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Current Options for the Emergency Management of Diverticular Disease and Options to Reduce the Need for Colostomy

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Abstract

This article reviews the current options and recommendations for the emergency management of acute diverticulitis, including the spectrum of antibiotics, percutaneous drainage, laparoscopic lavage, and surgical options for resection with the restoration of bowel continuity.

Keywords

- perforated diverticulitis
- peritonitis
- laparoscopic lavage
- resection

Most patients with acute diverticulitis respond to nonoperative treatment; however, up to 25% require urgent operative intervention.[1] Acute diverticulitis ranges in severity from uncomplicated inflammatory diverticulitis to complicated diverticulitis (abscess formation or free perforation). Hinchey et al introduced in 1978 a classification of the severity of acute complicated diverticulitis based on intraoperative findings of abscesses and peritonitis (►**Table 1**).[2] In the context of the Hinchey's classification, uncomplicated diverticulitis has been regarded as stage 0. The use of computed tomography (CT) as a primary diagnostic tool in patients with acute diverticulitis has led to several modifications of the Hinchey's staging as well as new classifications.[3–8] Nevertheless, the Hinchey's classification remains the one most widely used in the literature and everyday clinical practice.

Acute Uncomplicated Diverticulitis

Patients with acute uncomplicated diverticulitis (AUD) diagnosed by CT can be treated either in the outpatient or the inpatient setting.[9,10] The DIVER trial, a prospective, multicenter randomized controlled trial of 132 patients with AUD treated either in the hospital or the outpatient setting reported no difference in treatment failure rates between the two groups.[11] All patients received the first dose of antibiotics intravenously in the emergency department. The overall health care cost per episode was three times lower in the outpatient group.

Oral antibiotics used for outpatient management of diverticulitis must cover gram-negative rods and anaerobes, particularly *Escherichia coli* and *Bacteroides fragilis*. Commonly used regimens are ciprofloxacin or trimethoprim-sulfamethoxazole plus metronidazole, amoxicillin-clavulanate, and moxifloxacin (in patients intolerant of both metronidazole and β-lactam agents). The patients should follow a clear liquid diet and have a subsequent reevaluation in 2 to 3 days.

There is growing evidence supporting nonuse of antibiotics, and instead for supportive care in patients with AUD. The theory is that uncomplicated diverticulitis may be a self-limiting primary inflammatory condition in which local host defenses can manage the disease without antibiotics in immunocompetent patients, making antibiotics unnecessary. Evidence includes two retrospective case–control studies,[12,13] two prospective studies,[14,15] and one multicenter randomized trial.[16] Their results argue that symptomatic treatment of uncomplicated diverticulitis without antibiotics is safe and effective, with reported complication rates of approximately 2%. A recent systematic review concluded that confirmation from more randomized controlled trials is needed on the safety of nonantibiotic treatment of AUD before it can be implicated into clinical guidelines.[17] Overall, the nonantibiotic treatment for AUD has not been yet widely adopted in the clinical setting. However, guidelines from the World Society of Emergency Surgery (WSES),[18] the Danish Surgical Society,[19] and the Netherlands Surgical Society[20]

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Table 1 Hinchey's stages of acutely complicated diverticulitis[2]

Stage I	Pericolic or mesenteric abscess
Stage II	Pelvic, intra-abdominal, or retroperitoneal abscess
Stage III	Generalized purulent peritonitis
Stage IV	Generalized fecal peritonitis

already advise that antimicrobial therapy can be avoided in immunocompetent patients with AUD without systemic manifestations of infection.

Reasons for hospital admission for a patient with AUD include high fever, severe abdominal pain, inability to tolerate oral intake, significant leukocytosis, significant comorbidities, failure of outpatient treatment, and social considerations. Advanced age (>75 years) has been considered a reason for hospitalization.[21] However, a recent prospective study evaluated 52 patients older than 70 years with AUD; 34 patients were treated at home and 18 in the hospital. Mean age was similar in both groups (77 vs. 79). All patients in the outpatient group were treated successfully at home, and the study concluded that treatment at home of elderly patients with uncomplicated diverticulitis is as safe and effective as treatment in hospital, even in case of comorbidities.[22]

Intravenous Antibiotics

Patients with acute diverticulitis requiring hospitalization need to be treated with intravenous antibiotics covering gram-negative rods, anaerobic organisms, and enteric gram-positive Streptococci.[23] The choice of antibiotics is dictated by the severity of the disease (mild-to-moderate vs. severe), the patient's risk factors (i.e., whether they are at high risk for adverse outcomes or antimicrobial resistance), and whether this is a community- versus hospital-acquired infection. ►**Tables 2** and **3** discuss the options for antibiotic coverage based on the above groups.[24] The different antibiotic regimens have shown similar efficacy.[25]

Notably, clindamycin and cefotetan are no longer considered acceptable options for intra-abdominal infections involving anaerobes, because of increasing rates of resistance in the *B. fragilis* group.[24] Also, ampicillin-sulbactam is not recommended due to high levels of resistance among community-acquired *E. coli*. Empiric coverage of *Enterococcus* is not necessary for patients with low-risk community-acquired intra-abdominal infection, whereas it is recommended in patients with high-risk community-acquired infection. In the latter group, and because quinolone-resistant *E. coli* have become common in some communities, quinolones should not be used unless hospital surveys indicate > 90% susceptibility of *E. coli* to quinolones. Aztreonam plus metronidazole is an alternative, with the addition of an agent effective against gram-positive cocci. Newer antibiotics, such as the novel cephalosporin ceftolozane-tazobactam, have also emerged in the treatment of resistant bacteria.

If an abscess is drained percutaneously, cultures should be sent, and the antibiotic regimen should be targeted to the susceptibility results, in the interest of antibiotic stewardship. However, if a patient with a low-risk community-acquired infection is improving clinically, later identification of non-covered pathogens most likely does not warrant alteration of the antibiotic regimen.[24]

Typically the patients show improvement after 2 to 3 days of intravenous antibiotics. Failure to improve may signify the development of an abscess or other complications and should prompt repeat imaging.

Table 3 Antibiotic regimens for the initial empiric treatment of health care-associated acute diverticulitis requiring hospitalization

Health care-associated infections	
Single agent	Imipenem-cilastatin, meropenem, doripenem, piperacillin-tazobactam
Combination regimen	Cefepime or ceftazidime, each in combination with metronidazole, plus ampicillin, or vancomycin

Note: Ampicillin or vancomycin is added to a cephalosporin-based regimen to provide enterococcal coverage, particularly in those with postoperative infection, prior use of antibiotics that select for Enterococcus, immunocompromising condition, valvular heart disease, or prosthetic intravascular materials.[24]

Acute Complicated Diverticulitis

Diverticular Abscess

Approximately 15 to 20% of patients admitted with acute diverticulitis have an abscess on CT scan.[26] Percutaneous drainage is typically performed for abscesses equal or larger than 4 cm that is amenable to this approach, using either CT or ultrasound guidance.[27] Most abscesses are drained through the anterior abdominal wall. Abscesses deep in

Table 2 Antibiotic regimens for the initial empiric treatment of community-acquired acute diverticulitis requiring hospitalization

Community-acquired infection		
	Mild-to-moderate severity	High risk or severity
Single agent	Cefoxitin, ertapenem, moxifloxacin, tigecycline, ticarcillin-clavulanic acid	Imipenem-cilastatin, meropenem, doripenem, piperacillin-tazobactam
Combination regimen	Cefazolin, cefuroxime, ceftriaxone, cefotaxime, ciprofloxacin, or levofloxacin, each in combination with metronidazole	Cefepime, ceftazidime, ciprofloxacin, or levofloxacin, each in combination with metronidazole

Note: For low-risk community-acquired cases, the antibiotics need to cover *Streptococci*, *Enterobacteriaceae*, and anaerobes. For empiric therapy of high-risk community-acquired infections, the antibiotics also need to cover Enterobacteriaceae resistant to third-generation cephalosporins, and *Pseudomonas aeruginosa*.[24]

the pelvis may require drainage via a transgluteal approach; these drains typically produce discomfort during bed rest and ambulation. A transrectal or a transvaginal approach are also options for drainage of pelvic abscesses.[28] A transrectal drain may render a future colon resection with pelvic anastomosis challenging; collaboration and communication between the consulting surgeon and the interventional radiologist are important before the placement of such drain.

In the case of a resilient diverticular abscess, a recent retrospective study recommended limiting the percutaneous drainage procedures (not including readjustment or upsizing of the drain) to two attempts to control the abscess before proceeding with definitive surgery.[29] Once a drainage catheter is placed, it is left in place until the output is less than 10 mL in 24 hours. The patient is typically followed with CT and drain contrast studies to ensure resolution of the abscess cavity and rule out ongoing communication with the bowel.

Diverticular abscesses that are smaller than 4 cm are typically treated successfully with antibiotics alone. Abscesses larger than 4 cm that are not amenable to percutaneous drainage can also be initially treated with antibiotics as long as the patient does not show signs of systemic toxicity.[30] Careful clinical monitoring and repeat imaging are essential in this setting. Elagili et al published in 2015 a retrospective study of the efficacy of antibiotics as the sole initial therapy for patients with a diverticular abscess.[31] The antibiotic group had a significantly smaller median abscess diameter compared with the percutaneous drainage group (4 [3–18] vs. 6.7 [3–15] cm). The initial treatment failure rates, postoperative mortality, overall morbidity, length of hospital stay, and overall and permanent stoma rates were comparable in the two groups. The authors concluded that selected patients with diverticular abscess could be safely treated with antibiotics alone without adverse consequences on their outcomes.

Colonic Obstruction

Patients who present with colonic obstruction attributable to acute diverticulitis should undergo surgical resection of the involved colonic segment.[32] Colonic obstruction due to diverticular disease is rarely complete, and can be ameliorated by intravenous antibiotics, allowing for bowel preparation and subsequent resection with anastomosis. Alternatively, on-table lavage can be used to clean out the fecal load, which may also permit a primary anastomosis, with or without a diverting ileostomy. The use of colonic stents as a bridge to resection is an option, but it is rarely required.[33]

Acute Complicated Diverticulitis with Perforation

Studies have reported successful nonoperative management of acute complicated diverticulitis with perforation, even in the presence of pneumoperitoneum, in hemodynamically stable patients without signs of diffuse peritonitis.[34–36] Sallinen et al identified the presence of abundant distant intraperitoneal free air and fluid in the fossa of Douglas as risk factors for failure of the nonoperative management.[35] Close monitoring to identify an early failure of the nonoperative management is essential.

Patients who are hemodynamically unstable, have diffuse peritonitis or have failed nonoperative treatment are treated with emergency surgery, traditionally an open Hartmann's procedure (HP). Typically the sigmoid colon is resected down to the proximal rectum, and the rectal stump is left in the pelvis in the form of a Hartmann's pouch and marked with a long nonabsorbable suture tacked to the pelvic sidewall or sacral promontory to help identify the rectal stump at a subsequent second-stage surgery. A mucous fistula of the distal colon stump is not required as long as there any no concerns for distal obstruction of the stump. Furthermore, it is usually not possible as the entire sigmoid colon needs to be resected.

An open HP is still considered the procedure of choice in diverticulitis patients with diffuse peritonitis who are critically ill or have significant comorbidities. The mortality risk in these cases is in the range of 15 to 20%, and the morbidity is considerable and can exceed 50%.[37,38] The presence of a stoma severely affects the quality of life.[39] Many patients will never undergo reversal of an end colostomy.[40] Moreover, Hartmann's reversal carries significant comorbidity of its own.[41,42] For all these reasons, the trend in clinical practice is to avoid the creation of an end colostomy if possible, with multiple reports in the literature investigating the various techniques that enable restorative surgery.

Laparoscopic Lavage

Laparoscopic lavage (LL) without resection has gained popularity in the last decade in the treatment of acute complicated diverticulitis with purulent peritonitis (Hinchey's stage III) as a means to avoid a HP. The concept is that on some occasions, perforations have already sealed at the time of the surgery and the only intervention that seems necessary is to lavage the abdominal cavity to remove the pus. The procedure involves laparoscopic aspiration of the pus, irrigation of all four quadrants of the abdomen with saline (3 L or more) until the return of clear fluid, and placement of at least one drain in the pelvis. Adhesions at the area of the sigmoid are typically not taken down to avoid disturbing a sealed perforation. The findings of fecal peritonitis or an overt colon perforation should prompt the surgeon to perform a resection. Patients deemed to be candidates for LL need to be advised on the possibility of a resurgery if they fail to respond to the LL, or if a sigmoid carcinoma is subsequently found. They also need to be advised on the likely need for a delayed elective sigmoid resection.

There have been multiple initial reports with encouraging results, but they were small and uncontrolled, with a high risk of selection bias.[43–47] Many studies included patients with Hinchey's stage II diverticulitis treated with LL, which likely makes the results appear better given that Hinchey's stage II diverticulitis typically can be managed without surgery. A prospective, multi-institutional study from Ireland of 100 patients published in 2008 reported LL to be feasible and safe.[48] In 2013, a Dutch retrospective study of 38 patients treated with LL cautioned that patient selection and identification of an ongoing sigmoid perforation were key factors in the success of this surgery.[49] Multiple comorbidities, immunosuppression, a high C-reactive protein level and/or a high Mannheim peritonitis index were also predictors of a high risk of failure. A systematic review and meta-analysis of studies on the treatment of Hinchey's stage III and IV diverticulitis

found lower overall surgical morbidity and hospital stay for LL compared with primary resection.[50]

Three prospective trials on LL were published in the last 2 years. The LADIES trial was a multicenter randomized controlled trial in Belgium, Italy, and the Netherlands that evaluated major morbidity and mortality within 12 months after LL or sigmoidectomy for Hinchey's stage III diverticulitis.[51] The trial is split into two groups: the LOLA (LAparOscopic LAvage) group comparing LL with sigmoidectomy and the DIVA group comparing Hartmann's procedure with sigmoidectomy plus primary anastomosis. The DIVA section is still underway, but the results of the LOLA section were published in 2015. The LOLA section was stopped early at 33% of the planned sample size by the Data Safety Monitoring Board because of an increased event rate in the lavage group. A total of 90 patients were randomized in the study. The primary endpoint occurred in 30 (67%) of 45 patients in the lavage group and 25 (60%) of 42 patients in the sigmoidectomy group ($p = 0{\cdot}58$). By 12 months, the mortality rate was similar in both groups. Although LL resulted in a higher acute reintervention rate, 76% of patients were discharged without further surgery. The higher morbidity rates in the LL group did not result in excess mortality, suggesting that patients that fail lavage can be salvaged with timely reintervention. Failure to properly distinguish Hinchey's stage III from Hinchey's stage IV perforated diverticulitis and underlying colorectal cancer accounted for most of the lavage failures. The study concluded that LL is not superior to sigmoidectomy with regards to major morbidity and mortality in the treatment of purulent perforated diverticulitis. The authors postulated that optimizing the preoperative imaging may help identify the patients that are likely to fail LL and aid in patient selection.

The SCANDIV ("Scandinavian diverticulitis") trial was published shortly after; it is a randomized controlled trial of 199 patients in Sweden and Norway.[52] The study found that among patients with likely perforated diverticulitis undergoing emergency surgery, the use of LL versus primary resection did not reduce severe postoperative complications and led to worse outcomes in secondary end points. The authors concluded that their findings do not support LL for the treatment of perforated diverticulitis.

The DILALA trial "DIverticulitis—LAparoscopicLAvage versus resection (Hartman's procedure) for acute diverticulitis with peritonitis" is the most recent randomized controlled trial; it originated from nine institutions in Sweden and Denmark. A primary endpoint is a number of resurgeries within 12 months, and these results have not been published yet. The first results of the trial including short-term data within 30 days after surgery and mortality within 90 days were published in 2016.[53] A total of 83 patients found to have Hinchey's stage III diverticulitis upon initial laparoscopy were then randomized between LL and colon resection with a stoma. Morbidity and mortality were similar in the two groups. LL resulted in shorter operative time, shorter time in the recovery unit, and shorter hospital stay, with the additional benefit of avoidance of a stoma. The authors concluded that LL was a feasible and safe option in the short term in the treatment of patients with Hinchey's stage III diverticulitis.

The debate on the subject of LL continues given the discrepancy of the available randomized controlled trials and their limitations. More and adequately powered trials are needed—the LAPLAND (laparoscopic lavage for acute, non-falculant diverticulitis) trial is underway,[54] and so are the final results of the DILALA trial.[53] The additional favorable outcomes offered by LL, such as avoidance of a stoma, allowing delayed laparoscopic resection, or avoidance of further surgery need to be taken into consideration, provided that no excess mortality exists.[55] In patients treated successfully with LL, it is of utmost importance to perform a colonoscopy once the patient has recovered from the perforation, to rule out a missed colon cancer.[56]

Resection with Anastomosis

Patients with Hinchey's stage I or II diverticulitis that have failed medical management or percutaneous drainage of their abscess and require the same admission can usually tolerate a preoperative bowel preparation. Thus, if the abscess can be resected with the colonic segment, a primary anastomosis can be performed in these patients. Laparoscopic or laparoscopic-assisted sigmoid resection is frequently employed in cases of Hinchey's stage I and II diverticulitis.[57,58] Important technical considerations as in all cases of resection for the diverticular disease are that the distal margin of resection must extend to the proximal rectum, to minimize the occurrence of diverticulitis. The proximal extent of the resection must involve nonedematous colon, without thickened, hypertrophic tissue. It is not necessary to remove all diverticula-bearing colon; however, care should be taken to avoid incorporating diverticula in the proximal aspect of the anastomosis, because this will increase the risk of a leak.

The role of mechanical bowel preparation (MBP) has not been evaluated in the emergency/urgent setting. Although there is literature suggesting that bowel preparation can be safely omitted in elective surgery for diverticulitis,[59] it is unclear whether this can be extrapolated in cases of acute diverticulitis. Moreover, the overall data on MBP in elective colorectal surgery remains conflicting; a recent study of 8,442 patients based on the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP)–targeted colectomy data suggested that MBP combined by oral antibiotics reduced by nearly half the incidence of surgical site infections, anastomotic leak, and ileus after elective colorectal surgery.[60] An attempt to reduce the fecal load preoperatively if possible appears reasonable when operating on patients with acute diverticulitis.

Regarding patients with Hinchey's stage III and IV diverticulitis, several studies are reporting that resection with anastomosis is feasible and safe, with morbidity and mortality rates similar to HP.[61–65] Primary resection with anastomosis after intraoperative colonic lavage has also been reported to compare favorably to Hartmann's procedure.[66,67] All these studies though have a selection bias as evidenced by four systematic reviews.[38,50,68,69] A meta-analysis by Cirocchi et al in 2013 of 14 studies with 1,041 patients compared the different surgical treatments for Hinchey's stage III or IV stage of colon diverticulitis.[50] Primary resection with anastomosis was noted to have a significant advantage in terms of lower mortality rate and hospital stay compared with HP. However,

the authors noted a marked heterogeneity in the included studies limiting the feasibility of a meta-analysis for this disease and advised that the reported advantages of primary resection should be viewed with caution.

Primary anastomosis with proximal diversion may be the best option for selected patients with Hinchey's stage III and IV diverticulitis. Constantinides et al compared primary resection and anastomosis with or without a diverting stoma to HP for patients with Hinchey's stage III and IV diverticulitis.[70] A decision analysis was performed, and a total of 135 primary resections with anastomosis, 126 primary anastomoses with diverting stoma, and 6,619 HP were considered in the study. The primary outcome was quality-adjusted life years gained from each strategy. Factors considered were the risk of permanent stoma, morbidity, and mortality from the primary or reversal surgeries. Stomas remained permanent in 27% of HP and in 8% of primary anastomoses with diverting stoma. The study concluded that primary anastomosis with diverting stoma was the optimal strategy for patients with diverticular peritonitis, as it appeared to provide higher long-term quality of life and was a good compromise between postoperative adverse events and risk of permanent stoma. Notably, the HP had a superior quality of life when only the primary surgery was considered and in patients with high risk for complications.

Performing randomized controlled trials in the emergency setting for patients with diverticulitis with peritonitis is particularly challenging.[71] A small randomized trial of primary anastomosis with diverting ileostomy versus HP in patients with diffuse diverticular peritonitis was published by Oberkofler et al in 2012.[72] Overall, 62 patients with Hinchey's stage III and IV diverticulitis from four centers were randomized to HP ($n = 30$) and to primary anastomoses with diverting ileostomy ($n = 32$). A planned stoma reversal surgery was performed after 3 months in both groups. The study reported no difference in initial mortality and morbidity (mortality 13 vs. 9% and morbidity 67 vs. 75% in HP vs. primary anastomosis), but a reduction in length of stay, lower costs, fewer serious complications, and greater stoma reversal rates in the primary anastomosis group. Accrual to the study was stopped early because an interim safety analysis found that Hartmann reversal had significantly more severe complications compared with ileostomy reversal (20 vs. 0%). The study also demonstrated that Hartmann patients were significantly less likely to undergo stoma reversal compared with ileostomy patients (reversal rate 57 vs. 90%).

Factors favoring proximal diversion include patient and intraoperative factors, such as hemodynamic instability, acidosis, acute organ failure, and comorbidities, such as diabetes mellitus, chronic organ failure, and immunosuppression, as well as surgeon preference and experience.[73] The Cleveland Clinic developed a "diverticular disease propensity score" to preoperatively estimate the likelihood of the need for end colostomy creation in patients with acute diverticulitis.[74] Strong predictors of nonrestorative surgery included urgent or emergent cases, body mass index ≥ 30, Mannheim peritonitis index ≥ 10, immunosuppression, and Hinchey's stage III or IV.

Because of the limitations of the literature, the surgeon must decide on the creation of an anastomosis with or without a diverting stoma versus an end colostomy by taking into account the clinical condition, patient comorbidities, and weighing the risks associated with anastomotic failure, while recognizing that end colostomies created under these circumstances are often permanent.

Emergency laparoscopic sigmoid resection appears to be feasible in selected patients with Hinchey's stage III and IV diverticulitis if handled by an experienced surgeon.[75–77] A systematic review from 2015 in emergency laparoscopic sigmoidectomy for diverticulitis included four case series and one cohort study (total of 104 patients) out of 1,706 references.[78] Hartmann's procedure was performed in 84 patients and primary anastomosis in 20. The review concluded that laparoscopic sigmoidectomy in this setting is feasible, with an acceptable conversion rate, low reintervention rate, and low morbidity and mortality rates. However, the available studies report on results from selected groups of patients obtained by dedicated laparoscopic surgeons. Their results cannot as of yet be extrapolated unconditionally to the general population in less specialized hospitals.

Diversion proximal to the diverticulitis segment without resection was historically the first out of the three-stage approach for the emergency treatment of diverticulitis, having since been abandoned in favor of single or two-stage procedures. A randomized controlled trial from 2000 compared resection with suture colorrhaphy and proximal colostomy followed by secondary resection in diverticulitis with generalized peritonitis.[79] Primary resection was superior to secondary resection with significantly less postoperative peritonitis, fewer resurgeries, and shorter hospital stay. Diversion without resection should be reserved for the rare situation where the inflamed operative field is too hostile to permit resection.

Damage control surgery may be applied in the management of unstable patients with Hinchey's stage III and IV diverticulitis. It comprises of source control with limited resection of the perforation, lavage, and second-look surgery in patients presenting with hypotension, myocardial depression, and coagulopathy, who are not candidates for immediate complex surgeries. Some preliminary studies have suggested that this strategy may enhance sepsis control and improve the rate of anastomosis.[80–82]

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