Review article

The Indications for and Timing of Surgery for Diverticular Disease

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Summary

Background: Diverticular disease is one of the more common abdominal disorders. In 2016, approximately 130 000 patients received inpatient treatment for diverticular disease in Germany. The disease has a number of subtypes, each of which has an appropriate treatment. In this article, we present the current surgical indications and optimal timing of surgery for diverticular disease.

Methods: This review is based on publications that were retrieved by an extensive, selective search in Medline and the Cochrane Library (1998–2018) for studies and guidelines with information on the indications for surgery in diverticular disease.

Results: Studies of evidence grades 2 to 4 were available. Patients receiving a diagnosis of freely perforated diverticulitis and peritonitis (Classification of Diverticular Disease [CDD] type 2c) should be operated on at once. Covered perforated diverticulitis with a macroabscess (>1 cm, CDD type 2b) may be an indication for elective surgery after successful conservative treatment. New evidence from a randomized, controlled trial suggests that elective surgery should also be considered for patients with chronic recurrent diverticulitis (CDD type 3b). The decisive factor in such cases is the impairment of the quality of life for the individual patient. Elective surgery is indicated in chronic recurrent diverticulitis with complications (fistulae, stenoses). Asymptomatic diverticulosis (CDD type 0) and uncomplicated diverticulitis (CDD type 1) are not surgical indications. Likewise, in diverticular hemorrhage (CDD type 4), surgery is only indicated in exceptional cases, when conservative treatment fails.

Conclusion: The surgical indication and the proper timing of surgery depend on the type of disease that is present. Future studies should more thoroughly investigate the effect of surgery on the quality of life in patients with the various types of diverticular disease.

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Diverticular disease is one of the most common gastrointestinal conditions and diverticulitis is an important differential diagnosis of acute abdominal pain.

An analysis of the diagnosis data of the German Federal Statistical Office for 2016 identified more than 130 000 patients with diverticular disease treated

on an inpatient basis. A comparison with the oldest available dataset of the year 2000 revealed an almost 80% increase in inpatient cases (*eTable 1*).

Over the last two decades, the indications for surgery have undergone significant changes towards differentiated, patient-friendly and type-oriented treatment recommendation (*eTable 2*) (1, 2).

In addition, altogether 10 evidence-based recommendations on the diagnosis and management of diverticular disease have been published by various national and international specialist societies (3). In Germany, a consensus-based (S2k) “Diverticular Disease/Diverticulitis” guideline was jointly developed by the German Society of General Surgery and Visceral Surgery (DGAV, *Deutsche Gesellschaft für Allgemein- und Viszeralchirurgie*) and the German Society of Gastroenterology and Digestive and

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TABLE 1

Classification of diverticular disease (CDD) according to the German S2k guideline (4)

Term	Synonym	Definition	CDD
Asymptomatic diverticulosis		Identification of diverticula in colon ^{*1}	Type 0
Acute uncomplicated diverticulitis	Diverticulitis without perforation ^{*2}	Diverticulitis without peridiverticulitis	Type 1a
		Diverticulitis with phlegmonous peridiverticulitis	Type 1b
Acute complicated diverticulitis	Diverticulitis with covered perforation	Microabscess (≤ 1 cm), minimal free paracolic air	Type 2a
		Macroabscess (>1 cm)	Type 2b
	Free perforated diverticulitis	Purulent peritonitis	Type 2c*1
		Fecal peritonitis	Type 2c*2
Chronic diverticular disease	Symptomatic uncomplicated diverticular disease (SUDD)	Typical clinical features ^{*3}	Type 3a
	Relapsing diverticulitis without complications	Recurrent signs of inflammation	Type 3b
	Relapsing diverticulitis with complications	Identification of stenoses, fistulas, conglomerate tumor	Type 3c
Diverticular bleeding		Identification of source of bleeding	Type 4

^{*1} Typically diagnosed based on an incidental finding, e.g. during screening colonoscopy

^{*2} Defined as a diverticulitis with or without phlegmonous peridiverticulitis, but without clinical and/or radiographic signs of free or covered perforation

^{*3} This type of diverticular disease is defined by chronic relapsing or persistent symptomatic diverticular disease which cannot be identified by means of laboratory testing, radiography or endoscopy.

Metabolic Diseases (DGVS, *Deutsche Gesellschaft für Gastroenterologie, Verdauungs- und Stoffwechselerkrankungen*) in 2013 (4). This guideline introduced a classification addressing different types of diverticular disease which are defined in the German Classification of Diverticular Disease (CDD) (Table 1, eTable 3). Currently, the guideline is under revision.

Against the backdrop of these developments and the increasing complexity of treatment decisions, the authors prepared a selective review based on a selective search of the literature as part of a DGAV quality initiative and developed recommendations on the indications for surgery for the various types of diverticular disease. The following recommendations only apply to the indications for surgical management in adults. Detailed assessment of the preoperative workup and the choice of surgical technique was not within the scope of this analysis and the resulting recommendations. As a rule, a colonoscopy should be performed before patients undergo elective surgery, mainly to rule out the presence of a malignancy (e1–e3).

Material and methods

This review is based on pertinent publications retrieved by an extensive selective search of the Medline and Cochrane Library databases (1998–2018) for studies and guidelines with statements about indications for the surgical management of diverticular disease. A detailed description of the literature search is provided in the eMethods section.

Results

The indications for and timing of surgery for diverticular disease are presented in Box 1 and the corresponding levels of evidence in Table 2. The included studies are listed in eTable 4.

Asymptomatic diverticulosis (CDD type 0)

Asymptomatic diverticulosis is not associated with disease and is not considered an indication for surgery (4).

Acute uncomplicated diverticular disease/diverticulitis (CDD type 1a/b)

Uncomplicated diverticulitis typically has a benign clinical course. Only 2% of patients experience progression to complicated diverticulitis (e1). Thus, uncomplicated diverticulitis is associated with a very low risk of perforation (5). Overall, only 9% to 11.5% of patients who required inpatient care were readmitted for treatment of diverticulitis within a period of four to five years (6, e5). In the light of the above, conservative treatment has become the standard of care for patients with acute uncomplicated diverticulitis. The 5-year risk for diverticulitis recurrence is approximately 15% to 20% and recurrences are not associated with an increased rate of complications (7). Radiographic signs predicting a complicated disease course or recurrence have not been found (e6).

Uncomplicated diverticulitis is not considered an indication for surgery. This view is based on various retrospective and prospective case series; pertinent randomized controlled trials are not available (4). As a result of this understanding, the number of elective surgeries has markedly dropped. A Canadian registry study on diverticulitis patients treated on an inpatient basis reported a decline in the elective 1-year resection rate after successful conservative treatment of diverticulitis from 9.6% in 2002 to 3.9% in 2011 (e7).

When looking at the changes in the conservative management of this type of diverticular disease, this context should also be taken into account. In the absence of relevant risk factors, treatment on an outpatient basis and avoidance of antibiotic therapy have increasingly been recommended (e8, e9). Recent meta-analyses of prospective randomized studies evaluating the effect of additional mesalazine treatment have shown that mesalazine can reduce persistent symptoms, but has no effect on the risk of diverticulitis recurrence (e10, e11).

A special type of acute uncomplicated diverticular disease is the so-called “smoldering” diverticulitis. It is characterized by persistent abdominal symptoms

(localized left lower quadrant pain)/signs of inflammation after uncomplicated diverticulitis. Typically, symptoms persist for at least three months and do not improve with antibiotic therapy (8). In this subgroup of patients, several cohort studies showed complete resolution of symptoms after elective sigmoidectomy in the majority of cases (9). In addition, gross pathological examination of the surgical specimens found macroscopic abscesses, indicating the presence of a process that could lead to complicated diverticulitis (10). The effectiveness of elective sigmoidectomy in improving the quality of life of patients with smoldering diverticulitis in the long term was confirmed by a randomized controlled trial from the Netherlands. The study showed that the quality of life was significantly better after surgical treatment compared to conservative treatment in the 5-year follow-up after surgery. Of the 109 included patients, 69 (63%) experienced persistent symptoms after the first episode of acute diverticulitis and did not develop chronic recurrent diverticulitis. (11, e12).

Acute complicated diverticulitis without free perforation (CDD type 2a/b)

Currently, a precise cut-off value to differentiate between uncomplicated and complicated abscess formation is not yet available. In the S2k guideline, an arbitrary value of 1 cm was proposed. In most of the published studies, patients with type 2a and type 2b diverticular disease are combined in a single cohort as patients with contained perforation. However, the commonly used Hinchey classification takes the location of the abscess into consideration (adjacent to colon vs. distant; see *eTable 3*, e13). Other authors, rather using the possibility of interventional drainage or prognostic significance as a guidance, have proposed 3–4 cm (e14, e15).

According to the German guideline, primary treatment of patients with CDD types 2a and 2b should be conservative and hospitalization of these patients for parenteral antibiotic therapy is generally recommended (4). In approximately 15% of patients, however, conservative management fails and patients develop persistent/increasing abdominal pain or inflammation which, in the worst case, may culminate in secondary perforation (*eTable 5*). A large Danish registry study reported a 30-day mortality after acute complicated diverticulitis of 8.7% (12). Thus, this inflammation is to be considered severe and life-threatening.

Macroabscess formation can be treated by percutaneous abscess drainage; the German S2k guideline mentions this option for larger abscesses (> about 4 cm) (4). However, no prospective randomized studies demonstrating that this intervention increases the effectiveness of conservative primary treatment have yet been published. However, a case-control study indicated that in patients with smaller abscesses antibiotic therapy alone is not necessarily inferior to percutaneous drainage plus antibiotics (13).

BOX 1

Indications for and timing of surgery for diverticulitis/diverticular disease

Immediate surgery is indicated in case of:

- Identification of free perforated sigmoid diverticulitis (CDD type 2c) with clinical or radiographic signs of peritonitis
- Failure of conservative treatment for complicated diverticulitis with progressive signs of infection/sepsis or acute abdomen
- Hemodynamically relevant, persistent diverticular bleeding uncontrollable by radiological interventions or endoscopy (CDD type 4)

Elective surgery is indicated in case of:

- Identification of complicated chronic diverticular disease CDD type 3c with formation of a fistula to the urogenital tract or symptomatic colonic stenosis

Elective surgery may be indicated:

- In the interval after conservative primary treatment of complicated sigmoid diverticulitis with macroabscess CDD type 2b
- For symptomatic uncomplicated diverticular disease CDD type 3a or chronic relapsing diverticulitis CDD type 3b depending on the reduction of quality of life
- For clinically relevant, recurrent diverticular bleeding refractory to interventional treatment CDD type 4 with confirmed source of bleeding after exhaustion of non-surgical treatment options

Surgery is not indicated in case of:

- Isolated detection of asymptomatic colonic diverticulosis CDD type 0
- Acute uncomplicated diverticulitis CDD type 1
- In the interval after conservative treatment of complicated sigmoid diverticulitis with microabscess CDD type 2a
- Self-limiting diverticular bleeding or diverticular bleeding controlled by interventional treatment CDD type 4

TABLE 2

The indications for and timing of surgery for diverticular disease by CDD type (Classification of Diverticular Disease)

CDD	Indication for surgery/grade of recommendation	Timing of surgery	Level of evidence*3
Type 1	None/0	–	3
Type 2a	None/0	–	2
Type 2b	Can/C	Elective (inflammation-free interval)	2
Type 2c	Shall/A	Immediately (emergency)	2
Type 3a*1	Can/C	Elective	3
Type 3b*1	Should/B	Elective	2
Type 3c	Should/B	Elective	3
Type 4*2	None/0	–	3

*1 Depending on symptoms and subjective reduction in quality of life

*2 Exception: individual cases, e.g. persistent, hemodynamically relevant diverticular bleeding uncontrollable by interventions

*3 Oxford Centre for Evidence-Based Medicine 2011 Levels of Evidence

These recommendations largely correspond to the content of the statements of the 2014 S2k guideline "diverticular disease / diverticulitis" (chapter 6). The "can" recommendation for special risk groups with CDD type 1a/b was not adopted. The guideline made no statement in respect to the treatment of CDD type 2a. Furthermore, no levels of evidence were stated in the consensus-based guideline.

BOX 2

Special risk groups

Younger patients

For younger patients (<40 years of age), an increasing incidence of diverticulitis has been reported. However, while there is no evidence of more aggressive disease courses in this age group, the risk of recurrence is higher compared to older patients (e54–e58). Thus, an indication for surgery should not be established based on age.

Obesity

Patients with morbid obesity have a significantly higher incidence of acute diverticulitis which is often more severe and the rate of emergency surgery is increased. However, the risk of recurrence does not appear to be elevated compared to persons of normal weight. Thus, an indication for surgery should not be established based on weight (e59–e63).

Immunocompromised patients/solid-organ transplant recipients

An increased incidence of diverticulitis has been reported in immunocompromised patients/solid-organ transplant recipients. With approximately 40%, the proportion of complicated inflammatory episodes also appears to be increased. Current studies, however, have indicated that the indication for surgery should not be established because of immunosuppression or organ transplant status (e64–e68).

Oncology patients

As a rule, patients receiving chemotherapy should not be treated differently from non-oncological patients. An indication for elective surgery should not be established because of a planned chemotherapy (e48).

The risk of a recurrence of diverticulitis after initially successful conservative treatment is >20% (10–61%; *eTable 5*). Macroabscesses are a common cause of readmission for inpatient treatment (14). Without surgical treatment, secondary complications, such as fistulas and abscesses, are reported to occur in about 50% of patients (e16). A Danish registry study observed that surgical treatment lowered the recurrence rate (<10% vs. 15–25%), but found no differences in recurrence-associated 10-year mortality between patients with conservative treatment, interventional abscess drainage and sigmoidectomy (1.1% vs. 2% vs. 0.6%) (15). All in all, the available cohort studies have reported of only one-third of patients with complicated diverticulitis and abscess who could be treated without sigmoidectomy (e16, e17). Data from a US registry including more than 200 000 patients clearly showed that the risk of death after elective sigmoidectomy was significantly lower (0.3%) compared to that after the second episode of diverticulitis (2.2–4.6%) (7).

Recently, the first single-center, prospective randomized clinical trial comparing sigmoidectomy versus observation after the first episode of complicated diverticulitis has been published (16). The primary

endpoint was the 2-year risk of recurrence. The study confirmed the high risk of recurrent diverticulitis after conservative treatment (32%, median at seven months), which was significantly higher compared to the risk after surgical treatment. However, conservative management could be continued in all patients with recurrent diverticulitis and did not result in increased morbidity or mortality (3-year follow-up). It deserves critical appreciation that—unlike in the above mentioned cohort studies—the majority of included patient had no abscess, a finding likely to be indicative of more favorable prognosis.

A retrospective cohort study from Germany which had shown an improvement in quality of life in patients with CDD type 2b after resection, failed to demonstrate this effect in patients with CDD type 2a (17).

Thus, it seems reasonable to apply more stringent criteria for the decision to perform elective resection for CDD type 2a compared to CDD type 2b. The German guideline provides no explicit recommendation with respect to the indication for surgery in CDD type 2a.

Overall, the literature shows that a significant risk of complicated recurrences remains after successful conservative treatment. Consequently, it is reasonable to already offer patients the option of elective surgery at the first episode of complicated diverticulitis (6, e18–e20). This is also reflected in international guidelines, most of which recommend elective resection, albeit some with restrictions (3). The UK National Institute for Health and Clinical Excellence (NICE) guideline on diverticular disease, last published at the end of 2019 (recommendation 1.3.29), recommends elective surgery after initially successful conservative treatment, if symptoms persist (18).

With respect to the timing of surgery after successful conservative primary therapy of acute complicated diverticulitis (CDD type 2), sigmoidectomy during the elective interval after four to six week has—because of significantly lower risks of complication—become the standard of care, rather than early elective surgery during the inpatient stay, even though evidence from randomized controlled trials in support of this approach is still unavailable (19, 20). For elective laparoscopic sigmoidectomy, a mortality rate of 0.3% to 0.4% is reported in the literature (7); the overall morbidity is approximately 15% and the rate of anastomotic leak is approximately 2%. Thus, the mortality and morbidity associated with this procedure is generally low (21).

In conclusion, since the likelihood that sigmoidectomy is required after complicated diverticulitis with macroabscess (CDD type 2b) is high, the option of elective surgery can already be discussed with patients after the first episode of complicated diverticulitis. By contrast, it is more likely that a wait-and-watch approach, as taken with CDD type 1b, will be adopted for CDD type 2a as well.

Free perforated diverticulitis (CDD type 2c)

CT-confirmed freely perforated diverticulitis and/or clinical signs of peritonitis are an absolute indication for surgery. These patients should be treated surgically immediately after they have been diagnosed with the condition. Currently, it is being discussed which surgical technique should be the procedure of choice. It can, however, be stated at this point that the initially advocated technique of laparoscopic lavage and drainage alone without resection offers neither mortality advantages nor a reduction in the complication rate at a high level of evidence and thus can no longer be recommended as the primary treatment (22, 23).

Symptomatic uncomplicated diverticular disease (CDD type 3a, SUDD)

In the literature, CDD type 3a is frequently also referred to as “symptomatic uncomplicated diverticular disease” (SUDD) or atypical diverticulitis (24). Before a patient can be diagnosed with CDD type 3a, irritable bowel syndrome has to be ruled out (e21). While patients with irritable bowel syndrome typically complain about diffuse, poorly localized, often cramping abdominal pain, gas and diarrhea, patients with CDD type 3a rather report mild to moderate dull pain localized in the left lower quadrant of the abdomen and a tendency to constipation. It generally has a favorable prognosis; episodes of acute diverticulitis are comparatively rare, occurring only in about 2% of patients (25).

Nevertheless, some cohort studies report significant amelioration of symptoms after elective sigmoidectomy (8–10). Consequently, elective surgery could improve the quality of life in individual patients with symptomatic, uncomplicated diverticular disease (SUDD, type 3a of CDD). The negative effect of relapses on quality of life should be a key factor to consider when making treatment decisions in these patients.

Relapsing diverticulitis without complications (CDD type 3b)

In the German guideline, the indication for surgical management of chronic relapsing diverticulitis without complications was very conservatively worded as a decision to be made on a case-by-case basis after careful risk-benefit assessment. The finding that the risk of perforation is highest (5% to 25%) with the first episode of diverticulitis and subsequently declines with the number of further episodes, is still valid. Consequently, the number of previous episodes of diverticulitis should not be used as a criterion for making the decision to treat a patient surgically (4). Nevertheless, the risk of recurrence increases with each further acute episode of inflammation (7, 14). At the time the German S2k guideline was released, the only randomized, controlled, multicenter trial, comparing conservative versus surgical treatment for relapsing diverticulitis (only 35% of the randomized patients), had not yet been published. Now, both short-term and long-term results as well as data on cost effectiveness are available (11, e12,

Key messages

- Prerequisite for establishing an indication for surgery is that the diverticulitis has been correctly classified based on clinical signs and symptoms as well as computed tomography findings.
- With the exception of free perforation, the primary treatment of acute diverticulitis is conservative.
- After successful conservative treatment of acute diverticulitis, surgical management is not generally indicated, regardless of the number of previous episodes of the disease.
- Patients with acute complicated diverticulitis with macroabscess treated successfully with non-surgical therapy may be offer elective surgery in the inflammation-free interval.
- In patients with chronic relapsing diverticulitis, an individual risk-benefit analysis for resection should be performed on a case-by-case basis, with special consideration of the quality of life of the patient.

e22). The primary endpoint was patient-reported health-related quality of life. At both six months and five years of follow-up, surgical treatment was found to be significantly superior to conservative treatment. In addition, 23% of the patients in the conservative treatment arm underwent surgery for persistent abdominal complaints within six months. In both study arms, mortality was zero and six-month morbidity rates were comparable (34% surgical arm; 40% conservative arm). Even though the study was terminated early because of difficulties in enrolling patients, it still constitutes the best evidence on the subject currently available. In conclusion, it should be noted that elective surgery can significantly improve the quality of life in these patients (medium effect size, Cohen's *d* of 0.47). The negative impact of relapses on quality of life should be a key factor to consider when making treatment decisions in these patients. Early elective resection, however, does not provide additional benefits compared to delayed elective surgery (20).

Relapsing diverticulitis with complications (CDD type 3c)

In patients with chronic relapsing diverticulitis with complications, the formation of a fistula to the urogenital tract is an absolute indication for surgery because of the associated risk of urosepsis (4). Likewise, symptomatic stenosis is an indication for surgery. Interventional endoscopic stent treatment is still experimental and should be reserved to the palliative situation (e23, e24).

Diverticular bleeding (CDD type 4)

Diverticular bleeding is primarily managed with conservative or interventional treatment (4). In approximately 90% of cases, diverticular bleeding is self-limiting. If the clinical situation requires interventional

treatment, primary endoscopic management is advisable; another option, if available, is angiography with selective embolisation (e25, e26). Thus, surgical treatment remains largely limited to individual patients as an option in situations where non-surgical treatment approaches have failed. Consequently, indications for surgery include hemodynamically relevant, persistent bleeding as an emergency indication, as well as indications on a case-by-case basis in patients with recurrent diverticular bleeding uncontrolled by interventional treatment and clinically relevant with known bleeding source, after all non-surgical treatment options have been exhausted.

Discussion

The indications for and timing of surgery for diverticular disease recommended above were developed based on a selective search of the literature and reflect the current evidence. It should be noted that generally no level-1-evidence recommendations are available; all in all, only few randomized controlled trials have been conducted. In the future, changes to these recommendations may be made in some grades of recommendation and for some CDD types once relevant new study data have become available. In upcoming studies, the quality of life will play a key role in establishing the indication for elective surgery.

In conclusion, there is a clear recommendation for elective sigmoidectomy in patients with CDD type 3c, but in the majority of patients (especially with type 2b, type 3a and type 3b) treatment decisions are made on an individual basis, taking into account the disease-related reduction in quality of life, the patient-reported distress, the risk of recurrence, as well as comorbidity, and should be discussed with each patient individually (see Box 2). We recommend that patients should always seek personal advice by an experienced surgeon.

The absolute and immediate indications for the surgical management of freely perforated diverticulitis (type 2c) and patients with complicated diverticulitis (type 2b) who did not respond to conservative treatment remain unchanged.

Overall, the implementation of these recommendations is intended to improve the quality of the indication for surgical management of diverticulitis/ diverticular disease in Germany.

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Conflict of interest statement

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► Supplementary material

For eReferences please refer to:
www.aerzteblatt-international.de/ref3520
eMethods, eFigures and eTables:
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Supplementary material to:

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eMETHODS

Addition to Material and methods

The types of diverticulitis/ diverticular disease are classified according to the German Classification of Diverticular Disease (CDD) presented in the German S2k guideline. This classification deliberately uses the term “type“ in contrast to the term “stage“, which is still used by some authors, to highlight that these are different categories of the disease rather than phases of a disease continuum that follow each other. As a rule, the CDD type classification is based on tomographic imaging. It has become the generally accepted standard to perform a computed tomography (CT) scan before deciding on the indication for surgery.

The selective search of the literature in the Medline and Cochrane Library databases was performed on 5 February 2019 according to the recommendations of the German Cochrane Center (e4). Starting from known, relevant articles, suitable search terms were identified. The search period was limited to 20 years in favor of more recent studies and their comparability. Only publications in English and German were considered.

The algorithm for the literature search included a basic algorithm and specific additions for each CDD type (*eFigure*).

Basic algorithm of the literature search

((diverticul*[ti] AND (sigmoi* OR colonic OR colorec*) AND (guideline*[tiab] OR surg*[tiab] OR operative [tiab] OR resection [tiab] OR management [tiab] OR indication [tiab] OR therapy [tiab] OR treatment [tiab]) AND (english[Language] OR german[Language]) AND („1998/01/01“[Date – Publication]: „3000“ [Date – Publication]) NOT jejunal [tiab] NOT duodenal [tiab] NOT zenker* [tiab])).

Search criteria according to type of diverticulitis/diverticular disease

Type 1

Basic algorithm AND (acute [tiab] OR uncomplicated [tiab] OR first episode [tiab] OR (immunosuppr*[tiab] OR immunodef*[tiab] OR polycyst*[tiab] OR dialys*[tiab])) NOT bleed* [tiab] NOT hemorrhag* [tiab] NOT perforat* [tiab]

Type 2a/b

Basic algorithm AND (abscess* [tiab] OR (hinchey [tiab] AND (I [tiab] OR II [tiab]))) OR (abscess* [tiab] AND recurrence [tiab])) NOT bleed* [tiab] NOT hemorrhag* [tiab] NOT perforat* [tiab]

Type 2c

Basic algorithm AND (perforat* [tiab] OR (hinchey [tiab] AND (III [tiab] OR IV [tiab]))) OR peritonitis [tiab] OR laparoscopic lavage [tiab] OR peritoneal lavage [tiab]))

Type 3

Basic algorithm AND (recurrent [tiab] OR natural [tiab] OR chronic*[tiab] OR smoldering [tiab] OR ongoing [tiab] OR fistul*[tiab] OR stenosis* [tiab])) NOT bleed* [tiab] NOT hemorrhag* [tiab] NOT perforat* [tiab]

Type 4

Basic algorithm AND (bleed* [tiab] OR hemorrh* [tiab])

eFIGURE 1

PRISMA diagram of article selection

This data analysis and recommendations derived from it were presented and discussed during 3 meetings of the DGAV Quality Commission. The Oxford criteria (version 2011) were used for evidence rating. The final recommendations were presented to the members of the quality commission and subsequently adopted in an open vote with strong consensus (>95% of participants consented). The identified 1577 abstracts of studies, guidelines and reviews were independently screened by four authors (JPR, TS, CR, CTG) and subsequently 132 full-text articles were reviewed (Endnote X9, Clarivate Analytics, Boston, USA). After selection of the articles based on their relevance for the indication for surgery, finally 38 original articles, 12 systematic reviews and meta-analyses and 10 national and international guidelines were selected and analyzed. Based on the results of this analysis, recommendations for the indications for surgery were drawn up.

This data analysis and recommendations derived from it were presented and discussed in 3 meetings of the DGAV Quality Commission. The Oxford criteria (version 2011) were used for evidence rating. The final recommendations were presented to the members of the DGAV quality commission and subsequently adopted in an open vote with strong consensus (>95% of participants agreed).

eTABLE 1

“Diverticular disease” diagnosis as the primary diagnosis of an in-patient stay

ICD-10/Primary diagnosis	2000 ^{*1}	2016 ^{*2}	Increase [%]
K00–K93 Diseases of the digestive systems	1 676 425	1 968 771	17.4 %
K57 Diverticulosis of intestine	72 677	130 542	79.6 %

Age group [years]	2000 ^{*1}	2016 ^{*2}	Percentage2016
Under 40	3965	5895	4.5 %
40–50	7896	14 502	11.1 %
50–60	12 361	27 870	21.3 %
60–70	19 448	26 512	20.3 %
70–80	18 956	29 960	23.0 %
Over 80	10 050	25 803	19.8 %

^{*1}Diagnosis data of patients in hospitals 2000, subject-matter series 12, series 6.2.1, published November 2004, German Federal Statistical Office, Wiesbaden 2004

^{*2}Diagnosis data of patients in hospitals 2016, subject-matter series 12, series 6.2.1, published on 20 November 2017, article number: 2120621167005, German Federal Statistical Office (Destatis), 2017

eTABLE 2

High-quality studies since the publication of the S2k guideline in May 2012

Study	Recruitment	Study type	Indication	Question	Primary study endpoint	Sample size	Result	Evidence level*
DIVER trial (6)	2009–2011	RCT	Acute uncomplicated diverticulitis	Outpatient vs. inpatient treatment	Treatment failure	n = 132 (66 vs. 66)	Outpatient vs. inpatient treatment	2
DIABOLO trial (e8)	2010–2012	RCT	1 st episode of acute uncomplicated diverticulitis (incl. paracolic abscess <5 cm)	Observational vs. antibiotic treatment	Time to recovery	n = 570 (283 vs. 287)	Observation alone does neither prolong symptom duration nor increase the risk of recurrence	2
DIRECT trial (12, e12)	2010–2014	RCT	Chronic symptomatic or relapsing diverticulitis	Elective sigmoidectomy vs. conservative treatment	Quality of life after 5 years	n = 109 (53 vs. 56)	Improvement of quality of life after elective sigmoidectomy	2
You et al. (16)	2011–2014	Single-center RCT	1 st episode of complicated diverticulitis with successful inpatient antibiotic therapy	Elective sigmoidectomy vs. observation	Recurrent diverticulitis at 24 months	n = 107 (26 vs. 81)	Increased recurrence rate after observation, but non-surgical management still possible	2
Marshall et al. (e27)	2015–2016	Meta-analysis of 3 RCTs	Perforated diverticulitis	Laparoscopic lavage vs. Hartmann resection	Rate of reintervention within 30 days	n = 307 (191 vs. 179)	Three times higher rate of reintervention after laparoscopic lavage with similar mortality	1
Khan et al. (e10)	2013–2017	Meta-analysis of 6 RCTs	Symptomatic uncomplicated diverticular disease	Effectiveness of mesalazine	Recurrent diverticulitis	n = 1 918	Mesalazine does not reduce the risk of recurrent diverticulitis	1
Cochrane Review (e28)	2009–2020	Meta-analysis of 3 RCTs	Acute diverticulitis	Laparoscopic vs. open sigmoidectomy	Impact on post-operative pain, quality of life and length of inpatient stay	n = 392 (186 vs. 172)	No relevant advantage of laparoscopic resection found	2
Gachabayov et al. (e29)	2012–2019	Meta-analysis of 4 RCTs	Perforated diverticulitis	Hartmann resection vs. anastomosis	Morbidity, mortality, stoma rate	n = 384 (204 vs. 180)	Advantage for primary anastomosis	1
Lee et al. (e30)	1990–2018	Systematic review	Acute complicated diverticulitis with abscess	Prognosis	Failure of conservative treatment	n = 12 601	Failure of conservative treatment 18.9%, recurrences 25.5% at 38-month follow-up	2

RCT, randomized controlled trial; * Oxford Centre for Evidence-Based Medicine 2011 Levels of Evidence; vs., versus

eTABLE 3

Known classification systems for diverticular disease/diverticulitis

	Classification of Diverticular Disease (CDD) (4)		Modified Hinchey classification (e31)		Hansen-Stock classification (e32)	
	Type	Definition	Stage	Definition	Stage	Definition
Asymptomatic diverticulosis	Type 0	Identification of diverticula in the colon	x	–	0	Identification of diverticula in the colon
Acute uncomplicated diverticulitis	Type 1a	Diverticulitis without peridiverticulitis	0	Diverticulitis without peridiverticulitis	I	Diverticulitis without peridiverticulitis
	Type 1b	Diverticulitis with phlegmonous peridiverticulitis	Ia	Diverticulitis with phlegmonous peridiverticulitis		
Acute complicated diverticulitis	Type 2a	Diverticulitis with micro-abscess (≤ 1 cm); minimal paracolic air	Ib	Diverticulitis with paracolic abscess	IIa	Diverticulitis with phlegmonous peridiverticulitis
	Type 2b	Diverticulitis with macro-abscess (> 1 cm)	II	Diverticulitis with distant pelvic or abdominal macro-abscess	IIb	Diverticulitis with abscess
	Type 2c1	Free perforation with purulent peritonitis	III	Free perforation with purulent peritonitis	IIc	Free perforation
	Type 2c2	Free perforation with fecal peritonitis	IV	Free perforation with fecal peritonitis		
Chronic diverticular disease	Type 3a	Chronic symptoms related to diverticulum after acute diverticulitis	–	–	–	–
	Type 3b	Recurrent diverticulitis	–	–	III	Chronic recurrent diverticulitis
	Type 3c	Identification of inflammatory stenoses, fistulas, conglomerate tumor	–	–		
Diverticular bleeding	Type 4	Identification of source of bleeding	–	–	–	–

eTABLE 4

List of included studies

Study	Recruitment/ time interval	Study type	Indication	Question	Sample size	Result
Ahmed (e25)	2002–2012	Retrospective	Diverticular bleeding	Interventional angiography as a definitive treatment	40	Two-third of patients did not require reintervention/surgery
Al-Khamis (e66)	2005–2012	Registry	Acute diverticulitis	Postoperative complication risks in case of immunosuppression	26.987	Increased mortality after emergency surgery (OR: 1.8) but not after elective surgery (OR: 1.1), but increased major complications (OR: 1.5)
Bolkenstein (e22)	2010–2014	RCT multicenter (DI-RECT trial)	Chronic complaints after acute diverticulitis/recurrent diverticulitis	Long-term quality of life	109	Lastingly improved quality of life after surgery compared to control group after 5 years
Boostrom (9)	2005–2009	Retrospective	Acute uncomplicated diverticulitis	Course after conservative treatment	684	82% make full recovery, 10% develop chronic inflammation ("smoldering" diverticulitis), in 8% persistent symptoms (atypical diverticulitis)
Brandhuber (17)	2000–2010	Prospective	Acute diverticulitis managed with primary conservative treatment	Long-term quality of life after elective surgery	138	Improvement of quality of life in patients with complicated diverticulitis (CDD type 2b)
Buchs (e33)	2007–2011	Prospective	Acute uncomplicated diverticulitis	Recurrence risk and complications over the course of the disease	280	Recurrent diverticulitis in 16% within 24 months; of these, only 2% with complicated recurrence
Buchwald (e34)	1998–2009	Retrospective	Complicated acute diverticulitis (Hinchey Ib-II)	Recurrence risk after conservative treatment	107	Complicated recurrent diverticulitis in 28% after 4 months
Chabok (e1)	2010–2014	Retrospective	Acute uncomplicated diverticulitis	Characterization of the natural course	642	Low complication risks, 1-year recurrence rate 6%
Colas (e35)	2009–2015	Retrospective multicenter	Complicated diverticulitis with free air without abscess or peritonitis (PDwAP)	Risk factors for failure of conservative treatment	91	Conservative treatment failure in 32%; risk factors air accumulations > 5 mm, free abdominal fluid, CRFP >15mg/dL
Costi (e36)	2001–2010	Retrospective	Complicated diverticulitis with free air without peritonitis	Potential of conservative treatment	39	Successful primary conservative treatment in 92%
Devaraj (e16)	2004–2014	Retrospective	Complicated acute diverticulitis (Hinchey Ib-II)	Recurrence risk after conservative treatment	210	60% recurrent diverticulitis after 5.3 months, 42% higher Hinchey stage with recurrence
Dharmarajan (e37)	1995–2008	Retrospective	Complicated acute diverticulitis with abscess or free air	Success rate of primary conservative treatment	136	Successful primary conservative treatment in 95% of patients
El-Sayed (e5)	2006–2011	Registry	Acute diverticulitis managed with primary conservative treatment	Recurrence risk and rehospitalization after conservative treatment	65 162	Rehospitalization for recurrent diverticulitis 11%, increased risk of abscess (OR: 1.5)
Gaertner (e38)	2002–2007	Retrospective	Acute complicated diverticulitis with percutaneous drainage	Recurrence risk after conservative treatment	218	In 15%, no surgery was required in the long term
Garfinkle (e39)	2000–2013	Retrospective	Acute complicated diverticulitis with abscess	Recurrence risk after conservative treatment	73	30% recurrent diverticulitis after 23 months, no increased perforation risk with watch-and-wait approach
Gregersen (15)	2000–2012	Registry	Acute complicated diverticulitis with abscess	Recurrence risk	3148	10-year recurrence rate with antibiotic therapy 15%, after percutaneous drainage 24%, after surgery 9%, overall about 50% complicated recurrences
Jalouta (e17)	2001–2012	Retrospective	Acute complicated diverticulitis with percutaneous drainage	Number of patients responding to conservative treatment in the long term	118	55% without surgery after 5 years, no increased perforation risk with watch-and-wait approach
Keränen (e40)	1998–2008	Retrospective	Chronic diverticulitis with stenosis	Outcome after endoscopic stenting	10	Serious complications in 5/10 patients, only recommended as a pre-operative bridging
Klarenbeek (e41)	1990–2000	Prospective	Acute diverticulitis	Characterization of the natural course	291	48% recurrent diverticulitis after conservative treatment

Study	Recruitment/ time interval	Study type	Indication	Question	Sample size	Result
Lambrichts (e14)	2008–2015	Retrospective multicenter	Complicated acute diverticulitis (Hinchey Ib-II)	Success rates of conservative treatment	447	27% treatment failure with 9% emergency surgery, multivariate risk factor abscess ≥ 3 cm; no improve- ment in effectiveness with percu- taneous drainage; 27% recurrent diverticulitis after conservative treat- ment
Li (e7)	2002–2012	Registry	Acute diverticulitis managed with primary conservative treatment	Characterization of the natu- ral course	14 124	Rehospitalization for recurrent diverticulitis 8%, recurrence with emergency surgery also after compli- cated diverticulitis only 4% to 6% after 5 years
Mari (10)	2016–2018	Prospective multicenter	Chronic symptomatic or relapsing uncompl- icated diverticulitis	Examination of the resection specimens for inflammation	158	Pathological identification of ab- scesses in 24% of abnormal, “smoldering” diverticulitis frequently complicated diverticulitis
Mizrahi (e42)	1998–2008	Retrospective	Acute diverticulitis managed with primary conservative treatment	Characterization of the natu- ral course	249	Over the long term only 11% elective surgery for recurrence
Mozer (e43)	2005–2012	Registry	Acute diverticulitis managed with primary conservative treatment	Timing of surgery in case of treatment failure	2119	Delayed surgery increases post- operative morbidity, but not mortality
Parker (e44)	2000–2016	Retrospective	Diverticulitis in patients with polycystic kidney disease	Characterization of the natu- ral course	41	No differences regarding severity of diverticulitis regarding $\pm$ kidney transplant
Polese (e45)	2009–2014	Prospective multicenter	Chronic recurrent un- complicated diverticuli- tis	Assessment of quality of life after conservative vs. surgical treatment	141	Improvement of quality of life after elective surgery
Ricciardi (e46)	1991–2005	Registry	Diverticulitis	Impact of restrictive indication for elective surgery on perfor- ations	685 390	No increase in incidence of free per- forations
Rose (7)	1995–2009	Registry	Acute diverticulitis	Characterization of the natu- ral course	210 268	16% recurrent diverticulitis after con- servative treatment; mortality associ- ated with elective resection 0.3% vs. 4.6% with emergency surgery for the second episode
Salem (25)	1999–2001	Prospective	Acute uncomplicated diverticulitis	Characterization of the natu- ral course	163	5-year recurrence risk 2%
Sallinen (e47)	2006–2010	Retrospective	Complicated diverticuli- tis with free air without peritonitis	Potential of conservative treatment	132	15% treatment failure, especially with abscess and distant retroperito- neal air (here <50% success rate)
Samdani (e48)	1988–2004	Retrospective	Acute diverticulitis with chemotherapy	Impact of chemotherapy on disease severity and recur- rence risk	131	No increased mortality or higher recurrence rate with conservative management; recurrences often complicated; significantly higher postoperative risks with chemo- therapy
Shaikh (e49)	1990–2004	Prospective	Acute diverticulitis managed with primary conservative treatment	Success rates of conservative treatment	191	After 5 years without surgery 86% in patients with “mild” diverticulitis, but only 45% in patients with “severe” diverticulitis
Thaler (e50)	1992–2000	Retrospective multicenter	Surgery for diverticulitis	Recurrence risk after surgical treatment	236	5% recurrence rate after 78 months
Titos-Garcia (e51)	2010–2015	Retrospective	Complicated diverticuli- tis with free air without peritonitis	Success rates of conservative treatment	64	Successful primary conservative treatment in 85% of patients, recur- rences 20%
Trenti (e52)	1994–2011	Prospective	Acute diverticulitis managed with primary conservative treatment	Course after conservative treatment	560	15% recurrences after 18 months, higher rates of complicated recur- rences after complicated first epi- sode, only 7% elective and 1% emergency surgery
van de Wall (e53)	2005–2011	Retrospective	Elective surgery for diverticulitis	Quality of life after surgical treatment	105	Improved subjective quality of life after elective surgery

Study	Recruitment/ time interval	Study type	Indication	Question	Sample size	Result
van de Wall (e12)	2010–2014	RCT multicenter (DIRECT trial)	Chronic complaints after acute diverticulitis/ recurrent diverticulitis	Long-term quality of life	109	Lastingly improved quality of life after surgery compared to control group after 6 months
You (16)	2011–2014	RCT	Complicated acute di- verticulitis with abscess or free air	Recurrent diverticulitis after 24 months	107	3-year recurrence rate 32% conser- vative vs. 8% surgical, successful conservative management of recur- rences

LoE, Oxford Centre for Evidence-Based Medicine 2011 Levels of Evidence; OR, odds ratio; RCT, randomized controlled trial

eTABLE 5

Failure of conservative treatment and recurrence risk in patients with acute complicated diverticulitis without free perforation

Author	Country	Study type	n	Primary failure of conservative treatment & resection	Recurrence in follow-up of non- resected patients	Period	Cumulative resection rate
Buchwald (e34)	New Zealand	Retrospective, single-center	107	Not specified	28%	Median 4 months	4%
Devarai (e16)	USA	Retrospective, single-center	210	12%	61%	Median 3.5 months	43%
Garfinkle (e39)	Canada	Retrospective, single-center	135	23%	39%	2 years	51%
Gaertner (e38)	USA	Retrospective, single-center	218	10%	42%	7 years	73%
Gregersen (12, 15)	Denmark	National regis- try	3 148	6%	14%	max. 12 years	16%
Jalouta (e17)	USA	Retrospective, 2 hospitals	165	28%	10%	1 year	64%
Lamb (e69)		Meta-analysis	22 studies 1051 patients	30%	28%	12–90 months	66%
Lambrichts (e14)	Netherlands	Retrospective multicenter	447	9%	27%	max. 12 years	36%
You (16)	USA	Single-center RCT	81 (arm 2)	11%	32%	36 months	14%

RCT, randomized controlled trials

Questions on the article in issue 35–36/2020:

The Indications for and Timing of Surgery for Diverticular Disease

cme plus+

The submission deadline is 30 August 2021. Only one answer is possible per question.

Please select the answer that is most appropriate.

Question 1

How many patients were treated on an inpatient basis with the primary diagnosis of “diverticulosis of intestine” (ICD-10: K57) in Germany in 2016, according to the German Federal Statistical Office?

- a) approx. 130 000
- b) approx. 20 000
- c) approx. 90 000
- d) approx. 60 000
- e) approx. 200 000

Question 2

Which CDD classification is used for acute complicated diverticulitis?

- a) Type 1a and 1b
- b) Type 2a, b and c
- c) Type 3a, b and c
- d) Type 4
- e) Type 0

Question 3

When is surgery not indicated?

- a) In case, a complicated chronic diverticular disease has been diagnosed.
- b) In case of clinically relevant, recurrent diverticular bleeding refractory to interventional treatment
- c) In case, a free perforated sigmoid diverticulitis with clinical or radiographic signs of peritonitis has been diagnosed.
- d) In case of acute uncomplicated diverticulitis
- e) In the interval after primary conservative treatment of complicated sigmoid diverticulitis with macroabscess

Question 4

Which criterion is used to differentiate between type 2a and type 2b contained perforated diverticulitis?

- a) The type of peritonitis (purulent or fecal)
- b) The presence or absence of a (phlegmonous) peridiverticulitis
- c) The size of the abscess (microabscess ≤ 1 cm; macroabscess >1 cm)
- d) The degree of quality-of-life impairment
- e) The presence or absence of diverticular bleeding

Question 5

When is it possible, according to the German S2k guideline, to place a percutaneous drainage?

- a) In case, there are no abscesses
- b) In the presence of an abscess larger than about 4 cm
- c) In patients with free perforated diverticulitis
- d) Only in case of abscesses <2 cm
- e) In case of repeated diverticular bleeding

Question 6

How high is the risk of complications, such as fistula or abscess, after initially conservative treatment of acute complicated diverticulitis without free perforation?

- a) approx. 1%
- b) approx. 15%
- c) approx. 30%
- d) approx. 50%
- e) approx. 80%

Question 7

Which statement applies to patients with morbid obesity with regard to diverticulitis?

- a) They have a lower incidence of acute diverticulitis
- b) The risk of recurrence appears to be elevated compared to persons of normal weight.
- c) They are less frequently severely ill.
- d) Emergency surgery is rarely performed.
- e) The risk of recurrence appears to be not increased compared to persons of normal weight.

Question 8

What is known about the risk of perforation in chronic recurrent diverticulitis without complications?

- a) The perforation risk is with 5% to 25% highest during the first episode.
- b) The perforation risk increases with increasing numbers of episodes.
- c) The perforation risk is very low at all times ($< 5\%$).
- d) The perforation risk is so high that immediate surgery is indicated.
- e) This type of diverticulitis is not associated with any risk of perforation.

Question 9

Which type of diverticular disease is a clear indication for elective surgery?

- a) Acute uncomplicated diverticulitis
- b) Complicated chronic diverticulitis with fistula formation or colonic stenosis
- c) Any diverticular disease with microabscess or macroabscess
- d) Asymptomatic diverticulosis
- e) Acute diverticulitis with purulent or fecal peritonitis

Question 10

What is the clinical significance/prognosis of acute uncomplicated diverticulitis?

- a) It is typically an incidental finding and not associated with disease.
- b) The majority of patients experiences progression to complicated diverticulitis.
- c) Because the risk of perforation is high, surgical management should be considered.
- d) With about 60%, the 5-year risk for recurrence is high and recurrences are associated with an increase rate of complication.
- e) Only about 2% of patients experience progression to complicated diverticulitis