Management of colonic diverticulitis

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ABSTRACT

Left sided colonic diverticulitis is a common and costly gastrointestinal disease in Western countries, characterized by acute onset of often severe abdominal pain. Imaging is necessary to make an initial diagnosis and determine disease severity. Colonoscopy should be done six to eight weeks after diagnosis to rule out a missed colon malignancy. Antibiotic treatment is used selectively in immunocompetent patients with mild acute uncomplicated diverticulitis. The clinical course of diverticulitis commonly includes unpredictable recurrences and chronic gastrointestinal symptoms, which are a detriment to quality of life. A better understanding of prognosis has prompted a shift toward non-operative approaches. The decision to undergo prophylactic colon resection should be individualized to consider the severity of diverticulitis, the patient’s health and immune status, and the patient’s preferences and values, as well as benefits and risks. Because only a section of colon is removed, recurrent diverticulitis remains a risk. Acute diverticulitis with an abscess is treated with antibiotics that cover Gram negative and anaerobic bacteria, with or without percutaneous drainage. Acute diverticulitis with purulent or feculent contamination of the peritoneal cavity is managed with surgery; primary resection and anastomosis is the procedure of choice in stable patients.

Introduction

Left sided colonic diverticulitis is a common (209 cases per 100,000 person years) gastrointestinal disease in Western countries, characterized by acute onset of abdominal pain, which is often severe. The clinical course of diverticulitis commonly includes unpredictable recurrences and chronic gastrointestinal symptoms. Diverticulitis can lead to the development of a colonic stricture or fistula and, when complicated by an abscess or perforation, can be fatal. Among gastrointestinal diseases, diverticulitis is a leading cause of ambulatory visits, hospital admissions, and colon surgery, accounting for substantial healthcare expenditures.

Diverticulitis is a heterogeneous disease in both presentation and prognosis (box 1). Acute uncomplicated diverticulitis is the most common presentation of the disease and is characterized by acute onset of diverticulitis inflammation without abscess or perforation. This inflammation often includes surrounding tissues. Smoldering diverticulitis is an uncommon presentation that persists for weeks to months and should not be confused with symptomatic uncomplicated diverticulitis disease. Acute complicated diverticulitis is diverticulitis inflammation combined with obstruction, abscess, or perforation. Recurrent diverticulitis is diverticulitis that resolves completely and then abruptly returns.

In the past decade, our understanding of diverticulitis has expanded substantially with the publication of multiple observational studies and clinical trials. Historically, diverticulitis was thought to be an aggressive disease, and the threshold for surgical intervention was low. With a better understanding of prognosis, a shift toward non-operative approaches has occurred.

Diverticulitis is also now recognized as a chronic disease for patients with recurrent episodes or ongoing symptoms. Recent clinical trials have questioned the longstanding practice of treating uncomplicated diverticulitis with antibiotics. Although the contribution of a Western lifestyle to risk of diverticulitis has been validated, emerging evidence indicates a strong genetic component.

This article reviews the literature responsible for these important advances and provides a comprehensive and evidence based summary of the medical management of patients with acute diverticulitis. Surgical management is beyond the scope of this review. The review is written to inform specialists, academic clinicians, and clinical researchers. A summary of management is provided in a box at the end.

Sources and selection criteria

With the assistance of a librarian, I searched PubMed, Embase, and Cochrane databases from 2010 to December 2019, using the terms “diverticulitis” and “diverticular disease” and also identified references from international, European, and American
Box 1: Nomenclature

**Diverticulosis**
The presence of diverticula. Diverticula form when mucosa and submucosa herniate through the muscularis propria layer of the colon wall

**Acute uncomplicated diverticulitis**
Diverticular inflammation of acute onset, with or without a phlegmon. This is also called modified Hinchey Ia diverticulitis

**Acute complicated diverticulitis**
Diverticular inflammation of acute onset with an abscess and/or perforation, with or without peritonitis. The modified Hinchey classification is widely used in clinical practice to distinguish the stages of diverticulitis complicated by abscess or peritonitis:
- • Ib—paracolic or mesocolic abscess
- • II—pelvic, distant intra-abdominal, or retroperitoneal abscess
- • III—generalized purulent peritonitis
- • IV—generalized fecal peritonitis

**Acute diverticulitis with paracolic air or gas**
Diverticulitis with just extraluminal air or gas is considered by some authors to be uncomplicated diverticulitis, whereas others classify this as complicated diverticulitis because of an increased risk of abscess formation

**Diverticular stenosis/stricture**
A fibrotic narrowing in the colon that forms as a result of diverticulitis. This is sometimes non-specifically called complicated diverticular disease

**Diverticular fistula**
An abnormal connection from the colon to another hollow organ or skin that forms as a result of diverticulitis. This is also non-specifically called complicated diverticular disease

**Smoldering diverticulitis**
Overt diverticular inflammation that persists for weeks to months. This includes patients who improve somewhat or nearly completely and then relapse quickly after stopping antibiotics

**Recurrent diverticulitis**
Diverticulitis that resolves completely and then abruptly returns

**Diverticular disease**
This is a non-specific term that some authors use to describe any pathology related to a colonic diverticulum, including diverticular hemorrhage. Diverticulosis is also sometimes included in this definition

**Symptomatic uncomplicated diverticulosis**
This is defined as chronic gastrointestinal symptoms attributed to colonic diverticulosis in the absence of overt inflammation. This non-specific term should not be used to describe patients with ongoing symptoms after an episode of acute diverticulitis

guidelines on diverticulitis published during this time period. We selected systematic reviews, meta-analyses, randomized controlled trials, and observational studies (excluding case reports and small case series). We excluded articles that were not peer reviewed and those not published in English. Studies were prioritized by design, as noted above, and by patient numbers, quality, and publication date.

**Overall quality of evidence**
Randomized controlled trials and meta-analyses have assessed treatment with antibiotics, mesalamine for prevention of diverticulitis, and quality of life after elective surgery and have compared colon resection with a primary anastomosis with Hartmann’s procedure. This evidence is of higher quality than that for prognosis, risk factors, and diagnosis, which is informed by several large observational studies. The overall quality of evidence is low, and an urgent need for trials of diverticulitis treatment and prevention remains.

**Incidence and temporal trends**
The incidence of colonic diverticulitis was 209 adults per 100 000 person years in a US population based study between 2000 and 2007 (fig 1). The incidence of hospital admissions for diverticular disease was 49 adults per 100 000 person years in a population based Swedish study between 2003 and 2010. Most admissions (99.1%) were for diverticulitis. The incidence of perforated diverticulitis was 2.7 adults per 100 000 person years in a UK population based study between 1990 and 2005.

The incidence of surgery for diverticular disease was 8 per 100 000 person years in the Swedish study. The rates of elective surgery and urgent/emergent surgery were 3 and 2 per 100 000 person years, respectively, in a population based US study in 2006. Rates of both elective and urgent/emergent surgery were highest in the 65-79 year age group compared with all other age groups. Fatality rates for diverticular disease in a US registry of death certificates were 0.9 deaths per 100 000 adults. Increasing age, comorbidity burden, emergent admission, severe disease, surgical intervention, and low volume hospitals were all associated with increased odds of death in a population based US study.

In another US population based study of outpatient and inpatient diverticulitis, disease incidence increased by 50% in 2000-07 compared with 1990-99. The trend was similar in men and women. The increase over time was highest in adults aged 30-39 and 40-49 years. The incidence of complicated diverticulitis (10-14%) did not change over this time. Hospital admissions for diverticulitis have increased in other countries over approximately the same time. Increased age, comorbidity burden, emergent admission, severe disease, surgical intervention, and low volume hospitals were all associated with increased odds of death in a population based US study.

In Western countries, diverticula are most common in the sigmoid colon. In a US colonoscopy based study, 72% of participants with diverticulitis had only sigmoid diverticula. The average number of diverticula in the sigmoid colon (mean 12) was twice that of other colon locations (mean 5).

Diverticulitis are highly prevalent in Western countries. In a US colonoscopy based study of...
271 181 procedures, the prevalence of diverticulosis increased with age in men and women of all races and ethnicities, from 24% in ages 40-49 to 72% in ages 80 years and older (fig 2). Diverticulosis was less prevalent in women than in men of similar age. Non-Hispanic black and Asian/Pacific Islander individuals were less likely to have diverticulosis compared with non-Hispanic whites. When diverticulosis was present, Asian/Pacific Islanders were more likely to have proximal only diverticulosis whereas non-Hispanic black individuals were more likely to have pan-colonic diverticulosis.

Although colonic diverticula are common, the risk of progression to diverticulitis is low. In a retrospective cohort study of patients with colonic diverticulosis, the incidence of developing diverticulitis was 1-4% over seven years of follow-up (fig 2). With the exception of diverticular hemorrhage, colonic diverticula are otherwise thought to be asymptomatic. Among patients undergoing routine screening colonoscopy, the presence of diverticulosis was not associated with mucosal inflammation or chronic gastrointestinal symptoms.

First episode of diverticulitis

Most patients with diverticulitis have acute uncomplicated diverticulitis (box 1) and are managed in the outpatient setting. In a community based study of incident diverticulitis, 88% of patients presented with uncomplicated diverticulitis. In a trial of patients with acute uncomplicated diverticulitis confirmed by computed tomography, the median time to recovery was 14 days. Unfortunately, acute uncomplicated diverticulitis does not always resolve within days. In the same trial, 6% of patients had smoldering diverticulitis at six months. A small proportion of patients with acute uncomplicated diverticulitis will progress to complicated diverticulitis (fig 2). The risk of progression was 5% within three months in a prospective study of 1087 patients with diverticulitis confirmed by computed tomography. The complications were colonic obstruction (2.1%), perforation (1.2%), abscess (0.7%), and fistula (0.8%). Most (76%) perforations and abscesses occurred within 10 days of the initial presentation.

Only 1% of patients who presented with acute uncomplicated diverticulitis had an emergency resection within six months. Approximately 11-30% of patients presenting with acute diverticulitis have diverticular inflammation without an abscess but paracolic extraluminal air on a computed tomography scan. Whether this presentation is more likely to progress to an abscess or perforation is debated. In a systematic review of six studies with 195 diverticulitis patients with paracolic extraluminal air, 6% of patients needed emergency surgery. The timing of surgery was not reported. In a small trial published after the systematic review, 19% of diverticulitis patients with only extraluminal air developed an abscess within three days of diagnosis.

Of course, some patients present initially with diverticulitis and an abscess (Hinchey Ib or II) (box 1). In a community based study of incident diverticulitis that included outpatients and inpatients with diverticulitis, only 12% of patients presented with complicated diverticulitis. The most common complication was abscess (69%). In an observational cohort study of 10 342 patients with an incident diverticular abscess (Hinchey Ib or II), 32% of patients did not respond to non-operative management (antibiotics with or without percutaneous drainage) and needed surgery within 30 days (fig 2). Of those who did not have surgery within 30 days, 24% had an elective colectomy within six months of discharge. This surgery resulted in a stoma in 10% of patients (5% ileostomy, 5% colostomy). Although these surgeries were performed “electively,” some of these patients likely had ongoing diverticulitis necessitating diversion. In the cohort, 52% of patients were managed without surgery.

Rarely, a patient will present with acute diverticulitis and purulent or feculent contamination of the peritoneal cavity (Hinchey III or IV diverticulitis) (box 1). This is almost always managed with surgery. In a retrospective cohort study, 14% of patients with a first admission for diverticulitis underwent urgent/emergent colon resection. On the basis of data from a large national surgical quality improvement program, the risk of 30 day morbidity with urgent surgery was 55%. Mortality was 7%, and the median length of hospital stay was nine to 10 days.

Recurrent episodes

The risk of recurrent diverticulitis depends on multiple factors including severity of the initial episode and number of previous episodes. After an index episode of diverticulitis, the risk of a second episode was 8% at one year, 17% at five years, and 22% at 10 years. After a second episode of diverticulitis, the risk of a third episode was 19% at one year, 44% at five years, and 55% at 10 years. After a third episode of diverticulitis, the risk of a fourth episode was 24% at one year and 40% at three years. These estimates include patients with diverticulitis of any severity and accounted for
Fig 2 | Clinical course of colonic diverticulosis and diverticulitis. Panel A: prevalence of colonic diverticulosis increases with age. By the age of 80, ~70% of Western adults have colonic diverticulosis. Among adults with colonic diverticulosis, the risk of developing diverticulitis is low (1-4% over 7 years). Ongoing symptoms after an episode of diverticulitis are common. At 1 year follow-up, 25% of patients reported mild abdominal pain, 20% reported moderate to severe abdominal pain, and 33% reported altered bowel habits. Panel B: a small proportion (5% within 3 months) of patients with acute uncomplicated diverticulitis (Hinchey Ia) progress to complicated diverticulitis. Most (76%) perforations and abscesses occur within 10 days of the initial presentation. Acute uncomplicated diverticulitis does not always resolve within days; 6% of patients have smoldering diverticulitis. After an index episode of acute uncomplicated diverticulitis (Hinchey Ia), the risk of a second episode is 15% over 24 months. Panel C: among patients with a diverticular abscess (Hinchey Ib/Ii diverticulitis), 48% have urgent or elective surgery within 6 months. Among patients with Hinchey Ib/Ii diverticulitis managed successfully without surgery, the risk of recurrence requiring admission is 25-36% over 5 years of follow-up. Of patients with Hinchey Ib/Ii diverticulitis initially managed successfully without surgery, 5% will go on to have emergency surgery or to die from diverticulitis over 5 years of follow-up. Interval elective resection does not decrease this risk.

GI=gastrointestinal
recurrence of diverticulitis in the outpatient and inpatient settings. In a trial of patients with acute uncomplicated diverticulitis confirmed by computed tomography, only 3% had recurrent diverticulitis, of whom 1% underwent emergent sigmoid resection within six months. In the same trial, 15% of patients had recurrent diverticulitis within 24 months.7

Recurrent diverticulitis is more common after an episode of complicated diverticulitis managed without surgery than after an episode of uncomplicated diverticulitis. After successful non-operative treatment of complicated diverticulitis, the risk of recurrence requiring admission was 36% over 4.5 years of follow-up (fig 2).25 In another cohort, the five year risk of diverticulitis recurrence requiring admission was 25%. Recurrence of complicated diverticulitis was low at 14%, and the risk of urgent colectomy was 8%.28 The risks associated with complicated diverticulitis were highest in the first year after the initial diagnosis and decreased over time.28 These estimates did not include recurrent disease managed in the ambulatory setting. In a randomized trial of elective resection versus observation in diverticulitis with extraluminal air or abscess initially managed conservatively, observation was associated with a low risk of recurrence.7 Within three years of follow-up, 8% in the surgery group had a recurrence compared with 32% in the observation group. All recurrences were managed without surgery.

Recurrent diverticulitis is not associated with an increased risk of complicated diverticulitis. Multiple studies have shown that the risk of complicated diverticulitis is greatest with the patient’s first episode.1 In a UK population based retrospective cohort study, patients with two or more episodes of diverticulitis had a reduced risk of developing diverticulitis with perforation or abscess compared with those with no history of diverticulitis (odds ratio 0.78, 95% confidence interval 0.62 to 0.98).28 No association was seen with development of a diverticular stricture. Recurrent diverticulitis was associated with an increased but still very low risk of fistulizing disease (odds ratio 1.43, 1.00 to 2.04).

Risk factors for diverticulitis

Age

In a US population based study, incidence of diverticulitis increased with age and was most common in adults over the age of 60 (fig 1).1 Historically, diverticulitis in young adults (age <40-50 years) was thought to be a more severe disease with a more aggressive prognosis. However, a systematic review and meta-analysis of 21 studies with 7477 patients found that young age was not associated with higher risk of complicated diverticulitis at presentation (pooled risk ratio 1.19, 95% confidence interval 0.94 to 1.50).39 In 10 studies with 4115 patients, young age was not associated with need for emergency surgery (pooled risk ratio 0.93, 0.70 to 1.24).39 Young age was not a risk factor for recurrence (pooled risk ratio 1.19, 0.94 to 1.50) in four studies with robust reporting of follow-up.39 Although substantial heterogeneity was present in these studies, this work suggests that diverticulitis is not a more aggressive disease in young adults.

Sex

Across several studies, diverticulitis was more common among men than women at younger ages (<60 years) (fig 1).1 13 17 At older ages (>60 years), diverticulitis was more common among women than men. Use of hormone replacement therapy for menopause increased the risk of incident diverticulitis among postmenopausal women compared with those who never used such therapy (current use: hazard ratio 1.28, 95% confidence interval 1.18 to 1.39; past use: 1.35, 1.25 to 1.45).40

Genes

Genes contribute 40-50% of diverticulitis risk.41 42 In a population based study, siblings of cases had an increased risk of diverticular disease compared with the general population (relative risk 2.92, 95% confidence interval 2.50 to 3.39).41 The association was stronger for siblings of young cases (<40 years: relative risk 7.02, 4.82 to 10.23; 40-44 years: 4.35, 3.17 to 5.98; 45-49 years: 3.06, 2.33 to 4.03) than for siblings of older cases (≥50 years: 1.76, 1.33 to 2.33), suggesting a greater role for genetic factors in young onset disease.41

Obesity

Obesity increases risk of diverticulitis. In a prospective cohort study, men with an obese body mass index (>30) had a greater risk of diverticulitis than lean men (body mass index <21) (relative risk 1.78, 1.08 to 2.94).43 Estimates of central obesity were also associated with diverticulitis risk (relative risk 1.50, 1.13 to 2.00, for highest versus lowest fifth of waist to hip ratio, adjusted for body mass index).43 In a different prospective cohort study, obesity was associated with risk of diverticulitis in women (hazard ratio 1.42, 1.08 to 1.85 for body mass index >35 v <22.5), and this risk increased with severity of obesity.44

Diet and lifestyle

High quality diet, physical activity, and not smoking are associated with a reduced risk of diverticulitis in prospective cohort studies. Consuming a diet high in fruits, vegetables, whole grains, poultry, and fish was associated with reduced risk of hospital admission or death due to diverticular disease (relative risk 0.69, 0.55 to 0.86).46 Higher consumption of red meat was associated with an increased risk (relative risk 1.58, 1.19 to 2.11, comparing the lowest with the highest fifth).47 Vigorous physical activity was associated with a reduced risk of diverticulitis in a highest versus lowest fifth comparison (relative risk 0.66, 0.51 to 0.86).48 In a prospective cohort study, a healthy
lifestyle (defined as <51 g daily red meat, >23 g daily dietary fiber, 2 hours’ exercise weekly, normal body mass index, never smoker) was associated with a substantially reduced risk of diverticulitis (relative risk 0.27, 0.15 to 0.48).69

Non-steroidal anti-inflammatory drugs
Common over-the-counter medications are associated with increased risk of diverticulitis. In a prospective cohort study, regular use (at least twice a week) of aspirin (hazard ratio 1.25, 1.05 to 1.47) or non-steroidal anti-inflammatory drugs (1.72, 1.40 to 2.11) was associated with increased risk of diverticulitis.50 A meta-analysis of eight studies found that use of non-steroidal anti-inflammatory drugs was associated with increased risk of complicated diverticulitis (odds ratio 2.49, 1.98 to 3.14).51

Immunosuppression
Patients who are immunosuppressed have an increased risk of acute diverticulitis, complicated diverticulitis, and mortality from diverticulitis compared with patients who are immunocompetent. In a meta-analysis of 25 studies, patients with a solid organ transplant and/or taking chronic corticosteroids had an increased risk of incident diverticulitis compared with the general population.52 A different meta-analysis of five studies reported that corticosteroid use was associated with increased odds of diverticulitis with perforation (odds ratio 9.1, 3.5 to 23.6) compared with no use.51 In a population-based study, corticosteroid use was associated with increased mortality risk in patients with complicated diverticulitis compared with no corticosteroid use (hazard ratio for chronic use at one year 1.74, 1.42 to 2.14).53

Pathophysiology
The pathophysiology of diverticulitis is unknown. Longstanding hypotheses suggest that diverticulitis is a consequence of inspissated stool, bacterial translocation, local ischemia, and/or diverticular microperforation.54 Although the mechanism of this disease remains to be determined, provocative but limited evidence suggests that colonic dysmotility, dysfunctional connective tissue, gut dysbiosis, and chronic inflammation play a role.21 55-63 Evidence is also emerging for at least 35 novel risk loci and gene variants associated with altered smooth muscle or nerve functions, connective tissue function, and possibly epithelial or immune function.10-12 In these genome-wide association studies in diverticular disease, no overlap was seen with susceptibility loci for inflammatory bowel disease.64 The recent evidence on the pathophysiology of diverticulitis and the plausibility of the suggested gene variants has been reviewed previously.21

Clinical presentation and diagnosis
Diverticulitis most commonly presents with acute onset of left lower quadrant abdominal pain, fever, and leukocytosis. Complicated diverticulitis can present with diffuse abdominal pain. Non-specific inflammatory markers are often elevated; an initial C reactive protein concentration above 170 mg/L can predict complicated diverticulitis,65 66 although a low C reactive protein does not rule out complicated diverticulitis.67 68

Because the diagnostic accuracy of history, physical examination, and laboratory values alone for diverticulitis is poor,59 most guidelines recommend doing a computed tomography scan in a patient with suspected diverticulitis, both to make an accurate diagnosis and to determine disease severity. A meta-analysis determined the diagnostic test accuracy of computed tomography (eight studies) and transabdominal ultrasonography (six studies) for patients with suspected diverticulitis.70 The sensitivity of computed tomography was 94% (95% confidence interval 87% to 97%), and the specificity was 99% (90% to 100%). The sensitivity of ultrasonography was 92% (80% to 97%), and the specificity was 90% (82% to 95%). Computed tomography scanning was also more likely than transabdominal ultrasonography to identify alternative diagnoses. A computed tomography scan performs better in obese patients and is better able to assess the distal sigmoid colon, which is difficult to visualize with transabdominal ultrasonography.71

In Western countries, diverticulitis is most common in the sigmoid colon. Ultrasonography has the advantage of being radiation sparing, but an accurate interpretation is operator dependent.

Considerable disagreement exists about whether a patient should have a colonoscopy after an episode of diverticulitis to rule out a missed colon malignancy. Some authors consider the risk of a missed malignancy to be unacceptably high, whereas others consider the risk to be low.72 73 In a meta-analysis of 31 studies that included 50 445 patients, 1.3% (95% confidence interval 0.1% to 2.0%) of patients with uncomplicated diverticulitis and 7.9% (2.5% to 18.3%) of patients with complicated diverticulitis were found to have colorectal cancer on follow-up colonoscopy (fig 3).73 The prevalence of advanced adenomas was 4.4%, and the prevalence of adenomas was 14%.74 In a nationwide case-control study, the odds of receiving a diagnosis of colon cancer was 31 (95% confidence interval 19 to 52) within six months of an admission for diverticular disease.75 The increased risk was present only in the first six months, which is further evidence that colon cancer can be misdiagnosed as diverticulitis.

Given these clear risks, colonoscopy should be performed six to eight weeks after an acute episode of complicated diverticulitis or after a first episode of uncomplicated diverticulitis.72 76-79 If a high quality colonoscopy was performed in the previous year and no alarm symptoms are present, the examination does not need to be repeated. Patients with recurrent uncomplicated diverticulitis and no alarm symptoms should follow routine colorectal cancer screening and surveillance intervals. It is important to be aware that patients with post-colonoscopy colorectal
cancer are two to four times more likely to have a history of diverticular disease than those with detected colorectal cancer. This risk may be because patients with diverticular disease sometimes have distorted colonic architecture, making it easier to miss lesions or for lesions to be incompletely resected.

**Treatment**

Treatment of diverticulitis depends on multiple factors including disease severity, symptom burden, and a patient’s general health and comorbidities. Although patients with acute complicated diverticulitis are managed in hospital, most patients with acute uncomplicated diverticulitis are successfully treated in the outpatient setting. In a systematic review of 19 studies, outpatient treatment of acute uncomplicated diverticulitis was associated with only 7% risk of readmission, usually for symptom control. Emergency surgery was very rare (0.2%). Guidelines suggest that immunocompetent patients with acute uncomplicated diverticulitis can be managed in the outpatient setting if they have no significant comorbid diseases and a manageable symptom burden, can maintain oral intake, and have ready access to medical care and social support.

Despite limited evidence, bowel rest (consuming only liquids and avoiding all solid foods) is commonly recommended in the acute phase of diverticulitis. This recommendation is based on the small risk of progression to obstruction or perforation. This recommendation is reasonable in the acute setting of the hospital when surgery may be necessary, but preliminary work suggests that bowel rest may not be necessary for all patients with acute uncomplicated diverticulitis. In a small prospective cohort study, 86 patients with acute uncomplicated diverticulitis were allowed to consume an unrestricted diet. In six months of follow-up, 8% developed a serious adverse event defined as need for surgery, readmission due to pain, or recurrence. Although there was no control group, the risk of need for surgery (3%) was similar to what has been reported in other natural history studies. Anecdotally, patients have reported successfully managing mild recurrences of acute uncomplicated diverticulitis by adhering to a liquid only diet for a few days.

**Hinchey Ia diverticulitis**

Guidelines recommend that antibiotic treatment can be used selectively, rather than routinely, in immunocompetent patients with acute uncomplicated diverticulitis (Hinchey Ia) (table 1). Two randomized controlled trials and seven observational studies have shown no benefit of antibiotic treatment in patients with acute uncomplicated diverticulitis. In a meta-analysis of nine studies that included 2505 patients with acute uncomplicated diverticulitis treated with or without antibiotics, no significant difference was seen in the risk of complications, readmission, need for surgery or percutaneous drainage, or recurrence. Importantly, these studies excluded patients who were immunocompromised, patients with imaging concerning for complicated diverticulitis, and patients with any signs or symptoms of sepsis/systemic inflammatory response syndrome.

A minority of patients with uncomplicated diverticulitis will deteriorate and progress to complicated diverticulitis. Patients at risk for progression should be treated with a course of antibiotics that cover Gram negative and anaerobic bacteria. The risk of progressing from uncomplicated to complicated diverticulitis was 5% within three months in a prospective study of 1087 patients with disease confirmed by computed tomography. Risk factors for progression to any complication were American Society of Anesthesiologists score III or IV (odds ratio 4.43, 1.57 to 12.48), longer duration of symptoms (more than five days) before presentation (3.25, 1.72 to 6.13), baseline presence of vomiting (3.94, 1.96 to 7.92), and baseline C reactive protein above 140 mg/L (2.86, 1.51 to 5.43). Risk factors for progression to abscess/perforation were vomiting (odds ratio 3.53, 1.36 to 9.15), baseline C reactive protein above 140 mg/L (3.24, 1.36 to 7.91), and baseline white blood cell count above 15×10⁹ cells/L (3.66, 1.50 to 8.94). The presence of a fluid collection or longer segment of inflammation on a baseline computed tomography scan was associated with increased risk of developing complicated diverticulitis. Although paracolic extraluminal air was not associated with progression in this study, extraluminal air was associated with abscess development in another study.

**Hinchey Ib/II diverticulitis**

Smaller (<3 cm) paracolic abscesses are treated with antibiotics that cover Gram negative and anaerobic bacteria. No strong evidence is available to guide a particular antibiotic regimen, route, or duration. Antibiotic regimens for diverticulitis are numerous and are similar to what has been reported in other natural history studies. Anecdotally, patients have reported successfully managing mild recurrences of acute uncomplicated diverticulitis by adhering to a liquid only diet for a few days.
### Table 1 | Recommendations from major published guidelines on diverticulitis

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Imaging to make diagnosis</th>
<th>Colonoscopy to rule out malignancy</th>
<th>Antibiotics for uncomplicated diverticulitis in immunocompetent patients</th>
<th>Medical therapy for recurrence prevention</th>
<th>Prophylactic resection for recurrent uncomplicated diverticulitis in immunocompetent patients</th>
<th>Prophylactic resection for complicated diverticulitis successfully managed non-operatively in immunocompetent patients</th>
<th>Prophylactic surgery in immunocompromised patients</th>
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<tr>
<td>Germany, DGVS/DGAV, 2015 &lt;sup&gt;26&lt;/sup&gt;</td>
<td>Imaging should be performed, first US followed by CT in uncertain situations or complicated disease</td>
<td>Colonoscopy after conservative treatment of diverticulitis is recommended</td>
<td>Antibiotic therapy is not necessary</td>
<td>No recommendation</td>
<td>Surgery should be performed after individual case evaluation</td>
<td>Surgery in inflammation-free interval is recommended</td>
<td>No recommendation</td>
</tr>
<tr>
<td>Italy, SICCR, 2015 &lt;sup&gt;27&lt;/sup&gt;</td>
<td>CT is first line examination in patients presenting with symptoms suggesting diverticulitis</td>
<td>Colonic investigation is needed</td>
<td>Use on case by case basis</td>
<td>Fiber plus aminoflavone is more effective than fiber alone in preventing diverticulitis, with low therapeutic advantage</td>
<td>Decision to perform elective resection after one or more episodes of diverticulitis should be taken on case by case basis</td>
<td>No recommendation</td>
<td>No firm conclusions can be drawn</td>
</tr>
<tr>
<td>US, AGA, 2015 &lt;sup&gt;27&lt;/sup&gt;</td>
<td>No recommendation</td>
<td>Colonoscopy should be performed if high quality examination has not been recently done</td>
<td>Antibiotics should be used selectively, rather than routinely</td>
<td>Recommend against use of mesalamine; suggest against the use of aminoflavone or probiotics</td>
<td>Decision to perform elective prophylactic colon resection should be individualized</td>
<td>No recommendation</td>
<td>No recommendation</td>
</tr>
<tr>
<td>International, WSES, 2020 &lt;sup&gt;28&lt;/sup&gt;</td>
<td>Recommend selective imaging in patients with left lower quadrant abdominal pain, absence of vomiting, CRP &gt; 50 mg/L, and/or history of diverticulitis. Modality of choice is CT; alternatively, US at centers with expertise</td>
<td>Recommend against routine colonoscopy after successfully treated uncomplicated acute diverticulitis, unless high risk features are present</td>
<td>Trial of non-antibiotic therapy can be considered with appropriate follow-up</td>
<td>Use of mesalamine does not prevent recurrent diverticulitis, or improve chronic gastrointestinal symptoms; role of rifaximin, probiotics, and fiber is less well defined</td>
<td>Recommend elective resection in patients with symptomatic diverticular disease that is negatively affecting quality of life</td>
<td>Recommend surgery should not be routinely offered solely to avoid future episodes after single episode of successfully treated Hinchey I/II acute diverticulitis</td>
<td>Recommend early elective resection surgery</td>
</tr>
<tr>
<td>US, ASCRS, 2020 &lt;sup&gt;29&lt;/sup&gt;</td>
<td>CT is most appropriate initial imaging modality in assessment of suspected diverticulitis</td>
<td>In CT proven uncomplicated diverticulitis treated non-operatively, routine colonoscopy is not recommended. In diverticular abscesses treated non-operatively, early colonoscopy (4-6 weeks) is suggested</td>
<td>Recommend not to prescribe antibiotic therapy</td>
<td>No recommendation</td>
<td>No recommendation</td>
<td>After successful non-operative treatment of diverticular abscess, elective resection should typically be considered</td>
<td>Recommendation to offer sigmoid colectomy after recovery from uncomplicated acute diverticulitis in immunocompromised patients should be individualized</td>
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<td>European, ESGE, 2020 &lt;sup&gt;30&lt;/sup&gt;</td>
<td>Imaging is needed to confirm diagnosis if no previous diagnostic information. CT is recommended as first line investigation in suspected diverticulitis</td>
<td>Endoscopic follow-up remains controversial and may not be necessary for patients with symptom-free recovery after single episode of CT verified uncomplicated diverticulitis. All other patients treated without resection for acute diverticulitis should be followed up with examination of colon at least 6 weeks after episode, if not done within previous 3 years</td>
<td>Patients with acute uncomplicated diverticulitis do not need antibiotics routinely. Antibiotic treatment should be reserved for immunocompromised patients and patients with sepsis</td>
<td>Neither mesalamine, rifaximin nor probiotics can be recommended to prevent recurrent diverticulitis or persistent complaints after episode of acute diverticulitis</td>
<td>Goal of elective surgery after one or more episodes of diverticulitis is to improve QoL. Indication should be individualized and based on frequency of recurrences, duration and severity of symptoms after attacks, and comorbidity of patient. Elective surgery to prevent complicated disease is not justified</td>
<td>Decision to operate on patients after conservatively managed episode of acute complicated diverticulitis should follow same principles as for patients with uncomplicated diverticulitis, resection is not recommended routinely</td>
<td>Decision to offer sigmoid colectomy after recovery from uncomplicated acute diverticulitis in immunocompromised patients should be individualized</td>
</tr>
</tbody>
</table>

AGA=American Gastroenterological Association; ASCRS=American Society of Colon and Rectal Surgeons; 5-ASA=5-aminosalicylic acid; CRP=C-reactive protein; CT=computed tomography; DGAV=German Society of General and Visceral Surgery; DGG=German Society of Digestive and Metabolic Diseases; ESGE=European Society for Endoscopic Surgery; ESCP=European Society of Coloproctology; MR=magnetic resonance imaging; NRS=Netherlands Society of Surgery; QoL=quality of life; SAGES=American Society of Gastrointestinal Endoscopic Surgeons; SICCR=Italian Society of Colorectal Surgery; US=ultrasound; WSES=World Society of Emergency Surgery.
percutaneous drainage is limited. If this fails, surgery is necessary. In a retrospective cohort study of 447 patients with diverticulitis with abscess formation (Hinchey Ib and II) managed non-operatively with antibiotics with or without percutaneous drainage, 9% needed emergency surgery within 30 days of presentation. During this time, 5.6% developed a complication (defined as obstruction, perforation, or fistula), 21% had clinical deterioration/disease progression, and 14% had “persistent” diverticulitis. A cut-off size of 5 cm predicted need for emergency surgery within 30 days of presentation. Percutaneous drainage did not reduce the risk of treatment failure or emergency surgery.

**Hinchey III/IV diverticulitis**

Acute diverticulitis with purulent or feculent contamination of the peritoneal cavity is almost always managed with surgery and antibiotics. Although a Hartmann’s procedure (resection of sigmoid colon with formation of end colostomy) is most often used, robust evidence from four randomized clinical trials shows that colon resection is most often used, robust evidence from four randomized clinical trials shows that colon resection with a primary anastomosis (with or without diverting ileostomy) is associated with better outcomes. In a meta-analysis of the four trials comparing primary anastomosis with Hartmann’s procedures, patients who had a primary anastomosis were more likely to not have a stoma at 12 months after surgery (risk ratio 1.34, 1.16 to 1.54) compared with those who had a Hartmann’s procedure. Less than a third of patients undergo colostomy reversal within one year of a Hartmann’s procedure, and having a colostomy is a substantial detriment to quality of life. Take down surgery to reverse the stoma after primary anastomosis with ileostomy had a reduced risk (risk ratio 0.23, 0.07 to 0.70) of a major postoperative complication compared with take down surgery for a Hartmann’s procedure. No difference was found between the groups in major postoperative complications (risk ratio 0.88, 0.59 to 1.32) or postoperative mortality (0.84, 0.34 to 2.08). In a decision analysis considering surgical risk and quality of life, colon resection with a primary anastomosis provided greater quality adjusted life years for patients with Hinchey III diverticulitis compared with Hartmann’s procedure or laparoscopic lavage. In stable patients with Hinchey III and IV diverticulitis, primary resection and anastomosis is the procedure of choice.

**Smoldering diverticulitis**

A typical course of diverticulitis resolves within a few weeks, but chronic or smoldering diverticulitis, defined as diverticulitis that persists for weeks to months, has been reported. This includes patients who improve somewhat or almost completely and then relapse quickly after stopping antibiotics. This is in contrast to recurrent diverticulitis, in which patients tend to have a clear interval free from symptoms and inflammation. A small prospective study of patients who had elective segmental colectomy found that 41% of patients with “resolved” acute uncomplicated diverticulitis had a macroscopic or microscopic diverticular abscess on histology. In a small trial of elective surgery for patients with recurrent diverticulitis and/or ongoing complaints, 51% had diverticular inflammation and 9% had an abscess or covered perforation on histology. This work suggests that ongoing inflammation can be missed on imaging and that smoldering diverticulitis may be more common than previously recognized. No evidence is available to guide the management of smoldering diverticulitis. In clinical practice, patients with smoldering diverticulitis are treated with a course of antibiotics that cover Gram negative and anaerobic bacteria. A prolonged course of antibiotics is often necessary, and segmental resection is sometimes needed for persistent disease.

**Ongoing symptoms after an episode of acute diverticulitis**

Ongoing gastrointestinal symptoms are common after recovery from the acute phase of diverticulitis. In a nested case-control study with 2204 patients, patients with diverticulitis were 4.7 (95% confidence interval 1.6 to 14.0) times more likely to receive a diagnosis of incident irritable bowel syndrome over nine years of follow-up compared with controls. In another study, at one year follow-up after a diagnosis of acute uncomplicated diverticulitis confirmed by computed tomography, 25% of patients reported mild abdominal pain, 20% reported moderate to severe abdominal pain, and 33% reported altered bowel habits (fig 2). Compared with the general population, the prevalence of chronic gastrointestinal symptoms in patients who have recovered from diverticulitis is significantly higher than expected. Ongoing symptoms after an episode of diverticulitis should not be termed symptomatic uncomplicated diverticular disease; this is a non-specific term. The differential diagnosis for chronic gastrointestinal symptoms after an episode of diverticulitis is broad. Repeat imaging and colonoscopy are often necessary to rule out ongoing inflammation or a misdiagnosis. Delayed complications such as a diverticular stricture or fistulizing disease should be considered. Ongoing symptoms in the setting of otherwise normal laboratory values, imaging, and colonoscopy are a detriment to patients’ quality of life. Unfortunately, ongoing symptoms do not always improve with surgery. After colectomy, chronic gastrointestinal symptoms persisted in 22-25% of patients. Preliminary evidence suggests that patients with a history of diverticulitis have visceral hypersensitivity in association with low grade mucosal inflammation and alterations in neuropeptide receptor expression. Another preliminary study of patients with a history of diverticulitis found evidence of damage to the enteric nervous system with reactive remodeling of enteric ganglia, nerves, and interstitial cells of Cajal. In the setting of an otherwise normal work-up including imaging and colonoscopy, these
patients often benefit from a management strategy specific to visceral hypersensitivity, similar to that for post-infectious irritable bowel syndrome, with a low to modest dose of a tricyclic antidepressant.115

**Counseling patients after recovery from acute diverticulitis**

After recovery from an acute episode of diverticulitis, patients are at risk for recurrent episodes. Recurrent diverticulitis affects a person’s physical, social, and psychological health. In a qualitative research study, patients with a history of diverticulitis reported disease-associated anxiety, embarrassment, isolation, and lack of control. They also described avoiding social engagements, missing work, and restricting their diet.116 As misinformation about diverticulitis is common, all patients should be counseled on the prognosis, risk factors, and prevention strategies for diverticulitis to ensure that they are well informed.79

**Diet and lifestyle**

Compelling evidence shows that high quality diet, physical activity, not smoking, and a normal body mass index are associated with a reduced risk of incident diverticulitis. Multiple guidelines recommend encouraging patients with a history of diverticulitis to maintain or adopt a healthy diet and lifestyle. However, patients with a history of diverticulitis do not need to avoid nut, corn, and popcorn consumption.117 In a prospective cohort study, regular consumption (at least twice a week) of nuts (hazard ratio 0.80, 0.63 to 1.01) or popcorn (0.72, 0.56 to 0.92) was associated with a reduced risk of diverticulitis compared with infrequent consumption (less than once a month).117

**Non-steroidal anti-inflammatory drugs**

Regular use (at least twice a week) of aspirin or non-steroidal anti-inflammatory drugs is associated with increased risk of diverticulitis. Guidelines recommend that non-steroidal anti-inflammatory drugs should be avoided in patients with a history of diverticulitis.72 Patients with recurrent diverticulitis who take aspirin for primary prevention of cardiovascular disease can consider avoiding this drug after weighing the potential risks and benefits with their primary care provider.

**Medical treatment**

No medical therapies are available to prevent recurrent episodes of diverticulitis. 5-aminosalicylic acid (5-ASA) is an anti-inflammatory drug used for the treatment of ulcerative colitis. A meta-analysis of seven randomized controlled trials with 1805 participants found no evidence of an effect when comparing 5-ASA versus control for prevention of recurrent diverticulitis (31% vs 30%; risk ratio 0.69, 0.43 to 1.09).118 No evidence supports the use of any probiotic or cyclic rifaximin to prevent diverticulitis.78 119 Guidelines generally agree that treatment with 5-ASA, rifaximin, or probiotics to reduce the risk of recurrent diverticulitis is not recommended (table 1).6 72 86

**Prophylactic surgery**

Prophylactic segmental colon resection reduces the risk of recurrent diverticulitis. Resection has often used to treat a persistent abscess, stricture, or fistula. Treatment should not be confused with resection for prevention of recurrence. The three indications for prophylactic surgery are reviewed in box 2.

**Immunocompetent patient with recurrent uncomplicated diverticulitis**

Historically, the goal of elective surgery in this population was to prevent emergency surgery. This is no longer the goal. The risk of emergency surgery is highest with the initial presentation of diverticulitis.121 Guidelines recommend that the decision to have elective, prophylactic resection be individualized to consider severity of disease, general health status, and patient’s preferences and values, as well as benefits and risks (table 1).6 72 76 83 86-88

**Benefits**—A segmental colectomy reduces the risk of recurrent diverticulitis. Because only a section of colon is removed with this surgery, elective resection for diverticulitis is not a cure, and recurrent diverticulitis remains a risk. Using claims based data in a commercially insured population, the rate of recurrent diverticulitis at five year follow-up was found to be 61% in patients managed conservatively compared with 15% in patients who had elective surgery.121 Although evidence is limited, elective surgery may benefit quality of life and chronic gastrointestinal symptoms compared with non-operative management. In a systematic review and meta-analysis of 21 low quality studies that included 1858 patients, those who had surgery had higher quality of life scores and a lower proportion had gastrointestinal symptoms compared with those who did not have surgery.120 The first randomized controlled trial comparing elective surgery with conservative management for patients with recurrent or persistent complaints after an episode of left sided diverticulitis (DIRECT trial) was published in 2017.122 The trial randomized 109 generally healthy patients with a history of Hinchey I or II diverticulitis. At six month follow-up, the gastrointestinal quality of life index score was significantly higher in patients randomized to surgery (mean score 114) than in those managed without surgery (mean score 100; mean difference 14, 95% confidence interval 7 to 21). A difference of 10 or more is considered clinically important. Among patients randomized to non-operative management, 46% ultimately had surgery. At five year follow-up in an intention to treat analysis, general quality of life, mental and physical health, and pain also significantly improved. The gastrointestinal quality of life index score also remained higher in patients randomized to surgery (mean score 118) compared with those managed without surgery (mean score 109; mean difference 10, 2 to 18).109 Importantly, in two other studies, chronic gastrointestinal symptoms persisted in 22-25% of patients after colectomy.87 112

**Risks**—Although surgery will reduce the risk of recurrence and potentially improve chronic...
Box 2: Indications for prophylactic resection

Prophylactic resection for diverticulitis requires shared decision making between patient and physicians. This discussion should include disease severity, general health status, and the patient’s preferences and values, as well as benefits and risks. The three indications for prophylactic resection are as follows.

1) Immunocompetent patient with recurrent uncomplicated diverticulitis
- Resection should not be considered before the third episode of uncomplicated diverticulitis, as the risks of resection are too high.120
- Surgical resection should not be considered to prevent urgent surgery or colostomy, as those risks are very low.
- After a third episode of uncomplicated diverticulitis, patients should understand that they have two options: they can have surgery to prevent more episodes or they can continue to manage recurrent episodes without surgery.6 83 84 86
- The risk of recurrent diverticulitis at five year follow-up is 61% in patients managed without surgery compared with 15% in patients who have an elective resection.121
- An important factor in deciding whether to have prophylactic surgery for diverticulitis is how much recurrent episodes bother the patient. Diverticulitis episodes are unpredictable, and the effect of this uncertainty on day-to-day life is important to consider. Some evidence suggests that surgery improves quality of life.122

2) Immunocompetent patient with complicated diverticulitis successfully managed non-operatively
- Some guidelines recommend prophylactic resection with the singular goal of preventing a complicated recurrence, whereas others recommend individualized decision making.6 83 84 86
- The risk of recurrent diverticulitis at three year follow-up is 32% in patients with complicated diverticulitis managed without surgery compared with 8% in those who have an elective resection.6
- Of patients with Hinchey Ib/II diverticulitis initially managed successfully without surgery, 5% will go on to have emergency surgery or to die from diverticulitis over five years of follow-up. Interval prophylactic resection does not decrease this risk.29
- The most common surgery is a segmental resection of the colon with primary anastomosis. In some cases, a temporary diverting stoma (ileostomy) is necessary to protect the colorectal anastomosis while it heals. A second operation is performed weeks later to take down or remove the stoma.
- The major risks of surgery include infection, need for repeat operation, development of scar tissue in the abdomen, abdominal wall hernia, and rarely death.123 These risks are higher in older adults and those patients who are frail or have comorbidities.

3) Immunocompromised patient with diverticulitis successfully managed non-operatively
- Some guidelines recommend prophylactic resection with the singular goal of preventing a complicated recurrence, whereas other guidelines recommend individualized decision making.6 83 84 86
- Patients who are immunosuppressed have an increased risk of death from diverticulitis compared with patients who are immunocompetent.53 Evidence by immunosuppression type is limited.
- Evidence on prognosis after successful non-operative management of diverticulitis in patients who are immunocompromised is limited. Therefore, the benefits of prophylactic resection in this population are uncertain.
- The major risks of surgery include infection, need for repeat operation, development of scar tissue in the abdomen, abdominal wall hernia, and rarely death. The risks of surgery are higher in patients who are immunocompromised than in immunocompetent patients.

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gastrointestinal symptoms, this comes at the cost of risk of surgical complications. The risks of elective surgery are well described. Using data from a national surgical quality improvement program, 2.4% of patients who had an elective surgery for recurrent uncomplicated diverticulitis experienced an anastomotic leak, 16.5% had a surgical site infection, 2.5% had an unplanned return to the operating room, and 0.2% died within 30 days.123

**Timing**—When to offer a patient with recurrent diverticulitis an elective surgery is unknown. In a decision analysis comparing colonic resection with conservative management for patients with recurrent diverticulitis, elective surgery after two episodes of diverticulitis was associated with the highest chance of stoma formation and lowest quality adjusted survival.120 This was primarily driven by the mortality risk related to surgery. Elective surgery and conservative management were comparable after the third episode of diverticulitis. These results suggest that prophylactic surgery should not be considered until after a third episode of uncomplicated diverticulitis. 

**Immunocompetent patient with complicated diverticulitis successfully managed non-operatively**

Patients with a history of complicated diverticulitis successfully managed without surgery are at increased risk of recurrence and complicated recurrence. Some guidelines recommend resection after recovery from complicated diverticulitis to prevent a complicated recurrence and possible urgent surgery, whereas more recent guidelines have recommended a more individualized approach (table 1).6 83 84 86 In a population based study of patients with complicated diverticulitis successfully managed non-operatively, 5% went on to have emergency surgery or to die from diverticulitis over 4.5 years...
of follow-up. Importantly, interval elective resection did not decrease this risk (odds ratio 0.98, 0.81 to 1.19).29 Given these findings, prophylactic surgery should not be automatically recommended to this population with the goal of preventing emergency surgery or death from diverticulitis. In a randomized trial of elective resection versus observation in diverticulitis with extraluminal air or abscess initially managed conservatively, observation was associated with a low risk of recurrence.7 Within three years of follow-up, 8% in the surgery group had a recurrence compared with 32% in the observation group. All recurrences were managed without surgery.

**Immunocompromised patient with diverticulitis successfully managed non-operatively**

Some guidelines recommend that immunocompromised patients with a history of diverticulitis successfully managed non-operatively should consider prophylactic colon resection, whereas others recommend individualized decision making (table 1).6 83 84 86 The goal of surgery in this population is to prevent complicated recurrence. Patients who are immunosuppressed have an increased risk of complicated diverticulitis and an increased risk of death from perforated diverticulitis.51 53 Unfortunately, evidence on prognosis after successful non-operative management of diverticulitis in patients who are immunocompromised is limited. The risk likely differs by type of immunosuppressant drug and condition, but most evidence is for patients receiving corticosteroids. In the setting of an elective segmental resection for diverticulitis, patients who are immunosuppressed have an increased risk of postoperative morbidity (odds ratio 1.5, 1.17 to 1.83) compared with patients who are immunocompetent.124

**Emerging therapies**

Multiple studies of diverticulitis are under way. A trial is comparing the risk of readmission in patients with mild diverticulitis treated with antibiotics versus no antibiotics (clinicaltrials.gov NCT02785549). Another trial is evaluating the safety and efficacy of rifaximin versus placebo for the prevention of recurrent diverticulitis(NCT03469050). A prospective study is assessing whether biomarkers can predict recurrent diverticulitis and ongoing symptoms (NCT04407793). Investigators are determining the role of genes in diverticulosis (NIH R01DK094738) and diverticulitis (NIH K08DK124687). A prospective cohort study is examining the role of diet, lifestyle, and the gut microbiome/metabolome in incident and recurrent diverticulitis (NIH R01DK101495). A trial in patients with a history of diverticulitis is comparing the effect of placebo or probiotic on gut microbiota composition and function, gastrointestinal transit and permeability, and symptoms (NCT03742076). The DEBUT study is determining how doctors and patients make the decision to offer or have elective surgery for diverticulitis (NCT02776787). The COSMID trial is a pragmatic, patient level randomized superiority trial of elective colectomy versus best medical management for patients with quality of life limiting diverticular disease (NCT04095663). The FRESCO trial aims to understand the effect of elective surgery on bowel function and quality of life in patients with recurrent uncomplicated diverticulitis (NCT03994978). The estimated dates of completion for these studies are within the next five years.

**Guidelines**

Multiple national and international guidelines on the management of diverticulitis have been published and are referenced throughout this review (table 1). Most guideline developers performed a systematic review of the literature and assessed the quality of evidence by using Grade of Recommendation, Assessment, Development, and Evaluation (GRADE) methodology.5 72 78 83 86 88 The German and European Society of Coloproctology guidelines were consensus based.76 84 The guidelines all generally recommend that a diagnosis should be confirmed with imaging, that immunocompetent patients should be managed without antibiotics, and that the decision to recommend prophylactic colectomy in an immunocompetent patient after uncomplicated diverticulitis should be individualized. Some of the guidelines recommend that immunocompromised patients may benefit from early resection, whereas the two most recent guidelines recommend a more individualized approach. The guidelines do not agree on whether a colonoscopy should be performed after non-operative management of diverticulitis to rule out malignancy.

**Conclusion**

Colonic left sided diverticulitis is a common and costly gastrointestinal disease in Western countries. No definitive cure or identified means of prevention exists. Patients with diverticulitis have a painful and unpredictable disease that forces many to consider whether they may need major surgery. Until recently, we blamed this disease on dietary indiscretion and told our patients that the natural history was catastrophic. Thankfully, we now appreciate that multiple factors contribute to risk of diverticulitis and that the prognosis is not usually so dire.

Although management of diverticulitis is increasingly evidenced based, an urgent need to study this complex disease remains. The pathogenesis of diverticulitis is poorly understood and is more complicated than stool abrading the wall of a diverticulum. The prognosis for diverticulitis needs to be better defined, particularly in patients who are immunosuppressed and in those with a history of complicated diverticulitis managed non-operatively. Inadequate evidence exists to guide physicians and their patients through the decision to consider prophylactic surgery. The genetics of this disease need to be studied with a granular approach specific to each manifestation.
These gaps in our understanding are fundamental barriers to better treatment and prevention. The incidence of diverticulitis will likely continue to rise with increasing obesity and aging Western populations. Although recent research gives us more to offer patients with diverticulitis, the field of diverticulitis is several decades behind those of most common gastrointestinal diseases. Hopefully, ongoing studies and increased research funding can answer the many questions that remain.

**SUMMARY OF MANAGEMENT OF DIVERTICULITIS**

**Diagnosis**
- In patients presenting with suspected acute diverticulitis, an abdominal computed tomography scan should be performed to confirm the diagnosis, to determine the severity of disease, and to rule out an alternative diagnosis. This is most important for the first presentation and less important for a stereotypical mild recurrence.
- A step-up approach with computed tomography performed after an inconclusive or negative ultrasound scan may be considered in centers with expertise in ultrasonography; computed tomography performs better in obese patients and is better able to assess the distal sigmoid colon, which is difficult to visualize with transabdominal ultrasonography.
- Colonoscopy should be performed six to eight weeks after a diagnosis of complicated diverticulitis or first episode of uncomplicated diverticulitis; in the absence of alarm symptoms, a colonoscopy does not need to be repeated if a high-quality examination has been performed in the previous year. Patients with recurrent uncomplicated diverticulitis and no alarm symptoms should follow routine colorectal cancer screening and surveillance intervals.
- Ongoing gastrointestinal symptoms are common after recovery from the acute phase of diverticulitis, and alternative diagnoses should be considered. The diagnostic approach for chronic gastrointestinal symptoms is broad. Repeat imaging and colonoscopy is often necessary to rule out a misdiagnosis or ongoing inflammation.

**Treatment**
- Antibiotic treatment is not necessary in healthy, immunocompetent patients who present with mild acute uncomplicated diverticulitis. Patients with acute uncomplicated diverticulitis who have comorbidities or are frail, who present with refractory symptoms or vomiting, or who have a C reactive protein concentration above 140 mg/L or baseline white blood cell count above 15×10⁹ cells/L are at higher risk for developing a complication, and treatment with antibiotics should be considered.
- Patients who are immunosuppressed have an increased risk of mortality from diverticulitis and should always be treated with antibiotics.
- Small (<3 cm) paracolic abscesses can be treated with antibiotics. Larger abscesses are treated with percutaneous drainage and antibiotics. If this fails, surgery is necessary.
- In stable patients with Hinchey III and IV diverticulitis, primary resection and anastomosis is the procedure of choice.

**Prevention**
- Patients with a history of diverticulitis should understand that a high quality diet, physical activity, not smoking, and a normal body mass index are associated with a reduced risk of diverticulitis.
- Patients with a history of diverticulitis should avoid regular use of non-steroidal anti-inflammatory drugs.
- Patients with a history of diverticulitis do not need to avoid nut, corn, and popcorn consumption.
- 5-aminosalicylic acid, probiotics, and rifaximin should not be used to prevent recurrent diverticulitis.
- The decision to undergo prophylactic colon resection should be individualized to consider severity of diverticulitis, general health and immune status, patient’s preferences and values, and benefits and risks (box 2).

**RESEARCH QUESTIONS**
- What is the pathophysiology of diverticulitis? What factors are associated with recurrent diverticulitis and complicated recurrence?
- How can we effectively treat uncomplicated diverticulitis? Does percutaneous drainage improve outcomes in patients with an abscess? How can we prevent recurrent diverticulitis without surgery?
- Which patient populations benefit from an elective segmental resection?
- Why do patients with quiescent diverticulitis have ongoing gastrointestinal symptoms? How can these symptoms be effectively managed?

**PATIENT INVOLVEMENT**

Three patients with diverticulitis reviewed the manuscript and provided constructive feedback on treatment and prevention.

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**Contributors:** AP reviewed the literature and wrote this review. She is the guarantor.

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The image contains a page of a document discussing the State of the Art Review on acute diverticulitis. The text is a review of various studies and research findings related to acute diverticulitis, including antibiotic treatment, risk factors, and patient outcomes. The references cited are from studies published in journals such as *Clinical Gastroenterology and Hepatology*, *Gastroenterology*, and *Annals of Surgery*. The document highlights the importance of considering risk factors, such as age, sex, and the role of diet, in the management of acute diverticulitis. It also mentions the use of antibiotics in uncomplicated acute diverticulitis and the potential for complications. The text is a synthesis of various studies, indicating the evolving understanding of this condition and the need for continued research. The page includes numerous references to support the review, indicating a comprehensive approach to the topic.


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Dis Colon Rectum 2008;51:1044-5. doi:10.1097/DCR.0b013e3282f9e3e2


