



REVIEW ARTICLE

German guideline diverticular disease/diverticulitis

Part I: Methods, pathogenesis, epidemiology, clinical characteristics (definitions), natural course, diagnosis and classification

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Abstract

Diverticulosis and diverticular disease are ranked among the most common gastroenterological diseases and conditions. While for many years diverticulitis was found to be mainly an event occurring in the elder population, more recent work in epidemiology demonstrates increasing frequency in younger subjects. In addition, there is a noticeable trend towards more complicated disease. This may explain the significant increase in hospitalisations observed in recent years. It is not a surprise that the number of scientific studies addressing the clinical and socioeconomic consequences in the field is increasing. As a result, diagnosis and conservative as well as surgical management have changed in recent years. Diverticulosis, diverticular disease and diverticulitis are a complex entity and apparently an

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interdisciplinary challenge. To meet these considerations the German Societies for Gastroenterology and Visceral Surgery decided to create joint guidelines addressing all aspects in a truly interdisciplinary fashion. The aim of the guideline is to summarise and to evaluate the current state of knowledge on diverticulosis and diverticular disease and to develop statements as well as recommendations to all physicians involved in the management of patients with diverticular disease.

KEYWORDS

colon, diagnosis, diverticular disease, diverticulitis, treatment

CHAPTER 1: INTRODUCTION AND METHODOLOGY

Background

Diverticulosis and diverticular disease are ranked among the most common gastroenterological diseases and conditions. In Germany, one in every two to three individuals will develop diverticula at some point during their lifetime. Moreover, there is a noticeable trend towards increasingly complicated disease. As a result, a significant increase in hospitalisations has been observed in Germany in recent years.¹

Several pivotal trials have been conducted focussing on surgical indications and complications. Diverticular disease prophylaxis is described in detail, with specific dietary recommendations and suggestions for lifestyle modifications in those affected. These are derived not only from large cohort studies, but also from insights into the disease pathogenesis. Another focus, a subject of intense discussion, is symptomatic uncomplicated diverticular disease, which is characterised by pain related to the affected bowel segment without visual morphological or laboratory evidence of diverticulitis.

Objectives of the guideline

The aim of the guideline is to summarise and evaluate the current state of knowledge on diverticular disease and to develop statements as well as recommendations to all physicians involved in the diagnosis and therapy of patients with diverticular disease.

Organisational procedure of the consensus process

All procedures, working groups and participants of the guideline are described in detail in 'Supplemental methods'.

Evidence evaluation

The literature evaluation was conducted on the basis of the 2011 *Oxford Centre for Evidence-Based Medicine Levels of Evidence* for interventional, diagnostic and prognostic studies.² Experts from the respective Working Groups (WGs) assessed the methodological

quality of each study according to checklists, using the 'Critical Appraisal Tools' of the Oxford CEBM³ or, in the case of non-randomised (cohort and case-control) studies, the *Newcastle-Ottawa Scale*.⁴

Recommendations

The recommendations and background information were drafted by the WG leaders based on the evidence, and adopted within the individual WGs by means of an e-mail circulation procedure. The grading of the recommendations was based on the formulation should, should, can (Table 1).

All recommendations were voted upon according to a Delphi procedure by all guideline participants using a 3-option decision scale (yes, abstention, no). In the second Delphi vote, all but 9 recommendations received 95% approval. The remaining recommendations also achieved a high level of agreement, at over 90%. In consultation with the Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften (Working Group of the Scientific Medical Societies in Germany), it was decided to forego a consensus conference (SARS CoV-2 pandemic). The strength of consensus was defined as set out in Table 2. Following the second Delphi vote, the comments underwent final revision by the WGs and the guideline was editorially compiled by the coordinators.

TABLE 1 Grading scheme for recommendations

Recommendation grade	Description	Syntax
A	Strong recommendation	Should
B	Recommendation	Should
0	Open	Can

TABLE 2 Classification of degrees of consensus

Consensus	% Approval
Strong consensus	>95
Consensus	>75-95
Majority approval	>50-75
No consensus	≤50

Statements

“Statements” are explanations or observations regarding specific facts or questions without an immediate call for action. The statements have been adopted as part of a formal consensus procedure in accordance with that used for the recommendations, and can be based either on study results or on expert opinions.

CHAPTER 2: ANATOMY, PATHOLOGY, PATHOGENESIS, RISK FACTORS, COMORBIDITIES

Statement 2.1 Expert consensus, strong consensus
Colonic diverticula are acquired protruberances of the mucosa and submucosa through hiatal weak points in the muscle of the colon wall.

Statement 2.2 Expert consensus, strong consensus
Pathologically, diverticulitis is characterised by an inflammatory process that originates from colonic diverticula (peridiverticulitis) and spreads to the intestinal wall (focal pericolitis). This inflammation can result in severe complications (abscess and/or fistula formation, covert perforation, overt perforation with peritonitis, stenosis, diverticulitic tumour). Colonic diverticular haemorrhage is a further complication of diverticular disease.

Statement 2.3 Expert consensus, strong consensus
A thickening of the muscles of the bowel wall is often found in diverticulosis and diverticular disease.

Statement 2.4 Expert consensus, strong consensus
There are indications that diverticulosis and diverticular disease are associated with changes in the content, composition and linkage of connective tissue fibres and a faulty metabolism of the connective tissue matrix.

Statement 2.5 Expert consensus, strong consensus
There is evidence that diverticulosis and diverticular disease are accompanied by enteric neuropathy, which is characterised by structural changes in the enteric nervous system and disturbances

(Continued)

of the enteric neurotransmitter system.

Statement 2.6 Expert consensus, strong consensus
Congruent with the neuropathic and myopathic changes in the bowel wall, at least a proportion of patients with diverticulosis and diverticular disease show disturbances in colonic motility and sensitivity.

Statement 2.7 Expert consensus, strong consensus
The prevalence of diverticulosis or diverticular disease increases sharply with age. However, the incidence is currently increasing more rapidly in younger age groups.

Statement 2.8 Expert consensus, strong consensus
Alongside environmental factors, genetic predisposition also plays an important role in the development of diverticulosis and diverticulitis.

Statement 2.9 Expert consensus, strong consensus
The intestinal microbiome does not seem to be involved in the development of diverticula. It could, however, represent a pathogenic cofactor in the progression to diverticular disease.

Statement 2.10 Expert consensus, strong consensus
It is currently unknown whether mucosal/subclinical inflammation (low grade inflammation) plays a pathogenic role in diverticulosis or whether it can develop into diverticulitis.

Statement 2.11 Expert consensus, strong consensus
The development of diverticula and the course of diverticular disease are determined by non-influenceable pathogenetic factors and by influenceable risk factors.

Recommendation 2.12 Expert consensus, strong recommendation, strong consensus
Comorbidities should be taken into account in diagnostic and therapeutic decision-making due to associated risks for diverticulosis and diverticular disease/diverticulitis.

All statements and recommendations are commented in supplemental material.

CHAPTER 3: CLINICAL CHARACTERISTICS (DEFINITIONS), NATURAL DISEASE COURSE, COMPLICATIONS, EPIDEMIOLOGY

Definitions

Statement 3.1.1 Evidence level 1, consensus
 “Diverticular disease” of the colon is present when symptoms, inflammation and/or complications arise in patients with existing diverticulosis.

Statement 3.1.2 Evidence level 1, strong consensus
 Diverticulitis is the inflammation of diverticula. Acute “diverticulitis” occurs when the pseudodiverticula and adjacent structures become inflamed. Acute, complicated diverticulitis describes diverticulitis accompanied by a perforation, fistula, and/or abscess.

Statement 3.1.3 Evidence level 1, strong consensus
 Chronic diverticulitis is characterised by recurrent or persistent flares of inflammation, as a result of which complications (stenosis, fistulas) can occur.

Statement 3.1.4 Evidence level 1, consensus
 Symptomatic uncomplicated diverticular disease (SUDD) is characterised by pain related to the diverticulum-bearing segment.

All Statements commented in supplemental material.

Epidemiology

Statement 3.2.1 Evidence level 1, strong consensus
 The prevalence of diverticulosis in the general population of western industrialised nations is high, especially among older adults.

Statement 3.2.2 Evidence level 1, strong consensus
 The rate of hospitalisation due to diverticular disease (diverticulitis, bleeding) increases with age. In the western industrialised nations, the hospitalisation rate has noticeably increased over the past few decades.

Statement 3.2.3 Evidence level 4, strong consensus
 Right-sided diverticulosis differs from left-sided diverticulosis in terms of geographical distribution, clinical symptoms and disease course.

Statement 3.2.4 Evidence level 2, strong consensus
 After acute diverticulitis, quality of life can be impaired.

All statements commented in supplemental material.

Disease course/risk of recurrence/

Statement 3.3.1 Evidence level 1, strong consensus
 The majority of diverticulitis flares are mild and can be treated conservatively and on an outpatient basis. The recurrence rate after acute diverticulitis depends on the severity of the initial diverticulitis, whereby the relapse is no more severe than the initial diverticulitis.

Statement 3.3.2 Evidence level 1, strong consensus
 Increased complication rates during relapse after initial acute diverticulitis are associated with younger age, multimorbidity, and immunosuppression or complicated initial diverticulitis, especially abscess formation.

All statements are commented in supplemental material.

Mortality

Statement 3.3.3
 Complicated acute diverticulitis is associated with considerable mortality. Patients under immunosuppressive therapy are particularly at risk.
 Evidence level 3, strong consensus

Statement 3.3.4
 The lethality of acute diverticular haemorrhage depends primarily on comorbidity. Haemorrhage is usually not the cause of death.
 Evidence level 3, strong consensus

Comment on both statements

Data on mortality from diverticulitis are very heterogeneous and of relatively poor quality. Complicated diverticulitis, in particular, has a relevant mortality rate. This increases with age and the extent of comorbidity.^{5,6} In addition, the presence of ascites in patients with liver cirrhosis is associated with increased perioperative mortality.⁷ Immunosuppression represents a special situation in which steroid therapy, especially, increases the rate of postoperative complications.⁸⁻¹¹ Similarly, in diverticular haemorrhage, mortality depends to a large extent on comorbidity. In most cases, the cause of death is not the bleeding per se.¹²⁻¹⁷

Associated diseases

Statement 3.4.1 Evidence level 2, strong consensus
 The probability of a diagnosis of adenoma or carcinoma is significantly increased in patients with a history of diverticulitis.

(Continued)

However, there is no conclusive evidence of a heightened risk of colorectal cancer in diverticulosis.

Statement 3.4.2 Evidence level 2, strong consensus
There is no conclusive evidence for an association of diverticulosis with the occurrence of inflammatory bowel disease.

Statement 3.4.3 Evidence level 2, strong consensus
Diverticulosis can be associated with segmental colitis.

Statement 3.4.4 Evidence level 2, strong consensus
There is no evidence of an association between mucosal inflammation markers and diverticulosis with clinical symptoms.

All statements commented in supplementary materials.

CHAPTER 4: DIAGNOSIS AND CLASSIFICATION

Background; medical history, basic diagnosis, differential diagnosis

Recommendation 4.1 Evidence level 3, recommendation grade A, strong consensus
The medical history contributes fundamentally to the assessment of the disease potential of diverticulosis and should therefore always be recorded.

Recommendation 4.2 Evidence level 3, recommendation grade 0, strong consensus
Calprotectin can be used for differential diagnosis.

Recommendation 4.3 Evidence level 2, recommendation grade A, strong consensus
If diverticulitis is suspected, a physical examination and laboratory tests including leucocytes, C-reactive protein and urinary status should be performed.

Recommendation 4.4 Evidence level 2, recommendation grade B, strong consensus
Diverticulitis should be considered as a differential diagnosis of acute abdominal pain even in younger patients (<40 years of age).

Recommendation 4.5 Expert consensus, strong recommendation, strong consensus
Diverticulitis should be considered as a differential diagnosis of acute abdominal pain, even if the localisation of the pain is right-sided or suprapubic.

All recommendations commented in supplemental material.

Ultrasound / CT Imaging

Recommendation 4.6

To confirm the diagnosis of diverticulitis, a cross sectional imaging procedure should be carried out.

Evidence level 1, recommendation grade A, strong consensus

Comment—Recommendation—4.6

Different studies have consistently shown clinical diagnosis (without imaging procedures) of diverticulitis to have a substantial error rate. The studies of Toorenvliet et al.¹⁸ and Laméris et al.¹⁹ reported a sensitivity of 68% and a positive predictive value of 65%, and a sensitivity of 71%, respectively. Laurell et al.²⁰ found a similar sensitivity (64%), despite the already mentioned limitations. Schwerk et al.²¹ report a false positive purely clinical assessment of “highly suspected diverticulitis” in 9/28 cases and 44/68 cases with a less clear clinical suspicion (“possible but equivocal diverticulitis”), as well as a false negative assessment in 9/34 cases (“diverticulitis very unlikely”).

Recommendation 4.7

Ultrasound or computed tomography (CT) should be used as diagnostic procedures upon suspicion of diverticulitis.

Evidence level 1, recommendation grade A, strong consensus

Comment—Recommendation—4.7

Both sectional imaging methods (ultrasound, CT) illuminate the extraluminal structures, enabling a comprehensive differential diagnostic assessment of diverticulitis and related complications.

The colonic barium enema should no longer be used to diagnose diverticulitis.

Special technical preparations are not required for sonography in diverticulitis; in fact, acute diverticulitis is the most easily learnable ultrasound diagnosis of the intestinal tract.

The use of a high-resolution scanner head (>/= 5 MHz) ensures optimal resolution with, as a rule, sufficient soundability under well-dosed compression. The advantage of sonography is that imaging can be directly targeted according to the patient's description of the maximum point of pain and the palpation findings, where the diverticulitis and its complications, if applicable, will be localised. The characteristic findings can usually be found at this site; alongside the precisely localisable pressure pain, these include

- (1) the (depending on the extrusion of the causative faecalith²²) variable (i.e., +/- half-moon-shaped gas reflex in the inflamed

- diverticulum) hypoechoic appearance of the inflamed diverticulum, surrounded by
- (2) an echogenic mesenteric cap (pericolonic, inflammatory reaction of the fatty tissue) and
 - (3) a hypoechoic, initially asymmetrical wall thickening (>5 mm) with loss of wall layering, reduced deformability under pressure and constriction of the lumen, and
 - (4) occasionally hypoechoic strands of inflammation²²⁻²⁴

The hypoechoic diverticular protrusion with an echogenic centre has also been referred to as the dome sign (in patients with right-sided diverticulitis).²⁵

The sonographic criteria of an abscess are hypoechoic/anechoic paracolic or intramural foci formation with echogenic reverberation echoes or comet tail artefacts; on the other hand, gas reflexes within hypoechoic band-shaped structures are characteristic of fistulas. Key structures of overt perforation are evidence of free air and free, mixed echogenically reflecting fluids.

Using high-resolution sound frequencies (≥ 7.5 MHz), it is possible to reliably visualise the layers of the intestinal wall, which can be helpful for the differential diagnostic evaluation of diverticulitis. Muscle hypertrophy and elastosis, as well as nutritive vessels that thus run perpendicularly through the sigmoid wall, are regular findings that are prerequisite to (left-sided) diverticula formation. In about 85% of cases, endoscopically verified diverticulosis (without indication of the focus of pain) can be correctly detected sonographically, whereby the number of diverticula detected in ultrasound is always lower than in colonoscopy.²⁶

In acute diverticulitis, at the hands of an experienced examiner, the sensitivity and specificity of abdominal sonography with directed questions and prospective evaluation are each 98%.²¹ Direct visualisation of the inflamed diverticulum is possible with a sensitivity of 96% in uncomplicated acute diverticulitis, but noticeably more difficult in the case of complicated findings (overall sensitivity 77%, specificity 99%).²⁴ Whereas ultrasound is mostly primarily focussed on the (painful) inflamed diverticulum, the detection of an inflamed diverticulum as sole criterion in computed tomography (CT) diagnostics achieves a sensitivity of only 43%.²⁷

An early systematic prospective comparative study from France shows an accuracy of 84% for both sonography and CT; the sensitivity was 85 versus 91%, specificity 84 versus 77%, Positive Predictive Value (PPV) 85 versus 81%, and Negative Predictive Value 84 versus 88%. With regard to other, alternative diagnoses, the sensitivity of CT was higher, at 50% versus 33% (ultrasound), as was also the case for the detection of pericolonic abscesses.²⁷ A retrospective analysis from Spain shows a sensitivity of 86% in operated patients with acute diverticulitis, but 94% sensitivity in all patients with acute diverticulitis. The difference shows that uncomplicated acute diverticulitis, in particular, is a domain of sonography; however, this older study also found that 10 of 34 patients who underwent emergency surgery had false negative ultrasound findings (sensitivity 70%).²⁸

Due to developments in equipment, techniques and thematic know-how standards, both investigations must be regarded as no longer representative.

In a comparative prospective study from Germany with 4 experienced ultrasound examiners and the CT facilities of a university clinic, sonography showed a sensitivity of 100% (CT 98%), while the specificity of both methods was 97%. In cases of extensive peridiverticulitis and covert perforations, CT showed a clear tendency towards overstaging, whereas sonography showed a somewhat less pronounced tendency towards understaging. Overt perforations or abscesses were not missed by either procedure.²⁹

Like sonography, CT is a practicable and valuable examination where there is suspicion of acute diverticulitis. Both are suitable techniques to visualise the diagnosis and the severity of diverticulitis, to identify important differential diagnoses, and to guide the surgical approach in a stratified manner.

Diagnostic criteria for diverticulitis are the direct detection of inflamed diverticula, thickening of the intestinal wall to over 3 (5) mm and increased contrast medium absorption in CT and MRI (and, where appropriate, in contrast-enhanced ultrasound/CEUS). Indirect signs are perifocal mesenteric injection and free abdominal fluid as an expression of inflammation. Covert or overt perforations or evidence of abscesses detected by any imaging procedure are signs of complicated diverticulitis.

For CT, older studies still using a single-line detector configuration showed sensitivities and specificities of 87%–100% and 90%–100%, respectively.^{27,30-32} The technique was found to be highly suited as a means of determining disease severity and, if necessary, of initiating further surgical consequences.^{33,34} In initially conservatively treated patients, the severity of changes in the CT scan is an indicator of the likely necessity for surgery in the further disease course; however, even in the case of severe CT findings (pericolonic air, abscess), there was no indication for surgery in the majority of patients during the course of disease.³³ Complications such as abscesses and covert or overt perforations can be evaluated by CT with a high degree of certainty.³⁵ Early studies showed CT to be superior to sonography.²⁸ CT-guided, interventional abscess relief can improve patient outcomes prior to surgery.³⁶⁻³⁸

Recommendation 4.8

The technical implementation of CT can be modified depending on the clinical situation. A suitable methodology should be chosen and everything possible undertaken to minimise radiation exposure. Evidence level 2, recommendation grade A, strong consensus

Comment—Recommendation 4.8

Computed tomography is currently performed in most German clinics as an examination with positive intravenous and oral contrast using diluted iodine-containing contrast agents. In addition, for better assessment of the rectum and sigmoid colon, rectal contrast via

enema with a water-soluble contrast agent is recommended. The examination is carried out as a regular abdomen CT in the portal venous phase, with a tube voltage of 100–120 kVp and a tube current of around 120 mAs.

In recent years, studies have been conducted that dispensed with not only intravenous, but also oral and rectal contrasting; in addition, the use of modern multi-line CTs, which employ a low-dose technique with 30 mAs, can achieve the same diagnostic results as regular CT.³⁹ Theoretically, this could reduce radiation exposure from an average of 10 mSv to around 3 mSv, which would broaden the usability of the investigation. A comparison between single-line and multi-line technology in CT has not been conducted. Since studies using the single-line technique already achieved sensitivities and specificities of almost 100%, there is no relevant benefit to be expected from multi-line diagnostics.

As regards technology, therefore, it can be asserted that all modern CTs appear to be adequate and suitable for diagnosis. On the question of contrast, be it intravenous, oral or rectal, there are few publications suggesting that it may be possible to dispense with any type of contrast agent.³⁹ As yet, the evidence level of these few studies is insufficient for general application. Currently, if there are no contraindications, the technique with contrast should be used.

In the older, surgically dominated literature, CT is often the only cross-sectional imaging method that is used. A study from the Netherlands gives cause for critical consideration in this context: The study examined the validity of preoperative CT in all patients ($n = 75$) who underwent emergency surgery for perforated diverticulitis, after having been examined by CT within 24 h prior to the operation. The assessment was carried out retrospectively by two independent radiologists on the basis of the CT data sets, taking no account of the clinical presentation. The accuracy of the CT for different stages of perforation unexpectedly turned out to be only 71%–92% (PPV 45%–89%), and thus considerably lower than generally assumed. In 42% of patients with Hinchey stage 3, the study showed understaging in the CT (Hinchey stage 1 or 2) (indicating that CT has a PPV of only 61% for Hinchey stages 1 and 2).⁴⁰

In a comparable study from Germany, the preoperative CT was compared with intraoperative findings and histology in 204 patients. In patients with Hansen & Stock (HS) stage IIa (phlegmon), correct detection was found in 52% (intraoperative findings) and 56% (histology). Understaging was found in 12 (11%) and overstaging in 36 (33%). The accuracy of staging for abscessing (HS IIb, Hinchey I/II) was 92% (intraoperative findings) and 90% (histology), with understaging in 3% and 0%, respectively, and overstaging in 5 (10%). Overt perforation (HS IIc, Hinchey III/IV) was recorded correctly in 100%, yielding a PPV for CT of 52 (56)%, 92 (90)% and 100 (100)% for HS IIa, HS IIb and HS IIc, respectively.⁴¹ The value of the radiological assessment thus seems to be clearly examiner-dependent in the (important) HS stage IIa/IIb (understaging in the Netherlands, overstaging in Germany). For the preoperative differential diagnosis of phlegmonous diverticulitis (HS IIa) versus perforated diverticulitis (HS IIb/IIc), CT cannot universally be considered the gold standard.

Recommendation 4.9

MRI examinations can be performed on a case-by-case basis, but should not be used for routine diagnosis of diverticulitis
Expert consensus, recommendation, strong consensus

Comment- Recommendation—4.9

The use of MRI to assess colonic diverticulitis is not yet widespread, either in practice or in studies. There are several problems concerning its practical implementation: Severe abdominal pain during the long procedure required for data acquisition often results in motion artefacts. Occasionally, claustrophobia prevents the examination from being adequately conducted. MRI is also associated with higher costs than CT and, in many clinics, MRI is not available around the clock for emergency examinations. What is more, the clinically and therapeutically very important issue of small air pockets around the colon when diagnosing overt or covert perforation is especially difficult to assess with MRI; as a result, its usefulness in complicated diverticulitis is very limited. To date, a systematic evaluation of the limit of detectability of small quantities of abdominal air is lacking in the literature. The technique has only been evaluated in small, usually specially chosen patient collectives.^{42–45} Based on the results of these studies, it can only be concluded that similar results are achievable using MRI with oral or rectal contrast, or with intravenous contrast agent administration, as can be achieved by CT. However, it must be noted that there are no available studies dedicated to complicated diverticulitis or the detection of small pockets of free air in covert perforation.

In the absence of study data, it is not possible to give a definitive recommendation for the technical implementation of MRI in diverticulitis. Currently, analogous to CT imaging, a contrast-enhanced MRI examination with intravenous, oral and rectal contrast should be performed. The protocol should include high-resolution T1 weighted 3D gradient echo sequences as well as T2 sequences to allow assessment of acute inflammatory situations. The question as to whether intraluminal contrast using the dark-lumen technique⁴⁴ or T1 positive contrast can achieve a better differential diagnosis of abscesses⁴³ has not yet been answered in the literature.

Colon MRI for diagnosis of diverticulitis should therefore only be carried out in centres conducting controlled studies and in certain specific cases (e.g., examinations in pregnant women or paediatric patients, for reasons of radiation reduction).

Endoscopy, haemorrhages, interventions, fistulas

Colonoscopy in acute diverticulitis.

Recommendation 4.10

Colonoscopy should not be used to diagnose acute diverticulitis.
Evidence level 2, recommendation grade B, strong consensus

Comment—Recommendation 4.10

Colonoscopy can explain abdominal complaints, is able to detect lower Gastrointestinal (GI) bleeding and to rule out tumours. It is suited for the differentiation between diverticula and mucosal inflammation and polypoid findings or diverticulosis with an atypical or symptomatic course.⁴⁶

Colonoscopy is not required to detect acute diverticulitis⁴⁷; an increased risk of perforation, although unproven, cannot be ruled out.

Endoscopically visible inflammatory changes at the diverticular neck are detected in about 0.8% of colonoscopies without the presence of acute diverticulitis.⁴⁸

Luminal changes are secondary in the pathogenesis of diverticulitis, since the disease begins as a bacterial penetration into the depths of the diverticulum, and crucial complications (phlegmon, microperforation, fistula, abscess) are transmural. If sonography indicates the intestinal wall to be thickened by >11 mm, colonoscopy shows the spontaneous drainage of pus from inflamed diverticula.⁴⁹

Recommendation 4.11

In certain situations (e.g., uncharacteristic clinical picture or disease course), colonoscopy (probably with a slightly increased risk of perforation) can be performed in acute diverticulitis, provided covert perforation and abscesses have been ruled out.

Evidence level 4, recommendation grade 0, strong consensus

Comment—Recommendation—4.11

Due to insufficient data, opinions regarding the safety and importance of colonoscopy differ considerably.

In a series of 54 patients with diverticulitis, perforation occurred during colonoscopy in 1.9%; however, in a further 39 patients in whom covert perforation or abscess had been excluded by CT, no perforations were observed. A total of two CT-negative adenocarcinomas and a bone fragment in the inflamed diverticulum were detected as relevant findings.⁵⁰ The colonoscopies were carried out 4–12 days after hospital admission (median 5.8 days). The rate of total colonoscopies (reaching the caecum or tumour stenosis in 81.7% of cases) was lower than in an elective situation.

In the same clinic, a study was conducted to investigate early (in the hospital stay) versus postponed (after 6 weeks) colonoscopy for CT-confirmed diverticulitis. The authors identified neither perforations, nor any diagnostic gain.⁴⁷ They did, however, recognise a benefit for patients with an atypical disease course who had persistent symptoms after a week of antibiotic therapy or a relapse within 2 months. In this situation (23/224 patients), a therapeutically relevant diagnosis was made by colonoscopy in 4/23 cases (17%): in 3 cases, an adenocarcinoma, and in one case, a chicken bone lodged in a diverticulum, which was successfully endoscopically removed.⁵¹

Statement 4.12

In patients with fully healed conservatively treated diverticulitis (usually after 6–8 weeks), the indication for colonoscopy should be based on clinical and anamnestic factors (protracted disease, persistent symptoms, patient age, imaging).

Evidence level 3, recommendation grade B, strong consensus

Comment—Recommendation—4.12

Until now, colonoscopy has often been recommended (a) in principle after conservatively treated acute diverticulitis and (b) before sigmoid resection. This recommendation is based firstly on the differential diagnosis of other diseases with similar symptoms, and secondly, on coincidence of synchronous carcinoma or adenoma in predominantly older patients.

However, the importance and necessity of colonoscopy has been called into question by several studies in differing healthcare systems, due to the quality of consistent CT diagnostics of diverticulitis (and doubtless also on the grounds of health-economic considerations).

In a retrospective longitudinal study of 205 patients with a CT-guided diagnosis of acute uncomplicated diverticulitis, colonoscopy revealed adenomas in 9.3% of patients, 5.4% of which were advanced neoplasms.⁵² One patient was diagnosed with sigmoid carcinoma and one with Inflammatory Bowel Disease (IBD) (however, these two patients reported symptoms that would in any case have prompted colonoscopy). This rate of adenoma and carcinoma detection is somewhat lower than would be statistically expected based on the evaluation of data from screening colonoscopies.

In 100 patients four to six weeks after hospital treatment for acute diverticulitis (CT-based diagnosis), colonoscopy revealed at least one polyp in 32%, advanced adenoma in only one case and not a single malignancy; therefore, there were only a few (directly) relevant findings in only a small number of cases.⁵³

Though, prognostically, even findings of non-advanced adenoma should generally be considered a relevant pathology of the colon, other investigations allow detection of coincidental colon carcinoma on a larger scale. A widely cited retrospective study from the USA found that 5 out of 73 (7%) patients who underwent surgery for acute diverticulitis at the University Hospital of St. Louis between 1992 and 2001 had a previously undetected colon carcinoma.⁵⁴

In addition, a database analysis from Australia⁵⁵ found a slightly increased rate (2.1%) of colon carcinoma within one year after CT-based diagnosis of left-sided diverticulitis (evaluation of 1088 patients; comparison with the national cancer registry). In 319 patients, colonoscopy was performed within one year after diverticulitis was diagnosed: In nine of these patients, a colon carcinoma was identified (2.8%).

A systematic literature search on the usefulness of colonoscopy with respect to colon carcinoma detection up to 24 weeks after CT diagnosis of diverticulitis identified only 10 studies, with 771 documented patients.⁵⁶ The rate of colorectal cancer was 2.1% (95% Confidence Interval 1.2%–3.2%), and thus well above the expected prevalence (0.68%) in US citizens aged >55 years.

In another meta-analysis⁵⁷ that included 1796 patients after resolution of diverticulitis, the prevalence of carcinoma was 1.6% and the rate of detected polyps 20.2%. A systematic review by Meyer et al.⁵⁸ showed almost identical results, with a 1.9% prevalence of colorectal cancer (polyps 22.7%, advanced adenomas 4.4%, adenomas 14.2%). This review also showed that Colorectal Carcinoma was found significantly more frequently in patients with complicated than with uncomplicated diverticulitis (7.9% vs. 1.3%).

In a prospective, multicentric study,⁵⁹ no differences were observed in the prevalence of carcinoma or adenoma in patients who had had diverticulitis compared with a group undergoing routine screening.

Thus, the recommendation for total colonoscopy in patients >50 years of age with clinically conspicuous diverticular disease who have not undergone colonoscopy <5 years previously equates to a special situation of preventive colonoscopy; that is, colonoscopy is useful, despite reports of discrepant views from other health care systems.

This recommendation also serves to decisively counter the patients' subjective view that ultrasound or CT examination carried out due to the diverticulitis might be sufficient to rule out malignancy or dysplasia.

Indisputably, colonoscopy makes an essential contribution to further diagnostic clarification of CT-detected thickening of the colon wall.^{60,61} Likewise, in the case of bowel stenosis, that is, including patients with recurrent diverticulitis with an indication for surgery, colonoscopy should generally be performed to ascertain the dignity (malignant vs. benign) of the stenosis. Since diverticulitis can also occasionally mask IBD, in patients with persistent pain, blood and/or mucus in the stool and signs of inflammation, it seems appropriate to confirm the diagnosis by colonoscopy, regardless of the patient's age.⁶²

Medical history and clinical findings

Recommendation 4.13

Medical history taking in patients with suspected diverticular haemorrhage should include questioning on the severity of the bleeding, as well as risk factors for prolonged bleeding and recurrent bleeding.

Evidence level 2, recommendation grade A, strong consensus

Recommendation 4.14

In addition to a shock index assessment, the examination should include evaluation of signs of anaemia, cardiovascular risk factors and other comorbidities, as well as abdominal palpation and rectal examination.

Evidence level 2, recommendation grade A, strong consensus

Comment—Recommendation—4.13 and 4.14

Painless lower GI bleeding is predominantly ascribable to arterial diverticular bleeding (35%) and angiodysplasia (21%)⁶³; in elderly patients with diverticula, diverticular bleeding accounts for up to 50% of lower GI bleeding,^{64,65} whereby diverticular bleeding is, however, usually a complication of diverticulosis rather than diverticulitis.

The aims of diagnosis and therapy of arterial diverticular haemorrhage are to clearly localise the source of bleeding, assess its severity and the probability of recurrence, and stop the bleeding - if possible as a definitive therapy, that is, also in respect of subsequent rebleeding.

Details of earlier bleeding severity are based on the patient's (only limitedly reliable) description of the amount of blood. Blood pressure and pulse rate (shock index) indicate the circulatory impact of the bleeding.⁶⁴ Validated scores like those used in upper GI bleeding (Rockall, Glasgow Blatchford) have not been reported. While spontaneous descriptions of the colour of lower GI bleeding are often questionable, a colour comparison chart can be helpful.⁶⁶

Recurrent bleeding is more often found in patients with endoscopically detected active bleeding or evidence of a vascular stump and coagulum-covered bleeding site, as well as those with arterial hypertension (RR 4.2), platelet aggregation inhibition (RR 2.4) or NSAIDs (RR 2.6).⁶⁷

Anticoagulant drugs also constitute a risk for more severe bleeding and rebleeding.⁶⁸

In accordance with the S2k guideline "Gastrointestinal Bleeding",⁶⁹ if diverticular bleeding is suspected, gastroscopy should be performed early to rule out severe upper GI bleeding as the cause of haematochezia.⁶⁴

Recommendation 4.15a

In patients with lower gastrointestinal bleeding with haemodynamic instability, alongside measures to stabilise the circulation and having ruled out anorectal or gastric sources of bleeding (procto-rectoscopy, gastroscopy), a colonoscopy should be performed within 12 h of admission. Bowel cleansing should be shortened and intensified.

Evidence level 2, recommendation grade B, strong consensus

Recommendation 4.15b

In patients who are haemodynamically stable, a colonoscopy should be performed within 12–24 h.

Evidence level 1, recommendation grade A, strong consensus

Comment- Recommendation—4.15a and 4.15b

In the case of acute peranal bleeding, upper GI bleeding must be considered as a differential diagnosis; thus, gastroscopy should be performed as early as possible. If the gastroscopy findings fail to explain the bleeding, a sigmoidoscopy should be carried out in order to rule out an anorectal source of bleeding.

Haematochezia with fresh blood arouses high suspicion of a bleeding source in the lower GI tract. However, peranal passage of

fresh blood can also be a manifestation of heavy upper GI bleeding with a rapid transit time.

Diverticular bleeding is clinically indistinguishable from severe colonic bleeding of other origins; a priori, therefore, the situation is one of lower (i.e., colonic) GI bleeding. In this context, it should be noted that upper and mid-GI bleeding describes bleeding not only from within the gastroscopically visible segment, but also from anywhere within the whole small bowel. Heavy bleeding from the upper and mid-GI tract can mimic lower GI bleeding by causing the passing of brighter-coloured blood. Therefore, alongside colonoscopy, esophagogastroduodenoscopy is also part of the diagnostic concept, and additionally, if no evidence is found of a probable source of bleeding, (capsule) endoscopy of the small bowel (in haemodynamically stable patients) or angiography (in unstable patients).

Since diverticular bleeding stops spontaneously in 90% of cases, early colonoscopy is generally recommended in order to precisely identify the source of bleeding. Early colonoscopy (here, <24 h; OR 8.4), an experienced endoscopist (>1000 colonoscopies; OR 3.0), use of an Endo-Cap (OR 3.4) and use of a water jet rinse (OR 5.8) were proven to be prognostically favourable factors in lower GI bleeding.⁷⁰ Reliable identification of the bleeding source is achieved in 22% of early elective colonoscopies, that is, 7.5 times more frequently than after 24 h ($p < 0.01$) and 22 times more frequently than after 48 h ($p < 0.01$). In addition to the detection and localisation of the bleeding source, however, the application of endoscopic therapy should also be a primary aim.⁷¹ In patients with active haematochezia and diverticula, early colonoscopy (<12 h) with antegrade irrigation allows bleeding diverticula to be identified and interventionally treated in at least 20% of cases.⁷² Therefore, in patients with haemodynamical instability, having ruled out upper GI and anorectal bleeding, it seems necessary to perform colonoscopy after shortened bowel prep (4–6 L polyethylene glycol solution; if required, via a gastric tube over up to 12 h), applying additional cleaning methods such as enemas, and using an endowasher, as required. In stable patients, it is sufficient to use conventional preparation (split dosage) and perform the examination within 12–24 h. The detection rate of certain or probable sources of bleeding decreases over time.

Indication for and techniques of endoscopic haemostasis in diverticular bleeding

Statement 4.16

(Definitive) identifiable diverticular bleeding during colonoscopy is an indication for endoscopic haemostasis.
Expert consensus, strong consensus

Comment—Statement—4.16

The following are considered stigmata of definitive diverticular bleeding:

- (a) endoscopically visible, active bleeding from the diverticulum,
- (b) a blood clot adherent to the diverticulum, and
- (c) a visible vascular stump,^{63,72}

while, on the other hand, diverticular bleeding is considered presumptive if

- (a) fresh blood is found segmentally in the proximity of diverticula during total colonoscopy, or
- (b) in patients with brightly coloured lower GI bleeding, a colonoscopy pinpoints colonic diverticula as the sole source of bleeding and upper GI bleeding (including capsule endoscopy) can be ruled out, or if
- (c) in the multidetector CT, a leakage of contrast medium is clearly attributable to a diverticulum^{63,72,73}

Poncet et al.⁷⁴ reported spontaneous cessation of bleeding in 92.4% of a population of 133 patients with definitive or probable diverticular haemorrhage (among 1145 patients undergoing colonoscopy due to lower GI bleeding) over a period of 8½ years. An intervention was required in only 10/133 patients, 3 endoscopic, 4 radiological, and 3 surgical; additionally, 4 of the 7 patients initially receiving an endoscopic/radiological intervention required surgery as a secondary measure.

Although, in the light of these data, diverticular haemorrhage may appear prognostically favourable, it must not be trivialised, since there is a considerable tendency for recurrence, risk factors for rebleeding (including age, hypertension, low-dose American Society of Anesthesiologists (ASA), and NSAIDs) are widespread, and emergency surgery without exact localisation of the bleeding is associated with relevant morbidity and mortality.

The current literature, predominantly from Asia, shows that endoscopic band ligation (EBL) is superior to endoscopic clipping in terms of the rebleeding rate (6% vs. 33%; $p = 0.018$), while both procedures achieve an initial haemostasis rate of 100% without complications due to the respective techniques.⁷⁵ In another Japanese multicentre study, the rebleeding rate under EBL was 10%, compared with 31% after endoscopic clipping ($p < 0.01$).⁷⁶ Early rebleeding was shown to emanate mainly from the same diverticulum as the initial bleeding. The main risk factor for earlier recurrence was the localisation of diverticular bleeding in the right colon, a peculiarity in Asia; it is thus unclear whether these results are transferable to the sigmoidal pseudodiverticula that are predominant in Western Europe.

As an alternative to rubber band ligation, the application of a so-called “over-the-scope clip” (OTSC) may be considered. In some case series, this procedure also seems to have a favourable effect on the further course of disease.^{77,78}

Although afflicted with many uncertainties, the questionnaire-based retrospective study of Mizuki et al.⁷⁹ at least suggests that left-sided diverticula are less likely to bleed recurrently than right-sided or bilateral diverticula. The finding of this study, that non-

interventionally treated patients had fewer rebleeding episodes (38.7% vs. 61.5%, $p < 0.05$) than those in the endoscopic intervention arm (clipping or adrenaline injection at the diverticular neck) should not be understood as an indication that the intervention increases the bleeding risk, but rather as an expression of the limitations of such an analysis. The detection of definitive bleeding stigmata was linked to therapeutic intervention, while the absence of a clear source of bleeding was associated with conservative treatment. In addition, no statement was made concerning the severity of bleeding (shock index, transfusions, haematocrit); therefore, despite having similar epidemiological data, the groups do not appear by any means comparable.

In Asia, bilateral diverticula increase the risk of acute diverticular haemorrhage ($p = 0.0021$), as do obesity, arterial hypertension, coronary sclerosis and low-dose ASA.⁸⁰

Indication for radiological or surgical therapy

Recommendation 4.17

In patients with persistent bleeding or clinically relevant rebleeding after initially successful endoscopic haemostasis, endoscopic, surgical, or radiologic-interventional therapy should be performed.

Expert consensus, strong recommendation, strong consensus

Comment—Recommendation—4.17

Today, it is generally accepted that in the therapeutic management of GI bleeding, the possibilities of endoscopic diagnostics and therapy should be first exploited.^{72,81–84} In the case of repeated or persistent bleeding without an endoscopically clearly identifiable source, a CT angiography (or angiography) should be performed for localisation diagnostics during the suspected active bleeding.

Computed tomography angiography and conventional angiography (+/–Digital Subtraction Angiography [DSA]) are valid options for localising diverticular haemorrhage during active bleeding. In practice, however, their use is rarely required. Computed tomography angiography enables reliable localisation of a haemorrhage if bleeding is still sufficiently active at the time of examination.⁸⁵ The same applies to conventional angiography, which offers the additional advantage of possible intervention (haemostasis through arterial embolisation: transcatheter arterial embolisation, TAE).

In a retrospective study, transarterial embolisation was performed in 52 patients with lower GI bleeding. The source of bleeding could only be clearly localised in 32/52 cases. Technical success was reported in 100%; however, there was a 30-day rebleeding rate of 27% and a 30-day mortality of 29%. In two patients, postinterventional intestinal ischaemia occurred.⁸⁶

Thus, the availability of technical equipment and personnel with sufficient expertise are of greater importance in acute severe haemorrhage than in less severe cases; this is particularly relevant when considering whether to transport patients if the appropriate equipment/expertise is lacking. In this situation - although there are no studies to confirm this - experience has shown that if endoscopic

therapy is insufficiently effective, emergency surgery, as an option that is both reliable and well proven, should be given preference.

In a retrospective study, the mortality rate associated with emergency colectomy for diverticular haemorrhage was 17% and the rate of non-fatal complications 20%.⁸⁷

Recommendation 4.18

In patients with recurrent, haemodynamically effective diverticular haemorrhage and a need for lifelong anticoagulation, there may be an indication for elective partial colectomy during the remission interval.

Expert consensus, recommendation open, strong consensus

Comment—Recommendation—4.18

There are no data available from clinical studies for this scenario. The individual decision must be made by the attending physician after detailed discussion with the patient, taking into account the perioperative risk of elective surgery compared with the perioperative risk of emergency surgery in the event of diverticular bleeding that cannot be stopped endoscopically.

Severe, endoscopically not manageable bleeding

Statement 4.19

In the threatening situation of severe active bleeding that cannot be either endoscopically or angiographically located, surgical exploration, possibly with colectomy (dissection at the terminal ileum and in the upper third of the rectum), is justifiable.

Expert consensus, strong consensus

Comment—Statement—4.19

There are no clinical data to show what is the most suitable surgical procedure. If the bleeding cannot be endoscopically and interventionally localised and brought under control, there is a vital indication for urgent surgical therapy. Since these patients are critically ill and often multimorbid, laparotomy should be followed by colectomy, this being the fastest procedure. Whether to perform an anastomosis by means of ileorectostomy, or a discontinuity resection with closure of the anorectal stump and creation of a terminal ileostomy, is an individual decision in which the bleeding activity and intensity (previous transfusions) and the patient's comorbidity must be taken into account. In view of the fact that patients in the emergency situation are predominantly critically ill, discontinuity resection is usually the procedure of choice. In the study by Plummer et al., for instance, anastomotic leak was the most common cause of postoperative mortality.⁸⁷

Likewise, in very rare cases of non-localised recurrent haemorrhage requiring repeated transfusions, subtotal resection can be indicated. If this intervention is performed electively, the choice of

procedure should be made individually, based on the characteristics of the patient and the experience of the surgeon. Studies comparing laparoscopic and conventional resection in this situation are not available.^{88,89}

Recommendation 4.20

If diverticular bleeding is recurrent or not to stop but clearly localisable, segmental resection can be performed.

Expert consensus, recommendation open, strong consensus

Comment—Recommendation 4.20

Few clinical data are available on the extent of surgical resection in patients with localisable diverticular bleeding. In a retrospective study of 42 consecutive patients with diverticular haemorrhage in the years 1993–2000, bleeding was localisable in 6 patients by colonoscopy ($n = 2$) or angiography ($n = 4$). Ten patients were treated by segmental resection and 32 patients underwent colectomy. In 5 of the 10 patients with segmental colon resection, the bleeding was localisable by colonoscopy, whereas this was achieved in only one of the 32 subtotal colectomised patients. The patients who underwent segmental resection were 10 years younger (65 ± 13 vs. 75 ± 12 years; $p = 0.03$), while there was no difference in the duration of surgery (208 ± 77 vs. 212 ± 58 min). Intraoperative blood loss was higher for subtotal resection (578 ± 347 ml) than for segmental resection (305 ± 146 ml; $p = 0.02$). No difference was found with regard to in-hospital morbidity (20 vs. 19%), mortality (10 vs. 3%), rebleeding (12.5 vs. 0%), stool frequency (2.4 ± 1 vs. 3.5 ± 2), the Cleveland Clinic incontinence score (0.6 ± 1 vs. 2 ± 3.6) or patient satisfaction over a mean follow-up period of 4.1 (0.5–7.4) years (p in each case > 0.05).⁸⁸ Older studies essentially confirm these results.⁸⁹ Against this background, segmental and total colectomy are justifiable procedures in certain individual cases.

In surgical practice, if the site of the bleeding is clear, segmental colectomy is more frequently performed.

Diagnostic procedures upon suspicion of sigmoidesical or colovaginal fistula

Recommendation 4.21

If there is clinical suspicion of sigmoidesical fistula and the fistula has not already been described morphologically (ultrasound, CT, MRI, colonoscopy), a poppy seed test should be performed.

Evidence level 2, recommendation grade B, strong consensus

Comment - Statement 4.21

Fistulas to the urinary bladder or vagina are a relevant complication of diverticulitis. About 90% of fistulas in diverticulitis involve these two entities, while fistulas to the small bowel, skin, uterus or ovaries,

psoas muscles or hip joints are less common findings.⁹⁰ The vast majority of patients (ca. 85%) with a sigmoidesical fistula are male.

In patients with sigmoidesical fistula, sonography or CT often shows a focal wall thickening of the (filled) bladder; evidence of air in the bladder in this situation confirms the fistula. Affected patients often report the presence of air bubbles in the urine (“champagne urine”) only when questioned; on the other hand, recurrent or therapy-refractory urinary tract infections and dysuria are characteristic and show the diagnostic path forward. No matter which tomographic technique is used, direct fistula detection is only realisable in a certain proportion of cases. If the symptoms are clear (pneumaturia, recurrent urinary tract infection), suspicion of an enterovesical fistula in the cross-sectional imaging is a sufficient indication for sigmoid resection.

While colonoscopy can detect residual inflammatory activity, Crohn's disease as an important differential diagnosis, and stenosis, endoscopic diagnosis of fistulas succeeds only rarely ($< 10\%$).⁹⁰ Similarly, detection rates of cystoscopy (10%), cystography (17%), colonic barium contrast imaging (36%), MRI (60%) and CT (61%) are disappointing. Qualitative detection of a fistula is best performed (sensitivity 95%) by the so-called poppy seed test, in which 250 g natural poppy seeds are taken in the evening and the urine is examined for the appearance of poppy seeds over the next 48 h.^{91,92}

The extent to which urological diagnostics are useful or necessary before sigmoid resection and fistula excision must therefore be decided on a case-by-case basis, and is consequently more often determined by local factors.

In another modification, 35 g poppy seeds were consumed in 160 g yoghurt or with 340 ml liquid; here, too, the poppy seed test, with a sensitivity of 100%, was significantly ($p = 0.03$) superior to CT examination (70% sensitivity) — at 8.2% of the cost.⁹³

In principle, the poppy seed test is also suitable for detecting a colovaginal fistula; it is recommended to insert a tampon or cotton wool pad for detection after ingestion of the test substance. In individual cases, colposcopy and vaginal transrectal endosonography can be useful supplementary techniques in addition to sonography and CT; general or comparable information on the respective detection rates of these methods is not available.

Classification

Recommendation 4.22a

The diagnosis of diverticular disease should include a classification. Evidence level 1, recommendation grade A, consensus

Comment—Recommendation 4.22

The Classification of diverticular disease (CDD) allows different degrees of severity and different situations to be categorised. This is useful if it is linked with different diagnostic and/or therapeutic pathways and recommendations, the provision and use of different

measures, and the possibility to improve safety for both patient and physician.

In principle, therefore, a classification should cover all facets of diverticular disease without becoming impractical by being excessively detailed and structurally emphasising rare situations. In addition, it should allow the disease course to be easily and correctly described according to the specific situation.

Statement 4.22b

The guidelines conference continues to recommend the use of the CDD (Table 3), which in this new version takes into account not only the discussions concerning SUDD, but also the practicalities of diagnostics in diverticulitis.

Evidence level 2, consensus

Comment—Recommendation 4.22b

In 2014, the DGVS and DGAV adopted a new classification, the CDD (Table 3), which has since found its way into the literature and clinical practice.⁹⁴

As evidenced by diverse classifications that accommodate national circumstances and take into account not only diagnostics and therapy, but also new aspects of aetiology, pathogenesis and the

nosological understanding of the disease, the classifications of Hinchey (including the modifications by Sher and Wasvary), Ambrosetti and Hansen/Stock (and their modifications by Köhler and Siewert) can now be considered outdated in terms of their practical relevance and/or content.

The scope of the more recent (since 2011) guidelines and classifications, and the relative weighting of different content, is presented in a thorough review by Galetin et al. (2018),⁹⁵ in which the previous S2k guideline of the DGVS/DGAV (2014).⁹⁶

Numerous classifications and modifications describe the various stages of diverticular disease. For current critical reviews, see^{97,98} and.⁹⁵

While Hinchey's classification was primarily aimed at stratifying surgical procedures appropriate to different manifestations of macroscopically perforated diverticulitis with abscess or overt perforation, and has subsequently undergone various modifications, the aim of a CDD and diverticulitis applicable in visceral medicine today must be

- (a) to describe the different forms of diverticular disease, independent of surgery, and
- (b) to enable stratification for different prognoses and therapy forms (outpatient/inpatient; need for antibiotic therapy;

TABLE 3 Classification of diverticular disease (CDD)

Classification of diverticular disease (CDD)		
Type 0	Asymptomatic diverticulosis	
	Incidental finding; asymptomatic	Not a disease
Type 1	Uncomplicated diverticular disease/diverticulitis	
Type 1a	Diverticulitis/diverticular disease without phlegmonous reaction of the surrounding tissue	
	Diverticulum-associable symptoms	
	Signs of inflammation and/or	
	Evidence of inflammation in the imaging (wall thickening, inflamed diverticulum)	
Type 1b	Diverticulitis with phlegmonous reaction of the surrounding tissue	
	Signs of inflammation; phlegmonous diverticulitis (colon wall, mesentery)	
	In the imaging: Possibly with strands of fluid (without air)	
Type 2	Complicated diverticulitis	
Type 2a	Microabscess	Covert perforation, small abscess (≤ 3 cm); minimal paracolic air
Type 2b	Macroabscess	Paracolic or mesocolic abscess (> 3 cm)
Type 2c	Overt perforation	Overt perforation, free air/fluid, generalised peritonitis
Type 2c1	Purulent peritonitis	
Type 2c2	Faecal peritonitis	
Type 3	Chronic diverticular disease	
Type 3a	Persistent/recurrent symptoms associated with diverticulitis (SUDD)	
Type 3b	Recurrent diverticulitis without complications	
Type 3c	Recurrent diverticulitis with complications	(Stenosis, fistula, conglomerate)
Type 4	Diverticular haemorrhage	Evidence of bleeding source

conservative/interventional/surgical) at initial diagnosis and in recurrent disease. It also needs to serve as a basis for adequate case depiction in diagnosis-based remuneration.

Both of these goals are achieved primarily by the Hinchey classification as modified by Wasvary,^{99,100} and by the classification of HS.¹⁰¹ However, the former includes only the different manifestations of diverticulitis with a category of mild clinical diverticulitis (relevant for outpatient treatment), while the classification by HS does not further differentiate perforated disease (micro/macroporforation, abscess size and site).

An advantage of the HS classification was the inclusion of chronic relapsing (recurrent) disease. However, it does not differentiate between chronic recurrent disease without complications (individual indication for elective surgery) and chronic recurrent disease with complications (obligatory indication for surgical therapy). In the Hansen-Stock classification, acute diverticulitis with accompanying phlegmon falls under the category of complicated diverticulitis.

The CDD classification correctly classifies this disease type as uncomplicated, with a good prognosis under conservative therapy. In particular, the sonographic finding of a hyperechoic mesenteric cap as a correlate of peridiverticular changes is found in both stages HS I and HS IIa (without being categorised as complicated diverticulitis). The boundary between HS I and HS IIa is difficult to visualise with CT (or with sonography) and a differentiation between microperforation and macroperforation, which would be desirable, is lacking.

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CONFLICT OF INTEREST

Honoraria for talks AllergoSan, Graz, Austria. Falk, Freiburg, Germany. Ferring Arzneimittel, Kiel, Germany. Nikkiso, Langenhagen, Germany. Consultation and studies Falk Pharma, Freiburg, Germany. Ferring Arzneimittel, Kiel, Germany. No other conflict of interest.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analysed in this study.

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REFERENCES

- Lammert F, Lynen Jansen P, Lerch MM. Weissbuch Gastroenterologie 2020/2021. Berlin: DeGruyter; 2019.
- OCEBM Levels of Evidence Working Group*. The Oxford levels of evidence 2. Oxford Centre for Evidence-Based Medicine. * OCEBM Levels of Evidence Working Group = Jeremy Howick, Iain Chalmers (James Lind Library), Paul Glasziou, Trish Greenhalgh, Carl Heneghan, Alessandro Liberati, Ivan Moschetti, Bob Phillips, Hazel Thornton, Olive Goddard and Mary Hodgkinson. (abgerufen am 05.03.2020). <https://www.cebm.net/index.aspx?o=5653>
- CEBM (Centre for Evidence-Based Medicine). Critical appraisal tools; 2017. (abgerufen am 05.03.2020). <http://www.cebm.net/critical-appraisal/>
- Newcastle-Ottawa Scale (NOS) for assessing the quality of non-randomized studies in meta-analyses (2014). (abgerufen am 06.03.2020). http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp
- Hsu CW, Wang JH, Kung YH, Chang MC. What is the predictor of surgical mortality in adult colorectal perforation? The clinical characteristics and results of a multivariate logistic regression analysis. *Surg Today*. 2017;47(6):683–9. <https://doi.org/10.1007/s00595-016-1415-4> zuletzt 4 Ab hier -S 10-270 wieder im Text
- Ballian N, Rajamanickam V, Harms BA, Foley EF, Heise CP, Greenberg CC, et al. Predictors of mortality after emergent surgery for acute colonic diverticulitis: analysis of National Surgical Quality Improvement Project data. *J Trauma Acute Care Surg*. 2013; 74(2):611–6. <https://doi.org/10.1097/TA.0b013e31827d5d93>
- Fleming MM, Liu F, Zhang Y, Pei KY. Model for end-stage liver disease underestimates morbidity and mortality in patients with ascites undergoing colectomy. *World J Surg*. 2018;42(10):3390–7. <https://doi.org/10.1007/s00268-018-4591-0>
- Biondo S, Trenti L, Elvira J, Golda T, Kreisler E. Outcomes of colonic diverticulitis according to the reason of immunosuppression. *Am J Surg*. 2016;212(3):384–90. <https://doi.org/10.1016/j.amjsurg.2016.01.038>
- Samdani T, Pieracci FM, Eachempati SR, Benarroch-Gampel J, Weiss A, Pietanza MC, et al. Colonic diverticulitis in chemotherapy patients: should operative indications change? A retrospective cohort study. *Int J Surg*. 2014;12:1489–94. <https://doi.org/10.1016/j.ijisu.2014.10.032>
- Golda T, Kreisler E, Mercader C, Frago R, Trenti L, Biondo S. Emergency surgery for perforated diverticulitis in the immunosuppressed patient. *Colorectal Dis*. 2014;16(9):723–31. <https://doi.org/10.1111/codi.12685>
- Biondo S, Borao JL, Kreisler E, Golda T, Millan M, Frago R, et al. Recurrence and virulence of colonic diverticulitis in immunocompromised patients. *Am J Surg*. 2012;204(2):172–9. <https://doi.org/10.1016/j.amjsurg.2011.09.027>
- Fukuda S, Shimodaira Y, Watanabe K, Takahashi S, Sugawara K, Suzuki Y, et al. Risks for rebleeding and in-hospital mortality after gastrointestinal bleeding in a tertiary referral center in Japan. *Digestion*. 2020;101(1):31–7. <https://doi.org/10.1159/000504088>
- Oakland K, Desborough MJ, Murphy MF, Schachter M, Jairath V. Rebleeding and mortality after lower gastrointestinal bleeding in patients taking Antiplatelets or Anticoagulants. *Clin Gastroenterol Hepatol*. 2019;17(7):1276–84.e1273. <https://doi.org/10.1016/j.cgh.2017.12.032>
- Lenti MV, Pasina L, Cococcia S, Cortesi L, Miceli E, Caccia Dominioni C, et al. Mortality rate and risk factors for gastrointestinal bleeding in elderly patients. *Eur J Intern Med*. 2019;61:54–61. <https://doi.org/10.1016/j.ejim.2018.11.003>
- Lorenzo D, Gallois C, Lahmek P, Lesgourgues B, Champion C, Charpignon C, et al. Middle-term mortality and re-bleeding after

- initial diverticular bleeding: a nationwide study of 365 mostly elderly French patients. *United European Gastroenterol J*. 2017;5(1):119–27. <https://doi.org/10.1177/2050640616647816>
16. Niikura R, Yasunaga H, Yamaji Y, Horiguchi H, Fushimi K, Yamada A, et al. Factors affecting in-hospital mortality in patients with lower gastrointestinal tract bleeding: a retrospective study using a national database in Japan. *J Gastroenterol*. 2015;50(5):533–40. <https://doi.org/10.1007/s00535-014-0994-3>
 17. Strate LL, Ayanian JZ, Kotler G, Syngal S. Risk factors for mortality in lower intestinal bleeding. *Clin Gastroenterol Hepatol*. 2008;6(9):1004–10. quiz 1955-. <https://doi.org/10.1016/j.cgh.2008.03.021>
 18. Toorenvliet BR, Bakker RF, Breslau PJ, Merkus JWS, Hamming JF. Colonic diverticulitis: a prospective analysis of diagnostic accuracy and clinical decision-making. *Colorectal Dis*. 2010;12(3):179–86. <https://doi.org/10.1111/j.1463-1318.2009.01778.x>
 19. Lameris W, van Randen A, van Gulik TM, Busch ORC, Winkelhagen J, Bossuyt PMM, et al. A clinical decision rule to establish the diagnosis of acute diverticulitis at the emergency department. *Dis Colon Rectum*. 2010;53(6):896–904. <https://doi.org/10.1007/DCR.0b013e3181d98d86>
 20. Lameris W, van Randen A, van Gulik TM, Busch ORC, Winkelhagen J, Bossuyt PMM, et al. A clinical decision rule to establish the diagnosis of acute diverticulitis at the emergency department. *Dis Colon Rectum*. 2010;53(6):896–904. <https://doi.org/10.1007/DCR.0b013e3181d98d8>
 21. Schwerk WB, Schwarz S, Rothmund M. Sonography in acute colonic diverticulitis. A prospective study. *Dis Colon Rectum*. 1992;35(11):1077–84. <https://doi.org/10.1007/bf02252999>
 22. Puylaert JB. Ultrasound of colon diverticulitis. *Dig Dis*. 2012;30(1):56–9. <https://doi.org/10.1159/000336620>
 23. Wilson SR, Toi A. The value of sonography in the diagnosis of acute diverticulitis of the colon. *AJR Am J Roentgenol*. 1990;154(6):1199–202. <https://doi.org/10.2214/ajr.154.6.2110728>
 24. Hollerweger A, Macheiner P, Rettenbacher T, Brunner W, Gritzmann N. Colonic diverticulitis: diagnostic value and appearance of inflamed diverticula-sonographic evaluation. *Eur Radiol*. 2001;11(10):1956–63. <https://doi.org/10.1007/s003300100942>
 25. Kori T, Nemoto M, Maeda M, Tsuzuki Y, Ando T, Sekihara M, et al. Sonographic features of acute colonic diverticulitis: the "dome sign". *J Clin Ultrasound*. 2000;28(7):340–6. [https://doi.org/10.1002/1097-0096\(200009\)28:7<340::aid-jcu4>3.0.co;2-b](https://doi.org/10.1002/1097-0096(200009)28:7<340::aid-jcu4>3.0.co;2-b)
 26. Hollerweger A, Macheiner P, Hubner E, Brunner W, Gritzmann N. [Colonic diverticulosis: a comparison between sonography and endoscopy]. *Ultraschall Med*. 2002;23(01):41–6. <https://doi.org/10.1055/s-2002-20075>
 27. Kircher MF, Rhea JT, Kihiczak D, Novelline RA. Frequency, sensitivity, and specificity of individual signs of diverticulitis on thin-section helical CT with colonic contrast material: experience with 312 cases. *AJR Am J Roentgenol*. 2002;178(6):1313–18. <https://doi.org/10.2214/ajr.178.6.1781313>
 28. Pradel JA, Adell JF, Taourel P, Djafari M, Monnin-Delhom E, Bruel JM. Acute colonic diverticulitis: prospective comparative evaluation with US and CT. *Radiology*. 1997;205(2):503–12. <https://doi.org/10.1148/radiology.205.2.9356636>
 29. Ripolles T, Agramunt M, Martínez MJ, Costa S, Gómez-Abril SA, Richart J. The role of ultrasound in the diagnosis, management and evolutive prognosis of acute left-sided colonic diverticulitis: a review of 208 patients. *Eur Radiol*. 2003;13(12):2587–95. <https://doi.org/10.1007/s00330-003-1861-4>
 30. Farag Soliman M, Wustner M, Sturm J, Werner A, Diehl S, Duber C, et al. [Primary diagnostics of acute diverticulitis of the sigmoid]. *Ultraschall Med*. 2004;25(05):342–7. <https://doi.org/10.1055/s-2004-813381>
 31. Stefansson T, Nyman R, Nilsson S, Ekbohm A, Pahlman L. Diverticulitis of the sigmoid colon. A comparison of CT, colonic enema and laparoscopy. *Acta Radiol*. 1997;38(2):313–19. <https://doi.org/10.1080/02841859709172071>
 32. Rao PM, Rhea JT, Novelline RA, Dobbins JM, Lawrason JN, Sacknoff R, et al. Helical CT with only colonic contrast material for diagnosing diverticulitis: prospective evaluation of 150 patients. *AJR Am J Roentgenol*. 1998;170(6):1445–9. <https://doi.org/10.2214/ajr.170.6.9609151>
 33. Werner A, Diehl SJ, Farag-Soliman M, Düber C. Multi-slice spiral CT in routine diagnosis of suspected acute left-sided colonic diverticulitis: a prospective study of 120 patients. *Eur Radiol*. 2003;13(12):2596–603. <https://doi.org/10.1007/s00330-003-1887-7>
 34. Ambrosetti P, Grosshöz M, Becker C, Terrier F, Morel P. Computed tomography in acute left colonic diverticulitis. *Br J Surg*. 1997;84(4):532–4. <https://doi.org/10.1046/j.1365-2168.1997.02576.x>
 35. Shaikh S, Krukowski ZH. Outcome of a conservative policy for managing acute sigmoid diverticulitis. *Br J Surg*. 2007;94(7):876–9. <https://doi.org/10.1002/bjs.5703>
 36. Lohrmann C, Ghanem N, Pache G, Makowiec F, Kötter E, Langer M. CT in acute perforated sigmoid diverticulitis. *Eur J Radiol*. 2005;56(1):78–83. <https://doi.org/10.1016/j.ejrad.2005.03.003>
 37. Singh B, May K, Coltart I, Moore N, Cunningham C. The long-term results of percutaneous drainage of diverticular abscess. *Ann R Coll Surg Engl*. 2008;90(4):297–301. <https://doi.org/10.1308/003588408x285928>
 38. Ambrosetti P, Chautems R, Soravia C, Peiris-Waser N, Terrier F. Long-term outcome of mesocolic and pelvic diverticular abscesses of the left colon: a prospective study of 73 cases. *Dis Colon Rectum*. 2005;48(4):787–91. <https://doi.org/10.1007/s10350-004-0853-z>
 39. Ambrosetti P, Robert J, Witzig JA, Mirescu D, de Gautard R, Borst F, et al. Incidence, outcome, and proposed management of isolated abscesses complicating acute left-sided colonic diverticulitis. A prospective study of 140 patients. *Dis Colon Rectum*. 1992;35(11):1072–6. <https://doi.org/10.1007/bf02252998>
 40. Tack D, Bohy P, Perlot I, De Maertelaer V, Alkeilani O, Sourtzis S, et al. Suspected acute colon diverticulitis: imaging with low-dose unenhanced multi-detector row CT. *Radiology*. 2005;237(1):189–96. <https://doi.org/10.1148/radiol.2371041432>
 41. Gielens MP, Mulder IM, van der Harst E, Gosselink MP, Kraal KJ, Teng HT, et al. Preoperative staging of perforated diverticulitis by computed tomography scanning. *Tech Coloproctol*. 2012;16(5):363–8. <https://doi.org/10.1007/s10151-012-0853-2>
 42. Ritz JP, Lehmann KS, Lodenkemper C, Frericks B, Buhr HJ, Holmer C. Preoperative CT staging in sigmoid diverticulitis--does it correlate with intraoperative and histological findings? *Langenbeck's Arch Surg*. 2010;395(8):1009–15. <https://doi.org/10.1007/s00423-010-0609-2>
 43. Heverhagen JT, Zielke A, Ishaque N, Bohrer T, El-Sheik M, Klose KJ. Acute colonic diverticulitis: visualization in magnetic resonance imaging. *Magn Reson Imaging*. 2001;19(10):1275–7. [https://doi.org/10.1016/s0730-725x\(01\)00469-6](https://doi.org/10.1016/s0730-725x(01)00469-6)
 44. Schreyer AG, Furst A, Agha A, Kikinis R, Scheibl K, Schölmerich J, et al. Magnetic resonance imaging based colonography for diagnosis and assessment of diverticulosis and diverticulitis. *Int J Colorectal Dis*. 2004;19(5):474–80. <https://doi.org/10.1007/s00384-004-0587-3>
 45. Ajaj W, Ruehm SG, Lauenstein T, Goehde S, Kuehle C, Herborn CU, et al. Dark-lumen magnetic resonance colonography in patients with suspected sigmoid diverticulitis: a feasibility study. *Eur Radiol*. 2005;15(11):2316–22. <https://doi.org/10.1007/s00330-005-2862-2>
 46. Heverhagen JT, Sitter H, Zielke A, Klose KJ. Prospective evaluation of the value of magnetic resonance imaging in suspected acute sigmoid diverticulitis. *Dis Colon Rectum*. 2008;51(12):1810–15. <https://doi.org/10.1007/s10350-008-9330-4>

47. Tursi A, Elisei W, Brandimarte G, Giorgetti GM, Lecca PG, Di Cesare L, et al. The endoscopic spectrum of segmental colitis associated with diverticulosis. *Colorectal Dis.* 2010;12(5):464–70. <https://doi.org/10.1111/j.1463-1318.2009.01969.x>
48. Lahat A, Yanai H, Menachem Y, Avidan B, Bar-Meir S. The feasibility and risk of early colonoscopy in acute diverticulitis: a prospective controlled study. *Endoscopy.* 2007;39(06):521–4. <https://doi.org/10.1055/s-2007-966399>
49. Ghorai S, Ulbright TM, Rex DK. Endoscopic findings of diverticular inflammation in colonoscopy patients without clinical acute diverticulitis: prevalence and endoscopic spectrum. *Am J Gastroenterol.* 2003;98(4):802–6. <https://doi.org/10.1111/j.1572-0241.2003.07383.x>
50. Herzog P. [Sonography in the diagnosis and follow-up of colonic diverticulitis]. *Z Gastroenterol.* 1989;27:426–31.
51. Sakhni E, Lahat A, Melzer E, Apter S, Simon C, Natour M, et al. Early colonoscopy in patients with acute diverticulitis: results of a prospective pilot study. *Endoscopy.* 2004;36(6):504–7. <https://doi.org/10.1055/s-2004-814398>
52. Lahat A, Yanai H, Sakhni E, Menachem Y, Bar-Meir S. Role of colonoscopy in patients with persistent acute diverticulitis. *World J Gastroenterol.* 2008;14(17):2763–6. <https://doi.org/10.3748/wjg.14.2763>
53. Westwood DA, Eglinton TW, Frizelle FA. Routine colonoscopy following acute uncomplicated diverticulitis. *Br J Surg.* 2011; 98(11):1630–4. <https://doi.org/10.1002/bjs.7602>
54. Schmilovitz-Weiss H, Yalunin E, Boaz M, Sehayek-Shabbat V, Levin I, Chervinski A, et al. Does a colonoscopy after acute diverticulitis affect its management?: a single center experience. *J Clin Gastroenterol.* 2012;46(4):317–20. <https://doi.org/10.1097/MCG.0b013e31823a43a1>
55. Granlund J, Svensson T, Granath F, Hjern F, Ekblom A, Blomqvist P, et al. Diverticular disease and the risk of colon cancer - a population-based case-control study. *Aliment Pharmacol Ther.* 2011;34(6): 675–81. <https://doi.org/10.1111/j.1365-2036.2011.04782.x>
56. Huang WY, Lin CC, Jen YM, Chang Y, Hsiao C, Yang M, et al. Association between colonic diverticular disease and colorectal cancer: a nationwide population-based study. *Clin Gastroenterol Hepatol.* 2014;12(8):1288–94. <https://doi.org/10.1016/j.cgh.2013.11.039>
57. Mortensen LQ, Burcharth J, Andresen K, Pommergaard HC, Rosenberg J. An 18-year nationwide cohort study on the association between diverticulitis and colon cancer. *Ann Surg.* 2017; 265(5):954–9. <https://doi.org/10.1097/sla.0000000000001794>
58. Jaruvongvanich V, Sanguankeo A, Wijarnpreecha K, Upala S. Risk of colorectal adenomas, advanced adenomas and cancer in patients with colonic diverticular disease: systematic review and meta-analysis. *Dig Endosc.* 2017;29(1):73–82. <https://doi.org/10.1111/den.12701>
59. Meyer J, Orci LA, Combescure C, Balaphas A, Morel P, Buchs NC, et al. Risk of colorectal cancer in patients with acute diverticulitis: a systematic review and meta-analysis of observational studies. *Clin Gastroenterol Hepatol.* 2019;17(8):1448–56.e1417. <https://doi.org/10.1016/j.cgh.2018.07.031>
60. Rottier SJ, van Dijk ST, van Geloven AAW, Schreurs WH, Draaisma WA, Enst WA, et al. Meta-analysis of the role of colonoscopy after an episode of left-sided acute diverticulitis. *Br J Surg.* 2019;106(8): 988–97. <https://doi.org/10.1002/bjs.11191>
61. Sultan K, Fields S, Panagopoulos G, Korelitz BI. The nature of inflammatory bowel disease in patients with coexistent colonic diverticulosis. *J Clin Gastroenterol.* 2006;40(4):317–21. <https://doi.org/10.1097/O1.mcg.0000210095.44123.6d>
62. Lahat A, Avidan B, Bar-Meir S, Chowers Y. Long-standing colonic inflammation is associated with a low prevalence of diverticuli in inflammatory bowel disease patients. *Inflamm Bowel Dis.* 2007; 13(6):733–6. <https://doi.org/10.1002/ibd.20065>
63. Cassieri C, Pica R, Avallone EV, Zippi M, Crispino P, De Nitto D, et al. Prevalence of colonic diverticulosis in patients affected by Ulcerative colitis: a prospective study. *J Clin Gastroenterol.* 2016;50(Suppl 1):S33–35. <https://doi.org/10.1097/mcg.0000000000000631>
64. Zuckerman GR, Prakash C. Acute lower intestinal bleeding. Part II: etiology, therapy, and outcomes. *Gastrointest Endosc.* 1999;49(2): 228–38. [https://doi.org/10.1016/s0016-5107\(99\)70491-8](https://doi.org/10.1016/s0016-5107(99)70491-8)
65. Farrell JJ, Friedman LS. Review article: the management of lower gastrointestinal bleeding. *Aliment Pharmacol Ther.* 2005;21(11): 1281–98. <https://doi.org/10.1111/j.1365-2036.2005.02485.x>
66. Green BT, Rockey DC, Portwood G, Tarnasky PR, Guarisco S, Branch MS, et al. Urgent colonoscopy for evaluation and management of acute lower gastrointestinal hemorrhage: a randomized controlled trial. *Am J Gastroenterol.* 2005;100(11):2395–402. <https://doi.org/10.1111/j.1572-0241.2005.00306.x>
67. Zuckerman GR, Trellis DR, Sherman TM, Clouse RE. An objective measure of stool color for differentiating upper from lower gastrointestinal bleeding. *Dig Dis Sci.* 1995;40(8):1614–21. <https://doi.org/10.1007/bf02212679>
68. Niikura R, Nagata N, Yamada A, Akiyama J, Shimbo T, Uemura N. Recurrence of colonic diverticular bleeding and associated risk factors. *Colorectal Dis.* 2012;14(3):302–5. <https://doi.org/10.1111/j.1463-1318.2011.02611.x>
69. Sugiyama T, Hirata Y, Kojima Y, Kanno T, Kimura M, Okuda Y, et al. Efficacy of contrast-enhanced computed tomography for the treatment strategy of colonic diverticular bleeding. *Intern Med.* 2015;54(23):2961–7. <https://doi.org/10.2169/internalmedicine.54.5097>
70. Gotz M, Anders M, Biecker E, Bojarski C, Braun G, Brechmann T, et al. [S2k guideline gastrointestinal bleeding - guideline of the German society of gastroenterology DGVS]. *Z Gastroenterol.* 2017;55(09):883–936. <https://doi.org/10.1055/s-0043-116856>
71. Niikura R, Nagata N, Aoki T, Shimbo T, Tanaka S, Sekine K, et al. Predictors for identification of stigmata of recent hemorrhage on colonic diverticula in lower gastrointestinal bleeding. *J Clin Gastroenterol.* 2015;49(3):e24–30. <https://doi.org/10.1097/MCG.000000000000140>
72. Cirocchi R, Trastulli S, Vettoretto N, Milani D, Cavaliere D, Renzi C, et al. Laparoscopic peritoneal lavage: a definitive treatment for diverticular peritonitis or a “bridge” to elective laparoscopic sigmoidectomy?: a systematic review. *Medicine (Baltimore).* 2015; 94(1):e334. <https://doi.org/10.1097/MD.0000000000000334>
73. Jensen DM, Machicado GA, Jutabha R, Kovacs TO. Urgent colonoscopy for the diagnosis and treatment of severe diverticular hemorrhage. *N Engl J Med.* 2000;342(2):78–82. <https://doi.org/10.1056/NEJM200001133420202>
74. Nagata N, Niikura R, Shimbo T, Ishizuka N, Yamano K, Mizuguchi K, et al. High-dose barium impaction therapy for the recurrence of colonic diverticular bleeding: a randomized controlled trial. *Ann Surg.* 2015;261(2):269–75. <https://doi.org/10.1097/SLA.0000000000000658>
75. Poncet G, Heluwaert F, Voirin D, Bonaz B, Faucheron JL. Natural history of acute colonic diverticular bleeding: a prospective study in 133 consecutive patients. *Aliment Pharmacol Ther.* 2010;32(3): 466–71. <https://doi.org/10.1111/j.1365-2936.2010.04362.x>
76. Setoyama T, Isii N, Fujita Y. Endoscopic band ligation (EBL) is superior to endoscopic clipping for the treatment of colonic diverticular hemorrhage. *Surg Endosc.* 2011;25(11):3574–8. <https://doi.org/10.1007/s00464-011-1760-8>
77. Okamoto N, Tominaga N, Sakata Y, Hara M, Yukimoto T, Tsuruta S, et al. Lower rebleeding rate after endoscopic band ligation than endoscopic clipping of the same colonic diverticular hemorrhagic

- lesion: a historical multicenter trial in Saga, Japan. *Intern Med.* 2019; 58(5):633–8. <https://doi.org/10.2169/internalmedicine.1473-18>
78. Kassab I, Dressner R, Gorcey S. Over-the-Scope clip for control of a recurrent diverticular bleed. *ACG Case Rep J.* 2015;3(1):5–6. <https://doi.org/10.14309/crj.2015.81>
 79. Wedi E, von Renteln D, Jung C, Tchoumak I, Roth V, Gonzales S, et al. Treatment of acute colonic diverticular bleeding in high risk patients, using an over-the-scope clip: a case series. *Endoscopy.* 2016;48(S 01):E383–5. <https://doi.org/10.1055/s-0042-118168>
 80. Mizuki A, Tatemichi M, Nakazawa A, Tsukada N, Nagata H, Kanai T. Long-Term clinical course after conservative and endoscopic treatment of colonic diverticular bleeding. *Digestion.* 2016;94(4):186–91. <https://doi.org/10.1159/000452301>
 81. Suzuki K, Uchiyama S, Imajyo K, Tomeno W, Sakai E, Yamada E, et al. Risk factors for colonic diverticular hemorrhage: Japanese multicenter study. *Digestion.* 2012;85(4):261–5. <https://doi.org/10.1159/000336351>
 82. Kaltenbach T, Watson R, Shah J, Friedland S, Sato T, Shergill A, et al. Colonoscopy with clipping is useful in the diagnosis and treatment of diverticular bleeding. *Clin Gastroenterol Hepatol.* 2012;10(2):131–7. <https://doi.org/10.1016/j.cgh.2011.10.029>
 83. Davila RE, Rajan E, Adler DG, Egan J, Hirota WK, Leighton JA, et al. ASGE Guideline: the role of endoscopy in the patient with lower-GI bleeding. *Gastrointest Endosc.* 2005;62(5):656–60. <https://doi.org/10.1016/j.gie.2005.07.032>
 84. Adams JB, Margolin DA. Management of diverticular hemorrhage. *Clin Colon Rectal Surg.* 2009;22(03):181–5. <https://doi.org/10.1055/s-0029-1236163>
 85. Lewis M. Bleeding colonic diverticula. *J Clin Gastroenterol.* 2008;42(10):1156–8. <https://doi.org/10.1097/MCG.0b013e3181862ad1>
 86. Sun H, Jin Z, Li X, Qian J, Yu J, Zhu F, et al. Detection and localization of active gastrointestinal bleeding with multidetector row computed tomography angiography: a 5-year prospective study in one medical center. *J Clin Gastroenterol.* 2012;46(1):31–41. <https://doi.org/10.1097/MCG.0b013e31823337ee>
 87. Lee HH, Oh JS, Park JM, Chun HJ, Kim TH, Cheung DY, et al. Transcatheter embolization effectively controls acute lower gastrointestinal bleeding without localizing bleeding site prior to angiography. *Scand J Gastroenterol.* 2018;53(9):1089–96. <https://doi.org/10.1080/00365521.2018.1501512>
 88. Plummer JM, Gibson TN, Mitchell DI, Herbert J, Henry T. Emergency subtotal colectomy for lower gastrointestinal haemorrhage: over-utilised or under-estimated? *Int J Clin Pract.* 2009;63(6):865–8. <https://doi.org/10.1111/j.1742-1241.2007.01632.x>
 89. Renzulli P, Maurer CA, Netzer P, Dinkel HP, Buchler MW. Subtotal colectomy with primary ileorectostomy is effective for unlocalized, diverticular hemorrhage. *Langenbeck's Arch Surg.* 2002;387(2):67–71. <https://doi.org/10.1007/s00423-002-0292-z>
 90. Schuetz A, Jauch KW. Lower gastrointestinal bleeding: therapeutic strategies, surgical techniques and results. *Langenbeck's Arch Surg.* 2001;386(1):17–25. <https://doi.org/10.1007/s00423000192>
 91. Krishnamoorthy S, Israel G. Imaging of acute diverticulitis. *J Clin Gastroenterol.* 2011;48(Suppl 1):S27–35. <https://doi.org/10.1097/mcg.0b013e318210c760>
 92. Schwaibold H, Popiel C, Geist E, Hartung R. Oral intake of poppy seed: a reliable and simple method for diagnosing vesico-enteric fistula. *J Urol.* 2001;166:530–1. <https://doi.org/10.1097/00005392-200108000-00026>
 93. Melchior S, Cudovic D, Jones J, Thomas C, Gillitzer R, Thuroff J. Diagnosis and surgical management of colovesical fistulas due to sigmoid diverticulitis. *J Urol.* 2009;182(3):978–82. <https://doi.org/10.1016/j.juro.2009.05.022>
 94. Kwon EO, Armenakas NA, Scharf SC, Panagopoulos G, Fracchia JA. The poppy seed test for colovesical fistula: big bang, little bucks. *J Urol.* 2008;179(4):1425–7. <https://doi.org/10.1016/j.juro.2007.11.085>
 95. Galetin T, Galetin A, Vestweber KH, Rink AD. Systematic review and comparison of national and international guidelines on diverticular disease. *Int J Colorectal Dis.* 2018;33(3):261–72. <https://doi.org/10.1007/s00384-17-2960-z>
 96. Kruis W, Germer CT, Leifeld L. Diverticular Disease: guidelines of the German society for gastroenterology, digestive and metabolic diseases and the German society for general and visceral surgery. *Digestion.* 2014;90(3):190–207. <https://doi.org/10.1159/000367625>
 97. Klarenbeek BR, de Korte N, van der Peet DL, Cuesta MA. Review of current classifications for diverticular disease and a translation into clinical practice. *Int J Colorectal Dis.* 2012;27(2):207–14. <https://doi.org/10.1007/s00384-011-1314-5>
 98. Böhm S. Diagnostik und Klassifikation der Divertikelkrankheit. *Viszeralmedizin.* 2012;28(3):171–81. <https://doi.org/10.1159/000339834>
 99. Hinchey EJ, Schaal PG, Richards GK. Treatment of perforated diverticular disease of the colon. *Adv Surg.* 1978;12:85–109.
 100. Wasvary H, Turfah F, Kadro O, Beauregard W. Same hospitalization resection for acute diverticulitis. *Am Surg.* 1999;65:632–5. Discussion 636.
 101. Hansen O, Stock W. Prophylaktische Operation bei der Divertikelkrankheit des Kolons. *Langenbeck's archives of surgery/Deutsche Gesellschaft für Chirurgie;* 1999. p. 1257–60.

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