follow standard guidelines as previously outlined.

In a retrospective analysis of 16 048 patients with diverticulitis (6309 aged ≥80 years) with a mean follow-up of 19.2 months, the proportion of individuals in the cohort newly diagnosed with diverticulitis but with no recurrent episodes was 83.2% (n = 13 346). Individuals 80 years or older whose care was initially managed medically (either as inpatients or outpatients) at the time of their incident diagnosis also had a reduced hazard of recurrence (hazard ratio, 0.47 [95% CI, 0.37-0.60]) and less likely to undergo operative intervention (hazard ratio, 0.64 [95% CI, 0.54-0.76]) compared with those younger than 80 years.[81]

For complicated diverticulitis in older adults, indications for surgery do not differ compared with other age groups. The observed postoperative mortality rates were 1.6% (21/1267) in patients younger than 65 years, 9.7% (63/648) in patients aged 65 through 79 years, and 17.8% (62/349) in patients 80 years or older.[82] Higher rates of in-hospital mortality in patients older than 65 years are attributable to their associated concomitant comorbidities.[83]

Diverticulitis in Immunocompromised Patients

Nonoperative management of diverticulitis is safe and effective in immunocompromised patients who have uncomplicated diverticulitis treated with antibiotics, with success rates of 95.0% vs 95.6% in the immunocompetent patients, respectively.[37] However, immunocompromised patients with complicated diverticulitis are more likely to require surgical intervention during initial hospitalization and have higher rates of surgical site infection, wound dehiscence, anastomotic leakage, stenosis, intra-abdominal abscess, sepsis, ileus, postoperative bleeding, and cardiovascular, pulmonary, thromboembolic, kidney and urinary tract complications (30% vs 7%, $P < .001$), and mortality (10%-19% vs 1%, $P = .002$) than immunocompetent patients.[37,84]

Limitations

This review has limitations. First, only English-language studies were included. Second, some relevant papers may have been missed. Third, there was no formal evaluation of the quality of the included studies.

Conclusions

Diverticulitis is typically diagnosed with a contrast-enhanced abdomen and pelvis CT scan. For patients with uncomplicated diverticulitis, first-line therapy is observation and pain control, with or without antibiotics. Treatment of complicated diverticulitis includes intravenous antibiotics, such as ceftriaxone plus metronidazole or piperacillin-tazobactam, and, if indicated, percutaneous drainage or colonic resection.

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