

# Guidelines of Diagnostics and Treatment of Acute Left-Sided Colonic Diverticulitis

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## Key Words

Practice guideline · Treatment · Colonic diverticulitis

## Abstract

**Background:** The incidence of acute left-sided colonic diverticulitis (ACD) is increasing in the Western world. To improve the quality of patient care, a guideline for diagnosis and treatment of diverticulitis is needed. **Methods:** A multidisciplinary working group, representing experts of relevant specialties, was involved in the guideline development. A systematic literature search was conducted to collect scientific evidence on epidemiology, classification, diagnostics and treatment of diverticulitis. Literature was assessed using the classification system according to an evidence-based guideline development method, and levels of evidence of the conclusions were assigned to each topic. Final recommendations were given, taking into account the level of evidence of the conclusions and other relevant considerations such as patient preferences, costs and availability of facilities. **Results:** The natural history of diverticulitis is usually mild and treatment is mostly conservative. Although younger patients have a higher risk of recurrent disease, a higher risk of complications compared to older patients was not found. In

general, the clinical diagnosis of ACD is not accurate enough and therefore imaging is indicated. The triad of pain in the lower left abdomen on physical examination, the absence of vomiting and a C-reactive protein >50 mg/l has a high predictive value to diagnose ACD. If this triad is present and there are no signs of complicated disease, patients may be withheld from further imaging. If imaging is indicated, conditional computed tomography, only after a negative or inconclusive ultrasound, gives the best results. There is no indication for routine endoscopic examination after an episode of diverticulitis. There is no evidence for the routine administration of antibiotics in patients with clinically mild uncomplicated diverticulitis. Treatment of pericolic or pelvic abscesses can initially be treated with antibiotic therapy or combined with percutaneous drainage. If this treatment fails, surgical drainage is required. Patients with a perforated ACD resulting in peritonitis should undergo an emergency operation. There is an ongoing debate about the optimal surgical strategy. **Conclusion:** Scientific evidence is scarce for some aspects of ACD treatment (e.g. natural history of ACD, ACD in special patient groups, prevention of ACD, treatment of uncomplicated ACD and medical treatment of recurrent ACD), leading to treatment being guided by the surgeon's personal preference. Other aspects of the man-

agement of patients with ACD have been more thoroughly researched (e.g. imaging techniques, treatment of complicated ACD and elective surgery of ACD). This guideline of the diagnostics and treatment of ACD can be used as a reference for clinicians who treat patients with ACD.

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## Introduction

Left-sided diverticulosis of the colon is a common condition in Western society. The prevalence of diverticulosis coli depends on age and increases from about 5% around 40 years of age to 65% at the age of 85 years or older [1, 2]. It is estimated that approximately 25% of the patients with diverticulosis will develop an episode of acute left-sided colonic diverticulitis (ACD) [3]. Patients with acute abdominal pain due to ACD impose an impressive burden to healthcare [4]. In the past years, a dramatic rise in the number of hospitalizations for ACD has been noted in the Netherlands. In 2009, 18,355 patients were hospitalized with ACD as compared to 13,655 patients in 2006. Meanwhile, expenditures for these hospital admissions in the Netherlands exceed EUR 80 million per year [5, 6]. This rise in hospital admissions is also notable in other countries. A recent study from the United States showed an increase in hospital admissions during the period 1998–2005 of 26%, with the greatest rise in patients between 18 and 44 years of age [4]. In the Netherlands, women make up 60% of hospital admissions for ACD [6]. This difference in incidence of ACD between men and women has been noticed in other countries as well. Patients younger than 50 years of age with ACD are predominantly men, whereas in the age group of 50–70 years there seems to be a preference for women [7–11]. Patients with mild (recurrent) diverticulitis are usually treated by a general practitioner or on an outpatient basis, which makes it difficult to accurately determine the true incidence and recurrence rates of diverticulitis.

Although ACD is a very common disease, the clinical diagnosis remains a challenge for clinicians and health care researchers. Diagnostics and treatment of diverticulitis are mostly characterized by doctors' personal preferences rather than standardized evidence-based protocols. This is mainly due to the fact that there is a large amount of conflicting and low-quality evidence in publications regarding diverticulitis. To provide doctors and other health care providers support in clinical decision-making, practice guidelines can be developed. Guidelines are

applicable nationwide, but if based on international literature can be applicable to developed countries. Therefore, a multidisciplinary working group developed national guidelines including the epidemiology, classification, diagnostics and treatment of ACD in all its aspects based on an evidence-based review of the international literature.

## Methods

The guideline was written under the auspices of the Netherlands Society of Surgery, in collaboration with the Netherlands Societies of Internal Medicine, Gastroenterologists, Radiology, Health Technology Assessment and Dieticians. The working group consisted of four surgeons, a gastroenterologist, a radiologist, an internist specialized in infectious diseases, a dietician and an epidemiologist and statistician. Participation of a patients' representative in the working group was not possible because a patient association for patients with ACD does not exist in the Netherlands. The working group defined the following sections of relevance: terminology and classification, epidemiology, special patient groups with ACD, prevention of recurrent ACD, clinical diagnosis and radiological imaging, colonoscopy, treatment of uncomplicated and complicated ACD, and elective surgery and medical treatment in patients with ACD.

### *Search Strategy*

Systematic searches of the Medline and Embase databases were performed using the keywords relevant to each section. Terms relevant to each section of the guideline were mapped to Medline Subjects Headings (MeSH) terms, as well as searched for as text items. Relevant keywords and search strategies can be found in Appendix 1. Articles describing randomized controlled trials and systematic reviews were searched for using the methodological filters of the Scottish Intercollegiate Guidelines Network (<https://www.sign.ac.uk/methodology/filters.html>). Different date censoring and limitations were applied according to the relevance of each keyword. Only publications in English, French, German and Dutch were retrieved and read in full. The bibliographies of included articles were subsequently hand-searched for other relevant references, and experts in the field were asked if they found any relevant reports missing.

### *Critical Appraisal*

Articles selected to support recommendations were assessed using the national classification system for evidence-based guideline development (<http://www.cbo.nl>), which is equivalent to the levels of evidence as published by the Centre for Evidence-Based Medicine of the University of Oxford ([www.cebm.net](http://www.cebm.net); table 1). Articles were classified according to the type of article and individually assessed for methodological quality using the GRADE method as proposed by the GRADE working group. That working group has developed a common, sensible and transparent approach to grading the quality of evidence and strength of recommendations (<http://www.gradeworkinggroup.org>).

The main literature on which the conclusion for each relevant topic is based is stated with the conclusion, accompanied by the

**Table 1.** Classification of evidence

Level of evidence	Interventional research	Studies concerning diagnostic accuracy	Studies on complications or side-effects, etiology, prognosis
A1	systematic review/meta-analysis of at least 2 independently performed level A2 studies		
A2	double-blind controlled randomized comparative clinical trial of good study quality with an adequate number of study participants	diagnostic test compared to reference test; criteria and outcomes defined in advance; assessment of test results by independent observers; independent interpretation of test results; adequate number of consecutive patients enrolled; all patients subjected to both tests	prospective cohort with sufficient amount of study participants and follow-up, adequately controlled for confounders; selection in follow-up has been successfully excluded
B	comparative studies, but without all the features mentioned for level A2 (including patient-control studies, cohort studies)	diagnostic test compared to reference test, but without all the features mentioned in A2	prospective cohort study, but without all the features mentioned for level A2 or retrospective cohort study or case-control study
C	noncomparative studies		
D	expert opinion		

level of evidence (table 2). The final recommendations are based on the available evidence from the literature, also taking into account 'soft' factors such as patient preferences, costs and availability of facilities. Recommendations can be strong ('we can be confident about the recommendation', level I) to weak ('we cannot be confident', level IV). A concept guideline was sent to all involved societies for comment and approval after which internal consensus was reached between the members of the working group. Amendments were made based upon these comments, leading to the final version of the guideline 'Diagnostics and Treatment of Acute Colonic Diverticulitis', as approved by all societies.

## Results

### *Terminology and Classification*

The term 'diverticular disease' used in Anglo-Saxon literature is made up of a spectrum of conditions all related to diverticulosis of the colon. Some use the term 'diverticular disease' for patients with symptoms associated with diverticulosis and distinguish diverticulitis as a different entity, whereas others include diverticulitis and diverticular bleeding in the term 'diverticular disease'. The lack of uniformity in terminology results in difficulties interpreting and comparing findings between studies. It seems best to use the term 'diverticulosis coli' and to distinguish between uncomplicated (asymptomatic) and complicated (symptomatic) diverticulosis. Patients with uncomplicated diverticulosis have no symp-

**Table 2.** Grading of the conclusions according to the level of evidence

Level	Conclusion based on
1	systematic review (A1) or at least 2 independent studies with evidence level A2 ('there is evidence that ...')
2	one study with evidence level A2 or at least 2 independent studies with evidence level B ('it is likely that ...')
3	one study with evidence level B or level C ('there are indications that ...')
4	expert opinion ('the working group recommends ...')

toms, and therefore the term asymptomatic diverticulosis is also used. Complicated diverticulosis coli, or symptomatic diverticulosis coli, is the complete spectrum of symptoms that can arise in patients with diverticulosis coli. This includes patients with (chronic) persistent abdominal pain, acute colonic diverticulitis and diverticular bleeding. ACD refers to inflammation of diverticula. Uncomplicated ACD is referred to when inflammation of one or more diverticula leads to an inflammatory process without perforation or abscess formation. Complicated diverticulitis is associated with

**Table 3.** CT findings according to Kaiser et al. [15] (2005)

Modified Hinchey classification		Accompanying CT findings
Stage 0	clinically mild diverticulitis	diverticula with or without wall thickening of the colon
Stage Ia	confined pericolic inflammation and phlegmonous inflammation	colonic wall thickening with inflammatory reaction in pericolic fatty tissue
Stage Ib	abscess formation (<5 cm) in the proximity of the primary inflammatory process	alterations as stage Ia + pericolic or mesocolic abscess formation
Stage II	intra-abdominal abscess, pelvic or retroperitoneal abscess, abscess distant from the primary inflammatory process	alteration as stage Ia + distant abscess formation (mostly pelvic or interloop abscesses)
Stage III	generalized purulent peritonitis	free air with local or generalized free fluid and possible thickening of the peritoneum
Stage IV	fecal peritonitis	similar findings to stage III

abscess formation, perforation or fistula formation. Recurrent episodes of ACD may result in stenosis and obstruction or fistula to nearby organs (mostly bladder) or the skin; these late complications are also referred to as complicated diverticulitis.

To classify acute diverticulitis, Hinchey et al. [12] proposed a classification system, which is currently used in clinical practice in a modified version [13] (table 3). The Hinchey classification has traditionally been used to distinguish four stages of complicated diverticulitis. Wasvary et al. [13] introduced stage 0, clinically mild diverticulitis, and differentiation in stage I between limited pericolic inflammation (stage Ia) and abscess formation smaller than 5 cm in the proximity of the primary inflammatory process (stage Ib). This broadened the original Hinchey classification by not only addressing perforated disease, but also by including mild clinical disease [13, 14]. After the introduction of computed tomography (CT) for diagnosing acute diverticulitis, several radiologic classification systems were proposed additionally [15, 16]. CT findings were correlated with the modified Hinchey scores to come to uniform reporting of CT findings (table 3).

#### *Conclusion and Recommendations*

Uniform terminology is needed in patients with diverticulosis coli. A distinction is made between uncomplicated (asymptomatic) diverticulosis and complicated (symptomatic) diverticulosis. The latter term is used for the complete spectrum of symptoms that can arise in patients with diverticulosis coli (level 4).

#### **Epidemiology**

Researching the natural history of ACD is hampered by a number of factors. There is no registry of patients regarding the natural course of the disease. Most patients with recurrent episodes of ACD have had elective surgery after two episodes of ACD, which makes it difficult to determine true recurrence rates in patients with ACD [17]. Recurrence rates of ACD, in which a recurrence is based on the clinical diagnosis without imaging, varies between 9 and 29% (level C [9, 18–23]). The accuracy of the diagnosis in these studies is questionable because of the lack of a good reference test. There are two studies with adequate reference testing that give information on the natural disease history, and they report an estimated chance of recurrence of 9% (level C [24]) and 23% (level C [25]). The highest risk of recurrence seems to be in the first year (10%) and drops to approximately 3% in the years thereafter (level C [21]). The real risk of recurrence is underestimated in these studies; recurrence rates apply invariably to a selected group of patients, namely patients with symptoms severe enough for hospital admittance. The majority of recurrences tend to be mild recurrences that can be managed by conservative treatment (level C [9, 18, 19, 21–25]). Based on recent studies, most perforations do not occur after recurrences, but after the first attack of ACD (level C [26–33]). Multiple recurrences were not associated with a higher chance of mortality, nor did they lead to a higher chance of complicated disease (level C [26–33]).

### *Conclusions and Recommendations*

The natural history of diverticulitis is usually mild and most patients are treated successfully by conservative means (level 3). Multiple recurrences do not lead to a higher risk of complicated diverticulitis (level 3). Patients should be informed of an approximately 25% risk of recurrence after an initial episode of ACD (level 3).

### **Special Patient Groups**

#### *Young Patients*

The definition of young age in patients with ACD is either below 40 or 50 years. Of all patients hospitalized for ACD, 18–34% are younger than 50 years [34, 35]. Some authors have reported that young patients have an increased risk of complications and recommend early resection [8, 36–38]. This assumption is based on outdated studies in which 48–88% of the patients who had surgery for suspected diverticulitis appeared to have another diagnosis at surgery. Recent studies, using CT to diagnose ACD, did not find a higher risk of complications in young patients (level C [7, 18–20, 25, 34, 35, 39, 40]). In young patients, the reported high risk of recurrent disease is caused by a higher accumulated risk due to higher life expectancy rather than absolute risk (level C [18–20, 40]). There is no evidence that younger patients should be treated differently than older patients (level C [20, 25, 34, 35, 39, 40]).

#### *Immunocompromised Patients*

In patients with a compromised immune system, an increased incidence of ACD has been reported compared to healthy individuals, especially in patients with kidney failure, organ transplant patients and patients using corticosteroids (level C [41, 42]). These patients were significantly more often diagnosed with complicated diverticulitis (level C [28, 42–45]). Screening and prophylactic sigmoid resection is not routine for patients waiting for organ transplantation (level C [42, 46]). Patients with immune deficiency caused by HIV infection, diabetes, malignancy or chemotherapy do not have an increased risk of complicated diverticulitis (level C [47, 48]). Some reports indicate an increased risk of ACD in obese patients, but evidence is inconsistent (level B [49] and level C [50, 51]).

### *Conclusions and Recommendations*

Young patients do not have a more aggressive course of ACD than older patients (level 3). Young patients have a higher risk of recurrent disease, but the absolute

risk difference is relatively small (level 3). Screening for diverticulosis in immunocompromised patients or patients awaiting organ transplantation in order to perform a prophylactic colonic resection is not effective (level 3).

### **Prevention of Diverticulitis**

There are indications that people with a healthy lifestyle, characterized by physical exercise, a fiber-rich diet, limited intake of red meat, low alcohol consumption and nonsmoking, have a decreased risk of diverticulitis (level B [52] and level C [53]).

### *Conclusions and Recommendations*

Counseling patients on risk factors for developing diverticulosis should be included in treatment protocols (level 3).

### **Clinical Diagnosis and Radiological Imaging**

#### *Clinical Diagnosis*

The clinical diagnosis of ACD, based on reported complaints, physical examination and laboratory results, is correct in 43–68% of patients (level B [54, 55] and level C [56, 57]). To improve diagnostic reliability, a clinical decision rule and a clinical scoring system for diagnosing ACD using logistic regression have been published [54, 55]. Reliable independent individual risk factors for ACD in both studies were pain only in the left lower abdominal quadrant, the absence of vomiting and a C-reactive protein level >50 mg/l. If all three criteria were met, 97% of the patients had ACD (level B [54, 55]).

#### *Radiological Imaging*

Radiological imaging techniques that are used for the diagnosis of ACD are soluble contrast enemas, ultrasound (US), CT and magnetic resonance imaging (MRI). Soluble contrast enemas are obsolete for diagnosing ACD due to low accuracy and the inability to determine the extent and complications of the disease (level A2 [58] and level B [59]). The most used US technique to examine patients with suspected ACD is the graded compression procedure. With this technique, interposing fat and bowel can be displaced or compressed by means of gradual compression to show underlying structures [60]. US is a real-time dynamic examination with wide availability and easy accessibility. The use of CT in evaluation of pa-

tients with ACD has increased to a large extent. CT has the advantage of delineating the extent of the extraluminal disease process, has an unlimited view and may also direct therapeutic intervention in case of complicated disease, e.g. US-guided percutaneous drainage of intra-abdominal abscesses. CT criteria are also used as a prognostic tool to determine the risk of complications during conservative treatment [16, 61]. The most used diagnostic criteria to diagnose ACD with US and CT are increased thickness of the colonic wall, pericolic fat stranding and presence of inflamed diverticula. To optimally depict diverticulitis, the use of intravenous, oral and/or rectal contrast agents are advised [62]. Studies report high diagnostic sensitivity and specificity for both US (92 and 90%, respectively) and CT after negative or inconclusive US (94 and 99%, respectively; level A1 [63, 64]). More recently, in a large prospective series of unselected patients with acute abdominal pain at the emergency department, for which imaging was indicated by the treating physician, a much lower sensitivity of 61% (52–70%) was found for US, whereas the sensitivity of CT for the diagnosis of ACD was 81% (74–88%). Sensitivity can be increased up to 94% by performing US first, and CT only in case of a negative or inconclusive US. This step-up approach lowered the exposure to ionizing radiation for the study population (level A2 [65, 66]). Besides the known differences between the techniques (availability, costs, reproducibility and interobserver differences), exposure to radiation during CT and contrast-induced nephropathy are a concern [60]. MRI has the advantage that no ionizing radiation and intravenous contrast medium are needed to reach a higher soft tissue contrast than CT. MRI is increasingly used in the acute setting for patients with acute abdominal pain, but accuracy data are still limited. Based on studies with small numbers of patients, sensitivity and specificity of MRI for diagnosing ACD vary between 86 and 100% and 88 and 100% (level B [67, 68] and level C [69, 70]).

#### *Conclusions and Recommendations*

In general, the clinical diagnosis of ACD is not sufficiently accurate and therefore radiological imaging is indicated in these patients (level 2). Patients with mild symptoms and no signs of complicated ACD, and the combination of pain in the lower left abdomen on physical examination, the absence of vomiting and a C-reactive protein >50 mg/l may be withheld from initial imaging for diagnosing ACD (level 2). If imaging is indicated, a conditional CT after negative or inconclusive US is the most appropriate approach in diagnosing ACD (level 2).

#### **Colonoscopy**

Colonoscopy is not recommended in the acute phase to diagnose ACD (level B [71] and level C [72]). Although proven feasible in one prospective study, it is rarely needed in the acute phase (level C). Possible difficulties of colonoscopy in the acute phase are incomplete examination due to pain, stenosis and incomplete bowel preparation. Discouragements to perform colonoscopy in the acute phase are based on the hypothesis that insufflation of air is associated with the risk of converting a sealed perforation to a free perforation [73–75].

Colonoscopy is usually done 6 weeks after an episode of ACD, so as to exclude a colonic malignancy. The lifetime risk of developing colonic cancer is approximately 5%. After an episode of ACD, it is unlikely that patients have an increased risk of developing colonic cancer (level B [76, 77] and level C [78]). Although safe, routine performance of a colonoscopy in asymptomatic patients after an episode of ACD to exclude other diagnoses was not found to be helpful (level B [71, 79, 80]).

#### *Conclusions and Recommendations*

Colonoscopy in the acute phase of diverticulitis is not recommended for diagnostic purposes (level 3). There is no place for routine endoscopic examination after an episode of ACD (level 2).

#### **Treatment of Uncomplicated Diverticulitis**

Most patients with uncomplicated diverticulitis (Hinchey 0 or Ia) can be treated conservatively with a success rate of 93–100% (level C [15, 81–86]). Conservative treatment includes antibiotics, starvation and bed rest in almost all studies. There is no evidence that bed rest, dietary restrictions or laxatives positively influence the treatment outcome of ACD. In patients who do not tolerate oral feeding, it is recommended to start parenteral feeding when oral feeding is not to be expected within 3 days (level D [87]). Almost all international guidelines advise the use of antibiotics for the treatment of diverticulitis [17, 88–91]. However, there is no evidence that routine administration of antibiotics influences the course of uncomplicated diverticulitis (level A2 [92] and level B [79]). Oral administration of antibiotics seems equally effective to intravenous administration (level B [93]). Intravenous administration over 4 days is equally effective as 7 days (level B [84]). A recent prospective randomized clinical trial did not find a reduction of abscess

formation, perforation and recurrence rates with the use of antibiotics [92]. The use of antibiotics seems appropriate in patients presenting with signs of generalized infection (temperature >38.5°C), affected general condition or signs of bacteremia or septicemia and in immunocompromised patients.

Analgesia is part of the treatment of patients with ACD. There is no evidence that acetaminophen, nonsteroidal anti-inflammatory drugs (NSAIDs) or morphinomimetics have a negative effect on the course of an episode of ACD. Multiple studies found that patients on home NSAID medication present more often with complicated diverticulitis, i.e. perforation (level C [48, 94–97]). The (adverse) effect of NSAIDs started as an analgesic in patients with uncomplicated ACD has not been studied. Morphinomimetics can be safely administered to patients with acute abdominal pain without negatively affecting the diagnostic accuracy of clinical evaluation (level A2 [98, 99]).

#### *Conclusions and Recommendations*

There is no evidence that bed rest, dietary restrictions or laxatives influence the treatment of ACD (no evidence). There is no evidence that antibiotics should be routinely administered to patients with uncomplicated diverticulitis (level 2). Antibiotic treatment is recommended when signs of generalized infection (temperature >38.5°C) and affected general condition or signs of bacteremia or septicemia are present (level 4). Antibiotic treatment is recommended in immunocompromised patients (level 4).

### **Treatment of Complicated Diverticulitis**

#### *Hinchey Ib and II*

There are no high-quality reports on the management of patients with ACD and abscess formation (Hinchey Ib and II); therefore, no consensus has been reached about the most optimal treatment strategy. Since the introduction of broad-spectrum antibiotics and improvement in US- and CT-guided percutaneous drainage techniques, alternatives to surgery have become available. Conservative treatment with antibiotics is successful in up to 73% (95% CI: 66.3–78.9) of patients presenting with an abscess of less than 4–5 cm in diameter (level C [16, 18, 100–104]). When conservative treatment fails, percutaneous drainage should be performed, which is successful in up to 81% (95% CI: 73.7–89.1) of patients (level C [15, 16, 100–104]). The risk of failure of conservative treat-

ment is higher in patients with abscesses larger than 4–5 cm than in patients with smaller abscesses (level C [15, 16, 100–104]).

#### *Hinchey III and IV*

Peritonitis is the most life-threatening complication of ACD, with a mortality of 14% [105, 106]. Perforation of the colon to the intra-abdominal cavity results in a purulent or fecal peritonitis. Perforation is a relatively rare complication with an incidence of 3.5 per 100,000 individuals per year [107]. In a large population-based study from the United States, only 1.5% of patients with ACD were found to have a perforation, and 9.6% were found to have an abscess [108]. Peritonitis is a progressive disease leading to general signs of illness expressed in organ dysfunction or organ failure caused by bacteremia and septicemia. Prevention of these events by early intervention, i.e. aggressive resuscitation preventing inadequate tissue perfusion and oxygenation, the administration of broad spectrum antibiotics, and elimination of the source of infection, is the keystone of sepsis treatment [109]. Early treatment in patients with peritonitis significantly improves outcome [109–111]. No evidence-based advice can be provided for the indications for surgery in patients with perforated diverticulitis, but the indication seems self-evident.

#### *Operative Therapy*

There are different surgical options for patients with Hinchey III and IV peritonitis: diverting colostomy, Hartmann's procedure or primary resection with anastomosis, and laparoscopic lavage with drainage of the abdominal cavity. Hartmann's procedure is the most performed, which is a two-stage procedure involving resection of the diseased colon, closure of the distal rectal stump and construction of an end colostomy. In the second stage the colostomy is reversed; however, restoration of the bowel continuity is not performed in up to 55% of patients due to operative risks [112]. Alternatively, resection with primary anastomosis, with or without a protective ileostomy or colostomy, can be performed. A diverting ileostomy or colostomy combined with intraoperative irrigation of the afferent colon can be performed to reduce the rate of symptomatic complications in case of anastomotic leakage (level B [113, 114]). Studies comparing mortality, morbidity, wound complications, operation time and antibiotic treatment of Hartmann's procedure and primary anastomosis did not show any significant differences. However, most studies were prone to selection bias: patients were not randomized for Hartmann's procedure or primary anastomosis and patient



groups were not comparable on patient characteristics and disease severity. It is likely that the choice of operation is influenced by patient conditions and perioperative findings. Nevertheless, there are indications that Hartmann's procedure and primary anastomosis have comparable outcomes (level B [113, 115, 116]). However, in critically ill patients, hemodynamic instability is a relative contraindication for a primary anastomosis. Due to administration of inotropes to maintain sufficient blood pressure, splanchnic perfusion can be reduced, leading to increased risk of anastomotic leakage. This hypothesis has been confirmed (mainly in animal experiments) in studies on anastomotic healing in general surgery, although not after resection for diverticulitis. Fecal contamination of the abdominal cavity is not thought to be a contraindication for construction of a primary anastomosis [117]. Another treatment option in patients with purulent peritonitis is laparoscopic lavage and drainage of the abdominal cavity in which the colon is not resected. In nonrandomized series, hampered by patient selection, laparoscopic treatment accompanied by intravenous antibiotics seems to be an effective and safe treatment in Hinchey III patients (level C [57, 118]). However, the results of the first randomized trial need to be reviewed for a definite conclusion [119].

#### *Conclusions and Recommendations*

Smaller abscesses (<4–5 cm) can be treated with antibiotics alone, whereas larger abscesses can best be treated with percutaneous drainage combined with antibiotic treatment (level 3). Operative treatment is considered standard therapy for patients with Hinchey III and IV diverticulitis (no evidence). In hemodynamically stable patients with acute diverticulitis and an indication for operative treatment, primary anastomosis with or without a diverting ileostomy or colostomy is preferred over Hartmann's procedure (level 2). In patients with Hinchey III diverticulitis, the safety and efficacy of treatment with laparoscopic peritoneal lavage is uncertain and will remain so until the results of the first randomized trial on the subject become available (level 3).

#### **Elective Surgery**

The American Society of Colon and Rectal Surgeons (ASCRS) state in their most recent guideline that elective sigmoid resection after recovery from ACD should be made on a case-by-case basis [90]. This advice differs significantly from the previous advice, given 6 years earlier, in

which a plea for elective surgery after two episodes of diverticulitis was proposed [120]. Recent data on the natural history of diverticulitis has shown that recurrent episodes of diverticulitis mostly run a benign course and only 5.5% of the patients with recurrent hospitalizations for diverticulitis are subjected to emergency surgery [20]. Moreover, most patients who present with complicated diverticulitis do so at the time of their first attack (level C [26, 121, 122]). Recurrent diverticulitis even seems to reduce the risk of perforation, possibly due to adhesion formation caused by inflammation. Therefore, a policy of elective sigmoid resection after recovery from uncomplicated ACD does not decrease the likelihood of later emergency surgery, and the number of previous episodes itself is no longer an indication for elective sigmoid resection (level C [18, 26, 33, 113, 121–123]). Persistent colonic symptoms, particularly abdominal pain, have been reported in patients after episodes of diverticulitis. It has been suggested that this pain represents increased visceral sensitivity [124]. These patients might benefit from early colonic resection.

After elective sigmoid resection, there is a risk of anastomotic leakage, stoma formation, morbidity and mortality. Despite resection, even recurrent diverticulitis and continuing complaints have been described. Patients with immune deficiencies might benefit from early resection since they have a greater risk of perforations and a complicated course of recurrent episodes of diverticulitis (level C [18, 33, 121, 122]).

Elective sigmoid resection for complicated diverticulosis can be performed either with an open or laparoscopic approach. Two randomized trials favored laparoscopic surgery over open surgery. In the 'Sigma trial', significantly more complications, higher pain scores and longer hospital stay were found among patients with open surgery. Operating time was significantly longer in the laparoscopic group, with a conversion rate of 19%. Quality of life was significantly better after 6 weeks, but did not differ after 6 months (level A2 [125]). The study by Gervaz et al. [126] also had equal long-term results, except for the cosmetic outcome, which was better in the laparoscopic group. No difference was found considering ventral hernia, patient satisfaction, quality of life or total costs (level A2). Laparoscopic surgery provides a faster functional recovery than open sigmoid resection and possibly less chance of complications, but the long-term advantages of laparoscopic sigmoid resection are not yet evident (level A2 [125, 126] and level B [127–131]). Both the Sigma trial and the Gervaz study did not use the Enhanced Recovery after Surgery (ERAS) principles, which are now widely adopted in the perioperative care of patients with ab-



dominal surgery. The ERAS program reduced the risk of complications and hospital stay of open surgery to a large extent [130]. In addition, laparoscopic surgery is often done by dedicated surgeons, while open surgery is usually performed by a much larger group of surgeons, possibly influencing the results.

To reduce the risk of recurrent diverticulitis, the sigmoid should be resected up to the proximal rectum (level C [131, 132]). There is no evidence for the optimal proximal resection margin; however, a resection as limited as possible in soft compliant bowel is recommended [90].

#### *Conclusions and Recommendations*

Patient-related factors, not so much the number of previous episodes of diverticulitis, should play the most important role in selecting patients who might benefit from elective sigmoid resection (level 3). If appropriate laparoscopic expertise is present, laparoscopic surgery for recurrent episodes of diverticulitis might be favored over open sigmoid resection in terms of short-term outcome, but no long-term benefits have been reported (level 1). During elective sigmoid resection, the part of the colon resected proximally to the inflammatory process should be as limited as possible with the proximal rectum as the distal margin (level 3).

#### **Medical Treatment of Recurrent Diverticulitis**

Traditionally, fiber-enriched diets in patients with diverticulitis have been considered to prevent recurrent episodes of ACD. However, randomized clinical trials on fiber-enriched diets in patients with ACD have had inconsistent results [133]. A recently published systematic review of high-fiber dietary therapy could not include any studies concerning prevention of diverticulitis with a high-fiber diet [134]. Despite the lack of evidence, high daily fiber intake is recommended as treatment in various guidelines [17, 88, 91, 135]. Since obesity and smoking are associated with an increased risk of complications of diverticulitis, weight reduction and cessation of smoking can have a favorable influence on prevention of recurrent diverticulitis (level B [51, 136]). Although evidence on lifestyle advice to prevent recurrent episodes of ACD is missing, it is likely that the same measures to prevent ACD also apply to patients after an episode of ACD. Hence, a healthy lifestyle, characterized by physical exercise, a fiber-rich diet, little intake of red meat, low alcohol consumption and nonsmoking are advised in patients after an episode of ACD (level B [52] and level C [53]).

Recently, new theories about similarities between ACD and inflammatory bowel disease have been proposed, leading to new treatment possibilities, such as probiotics, antibiotics and anti-inflammatory agents [137]. Regarding drug treatment, intermittent administration of a nonabsorbable antibiotic (rifaximin) after an episode of acute diverticulitis decreased the chance of readmission by 50% and of recurrent diverticulitis by 73% (level B [138]). Prevention of recurrent disease is more effective when 5-aminosalicylic acid (mesalazine) is combined with rifaximin, compared to rifaximin alone (level A2 [139] and level B [140]). Furthermore, a combination of probiotics and anti-inflammatory medication is preferred over treatment with probiotics alone (level A2 [141]).

Residual complaints after an episode of diverticulitis occur often and medical treatment can reduce symptoms. In these patients a trial period of intermittent administration of a nonabsorbable antibiotic with mesalazine or probiotics should be considered. This is especially so since there is little risk from treatment by nonresorbable antibiotics or mesalazine combined with probiotics, while mortality and morbidity of operative treatment are substantial.

#### *Conclusions and Recommendations*

The working group advises to give lifestyle advice to patients following an attack of diverticulitis, focusing on increasing daily fiber intake, weight reduction, cessation of smoking and increasing physical activity (level 4). Nonabsorbable antibiotics seem to reduce the risk of recurrent episodes of diverticulitis (level 3). The combination of 5-aminosalicylic acid and rifaximin is more effective than rifaximin alone in the prevention of recurrent episodes of diverticulitis (level 2). The working group opinion is that in patients with recurrent diverticulitis or patients with residual complaints following an episode of diverticulitis, in which other pathologies have been excluded, a trial period of intermittent mesalazine, with or without a combination of an oral non-resorbable antibiotic or probiotic, should be considered (level 4).

#### **Conclusion**

This review of guidelines for diverticulitis summarizes the extensive literature available on epidemiology, prevention, diagnosing and treatment of patients with acute diverticulitis in all its aspects. The guideline was devel-

oped in order to standardize the treatment of patients with acute diverticulitis and to provide clinicians who deal with patients with diverticulitis on a daily basis, with an evidence-based medical approach in treating and counseling patients. Despite a large amount of literature, not all topics were equally well addressed. Nevertheless, this review is the best evidence-based approach currently available. The results of well-designed randomized studies will become available in the near future and give more insight into the optimal treatment of patients with acute diverticulitis of the colon.

## Appendix 1

### *Search Strategies for the Relevant Key Words*

Last search update: February 2012

#### *Subject: natural course of ACD*

Date censoring: none

"Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] AND "Natural history" [MeSH] OR "Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] AND "Natural history" OR "Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] AND "uncomplicated"

#### *Subject: natural course in young and immunocompromised patients*

Date censoring: from 1960

Restrictions: none

"Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] AND "Young" OR "Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] AND "Recurrence" [MeSH] OR "Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] AND "diabetes mellitus" [MeSH] OR "Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] AND "transplantation" [MeSH] OR "Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] AND "immunosuppression" [MeSH] OR "Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] AND "AIDS or HIV" [MeSH] OR "Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] AND "neoplasms" [MeSH]

#### *Subject: colonoscopy*

Date censoring: from 1970

Restrictions: none

"Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] AND "colonoscopy" OR "Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] ("Diverticulitis" OR "Diverticular disease") AND ("Colon carcinoma" OR "Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields]) AND "colon cancer" OR "Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] AND "IBD"

#### *Subject: clinical diagnosis*

Date censoring: from 1980

Restrictions: none

"Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] AND "clinical parameters" OR "Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] AND "sensitivity" OR "Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] AND "Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] AND "diagnosis"

#### *Subject: radiological imaging*

Date censoring: from 1980

Restrictions: none

"Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] AND "contrast enema" OR "Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] AND "Ultrasonography" [MeSH] OR "ultrasonography" [subheading] OR "Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] AND "Tomography, Spiral Computed" [MeSH] OR "Tomography, X-Ray Computed" [MeSH] OR "Tomography Scanners, X-Ray Computed" [MeSH] OR "Computed Tomographic" [MeSH] OR "Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] AND "Magnetic Resonance Imaging" [MeSH] OR "Colonography"

#### *Subject: uncomplicated diverticulitis*

Date censoring: from 1975

Restrictions: none

"Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] AND "uncomplicated diverticulitis" OR "Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] AND "Anti-Bacterial Agents" [MeSH] OR "Anti-Bacterial Agents" [Pharmacological Action] OR "Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis"

((("diverticulitis" [MeSH Terms] OR "diverticulitis" [All Fields]) AND ("intestines" [MeSH Terms] OR "intestines" [All Fields]) AND "bowel" [All Fields]) AND ("rest" [MeSH Terms] OR "rest" [All Fields])) OR ((("diverticulitis" [MeSH] OR "diverticulitis" [All Fields]) AND ("bed rest" [MeSH] OR "bed" [All Fields] AND "rest" [All Fields]) OR "bed rest" [All Fields] OR "bedrest" [All Fields])) OR "Diverticulitis" [MeSH] OR "Diverticulitis, Colonic" [MeSH] OR "diverticulitis" [All Fields] AND ((("diverticulitis" [MeSH] OR "diverticulitis" [All Fields]) AND ("overweight" [MeSH] OR "overweight" [All Fields])) OR ((("diverticulitis" [MeSH] OR "diverticulitis" [All Fields]) AND "BMI" [All Fields]) OR ((("diverticulitis" [MeSH] OR "diverticulitis" [All Fields]) AND "adipositas" [All Fields]) OR ((("diverticulum" [MeSH] OR "diverticulum" [All Fields] OR ("diverticular" [All Fields] AND "disease" [All Fields]) OR "diverticular disease" [All Fields]) AND "adipositas" [All Fields]) OR ((("diverticulum" [MeSH] OR "diverticulum" [All Fields] OR ("diverticular" [All Fields] AND "disease" [All Fields]) OR "diverticular disease" [All Fields]) AND "BMI" [All Fields]) OR ((("diverticulum" [MeSH] OR "diverticulum" [All Fields] OR ("diverticular" [All Fields] AND "disease" [All Fields]) OR "diverticular disease" [All Fields]) AND ("overweight" [MeSH] OR "overweight" [All Fields]))))

“Diverticulitis” [MeSH] OR “Diverticulitis, Colonic” [MeSH] OR “diverticulitis” [All Fields] AND [Diet Therapy] OR “Diverticulitis” [MeSH] OR “Diverticulitis, Colonic” [MeSH] OR “diverticulitis” [All Fields] AND “Vegetables” OR “Diverticulitis” [MeSH] OR “Diverticulitis, Colonic” [MeSH] OR “diverticulitis” [All Fields] AND “Fruit” OR “Diverticulitis” [MeSH] OR “Diverticulitis, Colonic” [MeSH] OR “diverticulitis” [All Fields] AND “Starvation” OR “Diverticulitis” [MeSH] OR “Diverticulitis, Colonic” [MeSH] OR “diverticulitis” [All Fields] AND “Laxatives”

*Subject: complicated diverticulitis*

Date censoring: from 1990

Restrictions: Adults 19+, series >50 patients

“Diverticulitis” [MeSH] OR “Diverticulitis, Colonic” [MeSH] OR “diverticulitis” [All Fields] AND “Abscess” [MeSH:NoExp] OR “Diverticulitis” [MeSH] OR “Diverticulitis, Colonic” [MeSH] OR “diverticulitis” [All Fields] AND “Hinchey III” OR “Diverticulitis” [MeSH] OR “Diverticulitis, Colonic” [MeSH] OR “diverticulitis” [All Fields] AND “Hinchey IV” OR “Diverticulitis” [MeSH] OR “Diverticulitis, Colonic” [MeSH] OR “diverticulitis” [All Fields] AND “Diverticulitis, Colonic/mortality” [MeSH] OR “Diverticulitis, Colonic” [MeSH] AND “Intestinal Perforation” [MeSH] OR “Diverticulitis” [MeSH] OR “Diverticulitis, Colonic” [MeSH] OR “diverticulitis” [All Fields] AND “laparoscopy”

(“diverticulitis”/exp OR “diverticulitis”:ab,ti OR “diverticular disease”:ab,ti) AND (“laparoscopy”/exp OR “laparoscopic surgery”/exp OR “laparoscope”/exp OR “minimally invasive surgery”/exp OR laparoscop\*:ab,ti OR laparoscop\*:ab,ti OR (minimal\*:ab,ti AND adj:ab,ti AND invasive:ab,ti)) AND (“acute disease”/exp OR “emergency”/exp OR acute:ab,ti OR emergenc\*:ab,ti OR “colon perforation”/exp OR (perforat\*:ab,ti AND [1970–2011]/py)) “Diverticulitis, Colonic” [MeSH] AND “Recurrence” [MeSH] AND “Therapeutics” [MeSH] database

*Subject: prevention of recurrence and antibiotics*

Date censoring: from 1966

Restrictions: none

(“Diverticulitis” AND “Recurrence” AND “Therapy”) OR (“Diverticulum, Colon” [MeSH]) AND (“Diet Therapy” [MeSH]) OR (“Dietary Fiber” [MeSH]))

((“diverticulitis” [MeSH Terms] OR “diverticulitis” [All Fields]) AND (“overweight” [MeSH Terms] OR “overweight” [All Fields])) OR ((“diverticulitis” [MeSH Terms] OR “diverticulitis” [All Fields]) AND “BMI” [All Fields]) OR ((“diverticulitis” [MeSH Terms] OR “diverticulitis” [All Fields]) AND “adipositas” [All Fields]) OR ((“diverticulum” [MeSH Terms] OR “diverticulum”

[All Fields] OR (“diverticular” [All Fields] AND “disease” [All Fields]) OR “diverticular disease” [All Fields]) AND “adipositas” [All Fields]) OR ((“diverticulum” [MeSH Terms] OR “diverticulum” [All Fields] OR (“diverticular” [All Fields] AND “disease” [All Fields]) OR “diverticular disease” [All Fields]) AND “BMI” [All Fields]) OR ((“diverticulum” [MeSH Terms] OR “diverticulum” [All Fields] OR (“diverticular” [All Fields] AND “disease” [All Fields]) OR “diverticular disease” [All Fields]) AND (“overweight” [MeSH Terms] OR “overweight” [All Fields])) ((“diverticulitis” [MeSH Terms] OR “diverticulitis” [All Fields]) AND (“smoking” [MeSH Terms] OR “smoking” [All Fields])) (“diverticular disease” [MeSH Terms] OR “diverticular disease” [All Fields]) AND (“smoking” [MeSH Terms] OR “smoking” [All Fields]) ((“diverticulitis” [MeSH Terms] OR “diverticulitis” [All Fields]) AND (“exercise” [MeSH Terms] OR “exercise” [All Fields]) OR (“physical” [All Fields] AND “exercise” [All Fields]) OR “physical exercise” [All Fields])) OR ((“diverticulum” [MeSH Terms] OR “diverticulum” [All Fields] OR (“diverticular” [All Fields] AND “disease” [All Fields]) OR “diverticular disease” [All Fields]) AND (“exercise” [MeSH Terms] OR “exercise” [All Fields]) OR (“physical” [All Fields] AND “exercise” [All Fields]) OR “physical exercise” [All Fields])) OR ((“diverticulitis” [MeSH Terms] OR “diverticulitis” [All Fields]) AND (“physical therapy modalities” [MeSH Terms] OR (“physical” [All Fields] AND “therapy” [All Fields] AND “modalities” [All Fields]) OR “physical therapy modalities” [All Fields] OR “physiotherapy” [All Fields])) OR ((“diverticulum” [MeSH Terms] OR “diverticulum” [All Fields] OR (“diverticular” [All Fields] AND “disease” [All Fields]) OR “diverticular disease” [All Fields]) AND (“physical therapy modalities” [MeSH Terms] OR (“physical” [All Fields] AND “therapy” [All Fields] AND “modalities” [All Fields]) OR “physical therapy modalities” [All Fields] OR “physiotherapy” [All Fields]))

*Subject: Elective surgery*

Date censoring: 1970

Restrictions: none

“Diverticulitis” [MeSH] OR “Diverticulitis, Colonic” [MeSH] OR “diverticulitis” [All Fields] AND “Elective sigmoid resection” OR “Diverticulitis” [MeSH] OR “Diverticulitis, Colonic” [MeSH] OR “diverticulitis” [All Fields] AND “Elective colectomy” OR “Diverticulitis” [MeSH] OR “Diverticulitis, Colonic” [MeSH] OR “diverticulitis” [All Fields] OR “Surgery” AND “Diverticulitis” [MeSH] OR “Diverticulitis, Colonic” [MeSH] OR “diverticulitis” [All Fields] AND “laparoscopic colectomy” OR “Diverticulitis” [MeSH] OR “Diverticulitis, Colonic” [MeSH] OR “diverticulitis” [All Fields] AND “laparosc\*”.

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