PRACTICE GUIDELINES

Diagnosis and Management of Diverticular Disease of the Colon in Adults

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PREAMBLE

Guidelines for clinical practice are intended to suggest preferable approaches to particular medical problems as established by interpretation and collation of scientifically valid research, derived from extensive review of published literature. When data are not available, which will withstand objective scrutiny, a recommendation may be made based on a consensus of experts. Guidelines are intended to apply to the clinical situation for all physicians without regard to specialty. Guidelines are intended to be flexible, not necessarily indicating the only acceptable approach, and should be distinguished from standards of care that are inflexible and rarely violated. Given the wide range of choices in any health care problem, the physician should select the course best suited to the individual patient and the clinical situation presented. These guidelines are developed under the auspices of the American College of Gastroenterology and its Practice Parameters Committee. These guidelines are also approved by the governing boards of the American Gastroenterological Association and the American Society for Gastrointestinal Endoscopy. Expert opinion is solicited from the outset for the document. Guidelines are reviewed in depth by the committee, with participation from experienced clinicians and others in related fields. The final recommendations are based on the data available at the time of the production of the document and may be updated with pertinent scientific developments at a later time. The following guidelines are intended for adults and not for pediatric patients.

INTRODUCTION

Diverticular disease of the colon is very common in developed countries and its prevalence increases with age. To refer to an acquired deformity present in perhaps two-thirds of the elderly as a ‘disease’ may be inaccurate, particularly as the large majority of those affected will remain entirely asymptomatic. Nonetheless, an estimated 20% of patients may manifest clinical illness (1). The purpose of this guideline is to briefly review the epidemiology, etiopathogenesis, and clinical presentations of diverticular disease, and then propose recommendations regarding appropriate diagnostic and therapeutic strategies supported by the best available current evidence.

EPIDEMIOLOGY

The true incidence of colonic diverticulosis is difficult to measure, mainly because most patients are asymptomatic. The incidence clearly increases with age, varying from less than 10% in those under 40 yr, to an estimated 50–66% of patients over age 80 (2–4). There is no apparent sex predilection. Diverticulosis has been termed a “disease of Western Civilization” because of its striking geographic variability. The disorder is extraordinarily rare in rural Africa and Asia; conversely, the highest incidence rates are seen in the United States, Europe, and Australia (2).

PATHOLOGICAL ANATOMY

Diverticula have been observed to occur typically in two or four parallel rows. This pattern is likely related to the penetration of the small arteries supplying the colonic mucosa (the vasa recta), with relative weakness of the muscular wall at these sites allowing for herniation of the mucosa and submucosa. In Western societies, diverticula occur mainly in the distal colon, with up to 90% of patients having involvement of the sigmoid colon, and only 15% having right-sided involvement (3, 5, 6). This is in contrast to Asian countries, in which right-sided involvement is more prominent (7, 8). Diverticula can vary in number from solitary findings to literally hundreds. They are typically 5–10 mm in diameter, but can exceed 2 cm in size.
ETIOLOGY/PATHOGENESIS

Gross examinations of diverticular colons report thickening of the muscle wall and shortening of the taenia, with a resulting accordion-like bunching of the folds. Routine histology does not, however, reveal muscle hypertrophy. More recently, electron microscopic studies have confirmed that the colonic wall in diverticulosis has structurally normal muscle cells, but contains a >2-fold increase in elastin deposition between the muscle cells in the taenia (9). The elastin is laid down in a contracted form, presumably causing shortening of the taenia and the resulting bunching of the circular muscle.

The possibility of altered colonic motility playing an etiological role in diverticular disease has been explored for many years, with the repeated demonstration of higher resting, postprandial, and neostigmine-stimulated pressures in diverticular patients compared to controls (10–13). Painter postulated a theory of ‘segmentation’ in which contraction of the colon at haustral folds causes the colon to act as a series of discrete ‘little bladders’, rather than as a continuous single-chambered lumen (11, 14). He proposed that this segmentation might play a physiological role in delaying transport and augmenting water reabsorption, but could also generate excessively high pressures within each segment or ‘bladder’, forcing the mucosa to herniate.

The wide geographic variability of diverticular disease and its correlation with a Westernized diet has long suggested a dietary factor, most likely fiber, in its pathogenesis. Burkitt and Painter in fact labeled diverticulosis a ‘deficiency disease’, which, like scurvy, should be avoidable with dietary changes (2). They rigorously demonstrated that individuals in the UK, eating a refined Western diet low in fiber, had colonic transit times of ~80 h, and mean stool weights of ~110 gm/day. This was contrasted with rural Ugandans, eating very high fiber diets, who had significantly shorter transit times (~34 h), and greater stool weights (>450 gm/day) (15). The longer intestinal transit times and smaller volume stools in the UK patients were felt to increase intraluminal pressures and predispose to diverticular herniation. As reasonable as this postulate seems, studies in Western populations comparing patients with and without diverticular disease have generally failed to show significant differences. Nonetheless, corroborative animal data does exist. Most notable is a study of rats fed diets of varying fiber content throughout their natural lifespan; 45% of the rats on the lowest fiber diet developed diverticula, compared with only 9% of those fed the highest fiber diet (16).

PREVENTION OF DIVERTICULOSIS

Recommendation: Diets high in fruit and vegetable fiber may decrease the development of colonic diverticulosis.

The observations above, that low fiber diets are associated with colonic diverticulosis, has led to the postulate that active therapy with higher fiber diets might prevent diverticular disease. This theory of diverticular ‘prophylaxis’ is supported by results from the Health Professionals Follow-up Study, which prospectively followed 51,529 US male health professionals (17). Over a 6-yr period, 385 (0.75%) new cases of symptomatic diverticular disease were identified. A significant inverse association was found between insoluble dietary fiber intake (especially fruit and vegetable, e.g., cellulose fiber) and the risk of subsequently developing symptomatic diverticular disease (Relative Risk = 0.63, 95% CI 0.44–0.91). Although the results were fairly linear, suggesting increasing benefit with increasing fiber intake, the greatest benefit was seen in those individuals consuming an average of 32 g/day of total fiber. Further analysis of this large epidemiological study also described a similar protective effect of physical activity on the development of symptomatic diverticulosis (18), and no effect seen with alcohol, smoking, or caffeine consumption (19).

Although detection and recall biases must be considered in interpreting these results, they provide support for a more general recommendation that patients may benefit from increasing their fruit and vegetable fiber intake. Patients should be cautioned to gradually increase their fiber intake and maintain adequate hydration, to avoid transiently worsening their symptoms.

UNCOMPPLICATED DIVERTICULOSIS

Recommendation: Incidentally identified diverticulosis in an asymptomatic patient does not require further diagnostic evaluation. It is reasonable to recommend a diet high in fruit and vegetable fiber to patients with uncomplicated diverticulosis. There is little data supporting a role for antispasmodic agents in these patients, and no role for antibiotics in the absence of signs or symptoms suggesting diverticulitis.

The large majority of patients with diverticulosis will remain entirely asymptomatic. There is no data to support any therapeutic recommendations or routine follow-up in this large population. An unquantified subset of the remainder will have bothersome symptoms attributed to their diverticular disease, so-called symptomatic uncomplicated diverticulosis. Patients with nonspecific symptoms, such as pain, bloating, and/or changed bowel habits, will be discussed in this section. Patients with well-defined complications of their disease, such as diverticulitis, stricture, obstruction, or bleeding, will be discussed in the following section on complicated diverticulosis.

Patients may come to clinical attention because of nonspecific abdominal complaints, and are found to have diverticulosis coli; a causative relationship is often difficult to establish. Most will present with pain, typically in the lower abdomen, and more frequently, but not invariably, left-sided. By definition, such patients do not manifest signs of inflammation, such as pyrexia or neutrophilia, which might indicate diverticulitis. The pain is often exacerbated by
eating and diminished with defecation or the passage of flatus. It has been suggested, although this is purely conjecture, that this pain reflects colonic wall tension because of increased intraluminal pressure. Patients may also report other symptoms of colonic dysfunction, including bloating, constipation, diarrhea, or the passage of mucus, although the relationship of these symptoms to their diverticula is speculative. Physical examination may reveal fullness or mild tenderness in the left lower quadrant, but frank rebound or guarding should be absent. A stool positive for fecal occult blood in this setting should never be attributed to diverticulosis without a further complete colonic evaluation. Laboratory studies should be normal.

In a patient with nonspecific symptoms of colonic dysfunction, the demonstration of diverticula radiographically or colonoscopically adds little to the diagnostic probabilities or management because of the high prevalence of this finding in the general population. One must be careful to consider alternative diagnoses before attributing the symptoms solely to diverticulosis. These nonspecific symptoms obviously overlap considerably with those of the Irritable Bowel Syndrome (IBS). It has been postulated that diverticula may in fact be a late consequence of the IBS. Otte et al. reviewed 69 patients with IBS, 24 of whom had diverticula (20). Over a 7-yr follow-up period, symptoms or prognosis were no different between those with or without diverticula. Ritchie has reported on the similarity of pain sensation from rectal balloon distention in patients with IBS and diverticulosis (21). Whether or not these two disorders are in fact distinct entities is unknown and probably not clinically important, as both are treated in a similar fashion with equally good prognoses.

DIAGNOSTIC MODALITIES

For many years, the barium enema (BE) examination had been the standard investigation in patients with symptoms suggesting colonic disease. Barium studies can provide information on the number and location of colonic diverticula, but obviously cannot discern their clinical significance. More recently, caution has been expressed about a significant diagnostic error rate for BE examinations in patients with sigmoid diverticulosis. Boulos et al. described 65 patients with bowel symptoms who had double-contrast barium enemas revealing sigmoid diverticulosis (22). All underwent subsequent colonoscopy. Nineteen neoplastic lesions (17 polyps, two carcinomas) were reported on BE; colonoscopy revealed no polyps in nine of 17 (53%), and confirmed only one of the two carcinoma readings. In the 46 barium examinations showing only diverticulosis and no neoplasia, colonoscopy revealed polyps in eight and carcinomas in three, an error rate of 24%. Overall, the BE interpretation was inaccurate in 32%. The authors recommend routine colonoscopy in all patients with symptomatic diverticulitis, particularly to exclude neoplasia. Until further prospective data are available, however, no firm recommendation can be made regarding the relative utilities of these two diagnostic modalities, and the choice of testing should depend on the clinical scenario and the local expertise available.

Previously, the presence of diverticulosis was felt by some to be a relative contraindication to colonoscopy, for fear of an increased likelihood of perforation. Numerous series and many years of clinical experience, however, have demonstrated the relative safety of colonoscopy in patients with uncomplicated diverticular disease. One must remain cautious, however, about the possibility of undiagnosed or subclinical diverticulitis with undetected microperforation, and be judicious with air insufflation. This is particularly true if the tip of the colonoscope might be in the neck of a diverticulum, as very high ‘local’ pressures can develop within the diverticulum itself. The diverticular colon may also be difficult to examine colonoscopically because of spasm, luminal narrowing from prominent enlarged folds, fixation from prior inflammation and pericolic fibrosis, as well as confusion between luminal and diverticular openings. The use of a smaller diameter colonoscope may be helpful in this situation (23, 24).

The incidental identification of diverticulosis coli by barium examination, colonoscopy, or computerized tomography (CT) scanning does not require any further diagnostic evaluation.

TREATMENT

Dietary Fiber

The possible ‘protective’ effect of fiber in asymptomatic patients has already been mentioned (17). Although there have been multiple uncontrolled studies demonstrating the salutary effect of fiber supplements in patients with intestinal symptoms and diverticulosis, lack of a placebo group makes such data suspect. Brodribb published the first randomized, double-blind, placebo-controlled trial of a high fiber diet in patients with symptomatic diverticular disease, but reported results for only 18 patients (25). Although a significant placebo effect was observed at 1 month, by 3 months there was a statistically significant decrease in bowel symptoms in treated patients. A larger study of fiber supplementation in symptomatic patients with diverticulosis has been reported by Ornstein et al., in which patients took bran or placebo in a double-blind, cross-over study for 4 months (26). Unlike Brodribb’s data, no symptomatic improvement was demonstrated. Despite the conflicting data and the near certainty that diverticula do not regress with increased fiber intake, some amelioration of symptoms in patients with uncomplicated disease can be expected with a high fiber diet, which is reasonable to prescribe for its other potential health benefits as well. Historically, whole pieces of fiber (such as nuts, corn, seeds) have been excluded from such diets for fear they might become entrapped in diverticula. Controlled studies that support this belief are lacking.
Further, there is no data to support a role for any specific ‘fad’ or ‘elimination’ diet in this disorder.

Medications
The documented hypermotility of the colon in this disorder suggests that anticholinergic and antispasmodic agents may improve symptoms by diminishing muscular contraction. Nonetheless, there are no adequately controlled therapeutic trials documenting such a benefit. Intravenous glucagon has been reported in one study to offer short-term relief of pain, presumably as a result of smooth muscle relaxation (27).

**COMPLICATED DIVERTICULOSIS**

Diverticulitis
Diverticulitis, defined as inflammation and/or infection associated with diverticula, is the most common clinical complication of this disorder, affecting an estimated 10–25% of patients with colonic diverticula (3). The process through which a diverticulum becomes inflamed has been likened to that causing appendicitis, in which the diverticulum becomes obstructed by inspissated stool in its neck, ultimately leading to perforation of a single diverticulum (28, 29). The extent and localization of this perforation then determines its clinical behavior. Microperforations may remain very well localized, contained by the pericolic fat and mesentery, leading to small pericolic abscesses. Larger macroperforations can result in more extensive abscess formation, which may track longitudinally around the bowel wall forming a large inflammatory mass, extend to other organs, and/or cause fistulous disease. In its later stages, fibrosis and strictures may result. Free perforations into the peritoneum cause fistulous disease. In its later stages, fibrosis and strictures may result in more extensive abscess formation, which may track longitudinally around the bowel wall forming a large inflammatory mass, extend to other organs, and/or cause fistulous disease. In its later stages, fibrosis and strictures may result. Free perforations into the peritoneum causing frank bacterial peritonitis can be life threatening, but are relatively uncommon. Hinchey et al. have described a grading system reflecting the degree of perforation (30):

Stage I: Confined pericolic abscess.
Stage II: Distant abscess (retroperitoneal or pelvic).
Stage III: Generalized peritonitis caused by rupture of a pericolic or pelvic abscess, “noncommunicating” with bowel lumen because of obliteration of diverticular neck by inflammation.
Stage IV: Fecal peritonitis caused by free perforation of a diverticulum (“communicating”).

Clinical Features
Patients with acute diverticulitis classically present with left lower quadrant pain, reflecting the marked propensity for this disorder to occur in the sigmoid colon in Western countries. Patients with redundant sigmoid may well manifest suprapubic or even right-sided pain. Asian patients, as previously mentioned, have predominantly right-sided diverticula, and may also manifest right-sided pain. The pain may be intermittent or constant, and is frequently associated with a change in bowel habits, either diarrhea or constipation (31). Hematochezia is rare. Anorexia, nausea, and vomiting may occur. Dysuria and urinary frequency may be reported by patients, reflecting a ‘sympathetic cystitis’ induced by bladder irritation from the nearby inflamed sigmoid colon.

Physical exam usually discloses localized tenderness, generally in the left lower quadrant, although as noted above, right-sided signs do not preclude diverticulitis. Guarding and rebound tenderness may be present, as may a tender, cylindrical palpable mass. Bowel sounds are typically depressed, but may be normal in mild cases, or increased in the presence of obstruction. Rectal exam may disclose tenderness or a mass, particularly with a low-lying pelvic abscess. Fever is present in the majority of patients, although hypotension and shock are unusual. The white blood cell (WBC) count is frequently elevated, although not invariably so, with one study reporting a normal WBC count in 45% of patients with acute diverticulitis (31). No other laboratory abnormalities are routinely helpful.

**Differential Diagnosis**
The differential diagnosis of acute diverticulitis is extensive, with acute appendicitis the most common misdiagnosis. Other considerations include Crohn’s Disease, colonic neoplasms, ischemic or pseudomembranous colitis, complicated peptic ulcer disease, and gynecologic pathology (Table 1).

**Diagnostic Modalities**
**Recommendation:** The diagnosis of diverticulitis may be made on clinical grounds. Plain radiographs should be performed in all patients with significant abdominal pain and suspected diverticulitis. Select patients with severe ill-

<table>
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<tr>
<th>Differential Diagnosis</th>
<th>Clinical Scenarios and Diagnostic Considerations</th>
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<tr>
<td>Acute appendicitis</td>
<td>Suspect if RLQ symptoms or nonresolution with medical therapy</td>
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<tr>
<td>Crohn’s disease</td>
<td>Suspect if aphthous ulcers, perianal involvement, or chronic diarrhea</td>
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<tr>
<td>Colonic carcinoma</td>
<td>Suspect if weight loss, bleeding. Diagnose with colonic evaluation after acute inflammation resolved</td>
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<tr>
<td>Ischemic colitis</td>
<td>Suspect if high-risk patient, bloody diarrhea, or thumbprinting. Diagnose with limited flexible sigmoidoscopy</td>
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<tr>
<td>Pseudomembranous colitis</td>
<td>Suspect with antibiotic use or diarrhea. Diagnose with stool toxin or limited flexible sigmoidoscopy</td>
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<tr>
<td>Complicated ulcer disease</td>
<td>Suspect if pneumoperitoneum or peritonitis, or with clinical history, NSAID use, or dyspepsia</td>
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<tr>
<td>Ovarian cyst, abscess, torsion</td>
<td>Suspect in female patient with unilateral pain. Diagnose with pelvic or transvaginal ultrasound</td>
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<tr>
<td>Ectopic pregnancy</td>
<td>Suspect in female patient of childbearing age. Diagnose with pregnancy test and ultrasound</td>
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RLQ = right lower quadrant; NSAID = nonsteroidal anti-inflammatory drug.
ness, atypical presentations, clinical deterioration, or suspected complications should be evaluated further, with CT scanning the best initial diagnostic modality. Contrast enema examinations, ultrasonography, and limited sigmoidoscopy are appropriate in some patients.

PLAIN RADIOGRAPHY. An erect chest radiograph, together with erect and supine abdominal radiographs should generally be performed on most patients with clinically significant abdominal pain. The erect chest film has the dual purpose of detecting a pneumoperitoneum, which has been reported to be present in up to 12% of patients with acute diverticulitis (32), and to assess cardiopulmonary status in a generally elderly population with frequent comorbid illness. Abdominal X-rays have been reported to be abnormal in 30–50% of patients with acute diverticulitis (32). Findings include small or large bowel dilation or ileus, bowel obstruction, or soft tissue densities suggesting abscesses.

COMPUTERIZED TOMOGRAPHY. As diverticulitis is mainly an extraluminal disease, e.g., peridiverticulitis, luminal contrast studies, which for many years were the diagnostic standard, may be inaccurate. In recent years, CT scanning has been assuming an increasing role. Most now consider it the procedure of choice, both for its ability to image transmural/extraluminal disease and adjacent structures, as well as its therapeutic potential in the drainage of abscesses.

Abdominal and pelvic scanning is generally performed with water-soluble contrast, both orally to opacify the small bowel, and rectally to better evaluate the rectosigmoid. If not contraindicated, intravenous contrast is generally used as well. CT criteria suggestive of diverticulitis include the presence of diverticula with pericolic infiltration of fatty tissue, thickening of the colonic wall, and abscess formation. A number of prospective investigations have reported a sensitivity of 69–95% and a specificity of 75–100% for CT scanning, generally superior to contrast examinations (33–36). Most recently, a very large prospective study in Switzerland evaluated 423 patients over a 10-yr period (37). The sensitivity of CT scanning was excellent (97%). Further, the presence of severe disease, defined by abscess and/or extraluminal air or contrast, was prognostically very useful, accurately predicting failure of medical treatment and risk of secondary complications. Overall, and respecting issues of cost, availability, and local expertise, the data suggest that in cases where the patient is seriously ill, the diagnosis is in doubt, or clinical deterioration occurs, CT has become the most suitable primary investigation today. Nonetheless, a negative CT scan does not completely exclude this diagnosis.

CONTRAST ENEMA EXAMINATIONS. Contrast enemas still remain a useful complementary study to CT scanning, yielding additional and clinically useful information in some cases. The choice of contrast material to be used remains somewhat controversial. Although barium is less expensive than water soluble contrast media and provides better mucosal detail, the possibility of a perforation is a relatively strong contraindication to its use, for fear of fecal/barium peritonitis. In these situations, water-soluble contrast media should be used, a gentle single-contrast study should be performed and terminated once significant findings have been discovered. An attempt to visualize the entire colon should be deferred to a later date when the acute attack has resolved. Air (double) contrast studies are not indicated when acute diverticulitis is suspected, for fear that insufflation may dislodge a fecalith and result in perforation.

Findings considered diagnostic for diverticulitis include demonstration of extravasated contrast material outlining an abscess cavity, an intramural sinus tract or fistula (5, 33). Extensive diverticulosis, spasm, mucosal thickening or ‘spiking’, or deformed sacs are suggestive but nonspecific signs. An extraluminal mass compressing or displacing the bowel is said to be the most common finding in severe diverticulitis (32), although this finding is clearly not specific for this diagnosis. Obviously, the absence of any diverticula or the above findings should provoke a reconsideration of the diagnosis.

ULTRASONOGRAPHY. Based on its relatively low cost, convenience, and noninvasive nature, ultrasonography (US) has been advocated by some as a useful modality in diverticulitis. Characteristic findings have included hypoechoic bowel wall thickening, presence of diverticula or abscesses and hyperechogenicity surrounding the bowel wall, implying active inflammation. Three prospective studies have reported a sensitivity of 84–98% and a specificity of 80–98% (38–40). Two recent small studies have compared CT and US directly for acute colonic diverticulitis; one reported comparable accuracy (41), whereas the other found CT to be superior (42). Despite the above reports, the examination remains very operator dependent and in the absence of larger, well-designed prospective comparative studies, it remains a second line diagnostic tool to be used in selected clinical circumstances or research endeavors. Sonography may be most useful in female patients to exclude pelvic/gynecologic pathology.

ENDOSCOPY. Because of the risk of perforation, either from the instrument itself or insufflation of air, endoscopy is generally avoided in the initial evaluation of the patient with acute diverticulitis. Its use should be limited to situations in which the diagnosis of diverticulitis is unclear, in which case a limited rigid or flexible sigmoidoscopy with minimal air insufflation may be helpful to exclude other diagnoses, such as inflammatory bowel disease, carcinoma, or ischemic colitis.

Treatment Recommendation: Selected patients with mild diverticulitis (with good oral intake and a supportive social structure) can be treated as outpatients with broad-spectrum oral antibiotics. Patients with more severe illness or comorbid...
disease should be hospitalized and treated with bowel rest and intravenous antibiotics.

One of the initial decisions in uncomplicated diverticulitis involves a determination of the need for hospitalization. This ultimately depends on an individual patient’s initial clinical presentation and the impression of the physician. No hard and fast generalizations are appropriate. Factors to be considered include the patient’s ability to tolerate oral intake, severity of illness, comorbid disease and available outpatient support systems (e.g., a reliable family). An appropriate candidate for outpatient management would be one with mild symptoms, no peritoneal signs, the ability to take oral fluids, and a supportive home network. In general, the very elderly or immunosuppressed patients, those with severe comorbid disease and those with high fever or significant leukocytosis should be hospitalized. Appropriate patients for ambulatory care should be treated with a clear liquid diet and a broad-spectrum oral antibiotic with activity against anaerobes and Gram-negative rods (particularly E. coli and B. fragilis). Amoxicillin plus clavulanic acid, sulfamethoxazole-trimethoprim with metronidazole, or a quinolone with metronidazole have been recommended as reasonable choices (43). Patients so treated should obviously have close follow up. They should be instructed to call the physician for increasing pain, fever, or inability to tolerate oral fluids, which may necessitate hospitalization. In general, symptomatic improvement should be evident within 2–3 days, at which time the diet may be slowly advanced. Antibiotic treatment should be continued for 7–10 days.

Patients requiring hospitalization with acute diverticulitis should, in general, have their bowels ‘rested’ with clear liquids or nothing by mouth. Intravenous fluid therapy to maintain or restore intravascular volume, balance electrolytes, and ensure adequate urinary output should be initiated. Intravenous antibiotics should be started, aimed principally at the colonic anaerobic and Gram-negative flora, especially E. coli and Bacteroides species. Recommended combination regimens, based more on clinical consensus than randomized trials, include antianaerobic coverage with metronidazole or clindamycin and Gram-negative coverage with an aminoglycoside (e.g., gentamicin, tobramycin), monobactam (e.g., aztreonam), or third-generation cephalosporine (e.g., ceftazidime, cefotaxime, ceftriaxone) (43). Single agent coverage with intravenous second-generation cephalosporins, such as cefoxitin (44) or cefotetan, or B-lactamase inhibitor combinations such as ampicillin-sulbactam or ticarcillin-clavulanate are reasonable alternatives. Similarly to outpatients, one should expect improvement with decreasing fever and leukocytosis within 2–4 days, at which point the diet may be advanced. If improvement continues, patients may be discharged but should complete a 7- to 10-day oral antibiotic course. Failure to improve with conservative medical therapy warrants a diligent search for complications, consideration of alternative diagnoses and surgical consultation.

Treatment Outcome

Recommendation: A colonic evaluation is indicated after resolution of a clinically diagnosed case of presumptive diverticulitis to exclude other diagnostic considerations such as colonic neoplasia. Elective (prophylactic) surgery may be reasonable in patients with recurrent attacks of diverticulitis, patients with complicated disease (e.g., fistulas, abscess), or in young or immunocompromised patients. As diverticulitis may recur in as few as one of four patients, surgery is not generally indicated after a single uncomplicated episode.

Most patients hospitalized with acute diverticulitis will respond to conservative medical therapy, but it has been estimated that 15–30% will require surgery during that admission (1, 5, 45, 46). Not surprisingly, such patients have a higher mortality rate, up to 18% in one series (47). Free perforation with generalized peritonitis, although uncommon, carries a high mortality rate (up to 35%) and requires urgent surgical intervention (5, 46). For the majority who do respond well to conservative therapy, a complete colonic evaluation is indicated after resolution of a clinically diagnosed case of presumptive diverticulitis, to exclude other diagnostic considerations such as colonic neoplasia. Once this has been performed, an important clinical question subsequently revolves around the likelihood of recurrence and the role of elective ‘prophylactic’ surgical resection to prevent further attacks. The risk of recurrent symptoms after an attack of acute diverticulitis has been variously reported to range from as low as 7% to as high as 62%, with most authors accepting an approximation of one-third to one-quarter as a reasonable estimate of recurrence risk (1, 5, 45, 46–50). Recurrent attacks are less likely to respond to medical therapy and have a higher mortality rate (45, 46); therefore, most authorities agree that elective resection is indicated after two attacks of uncomplicated diverticulitis, although this recommendation has been questioned (51). The risk/benefit analysis of such an approach must be individualized for a specific patient, and consideration must be given to the severity and responsiveness of the attack, general health of the patient and the risk to the patient of a subsequent attack compared to that of surgery itself. The surgical morbidity of such ‘elective’ resections for recurrent disease may be changing as well, as laparoscopic techniques become more widely applied in this setting. Although a detailed review of such data (i.e., laparoscopic resections for diverticular disease) is beyond our scope here, a number of fairly large series of such patients has been published, with generally favorable results (52–55).

Diverticulitis is relatively uncommon in patients <40 yr old, representing 2–5% of all diverticulitis patients (5, 45); however, there seems to be a significant male predominance in these patients (5, 56, 57). Further, the disease is felt to be more virulent in younger patients, with 25–80% of patients reportedly requiring urgent surgery during their initial attack (5, 56, 58–60). Additionally, it has been reported that among young patients with diverticulitis (<50 yr old), those...
who initially responded to conservative medical measures had a significantly higher risk of recurrences or complications than older patients (31, 61, 62). The accuracy of this observation has been questioned, however. Nonetheless, based both on the low operative risk of an elective procedure in an otherwise healthy young person and the many years of risk for recurrence awaiting such patients, surgical resection may be reasonably considered after one well-documented episode of uncomplicated diverticulitis in the younger patient.

Physicians are seeing an increasing number of immunosuppressed patients, who may present with much more subtle signs and symptoms than immunocompetent patients and represent a more difficult diagnostic challenge. Perkins et al. (63), in comparing the clinical course of acute diverticulitis in 10 immunosuppressed patients with 76 nonimmunosuppressed ones, found that 24% of the immunocompetent patients failed medical therapy, whereas all of the immunosuppressed patients required surgery. A more recent series compared 40 immunocompromised patients with 169 immunocompetent patients with acute diverticulitis (64). The immunocompromised patients had a higher rate of free perforation (43% vs 14%), need for surgery (58% vs 33%), and postoperative mortality (39% vs 2%) than the noncompromised patients. Because of this high risk of complicated disease, some have advocated elective resection after one attack in an immunosuppressed patient (65).

Up to 10% of patients will have symptomatic recurrent diverticulitis after surgical resection. Re-operation may be required in up to 3% of patients (46, 66, 67), which is often technically more difficult because of inflammation and adhesions. In a series of 501 patients from the Mayo Clinic who had resection and reanastomosis for diverticular disease, a higher recurrence rate was found when the sigmoid colon was used for the distal resection margin as compared to the rectum (66). These authors and others (67) have advocated that the entire distal colon be routinely removed during resections for diverticular disease with a rectal (rather than sigmoid) anastomosis.

### Complications of Diverticulitis

**Abscess**

**Recommendation:** An abscess should be suspected when clinical improvement is slow to occur, and it is managed based on its size and complexity. Small pericolic abscesses can frequently be managed conservatively, whereas larger abscesses require drainage. CT-guided percutaneous drainage may allow for rapid stabilization and a later, elective, single-stage surgical resection. Multiloculated, inaccessible or poorly responsive abscesses may require initial surgical drainage.

When perforation of a colonic diverticulum occurs, the ability of the pericolic tissues to control the spread of the inflammatory process will determine subsequent clinical behavior and treatment. When very limited spread occurs, a localized phlegmon develops. Further spread can lead to the formation of larger local or distant abscesses. Generalized peritonitis uncommonly occurs, but requires urgent surgical intervention.

Clinical signs suggesting abscess formation include persistent fever and/or leukocytosis despite an adequate trial of appropriate intravenous antibiotics, or a tender mass on physical examination. Once suspected, radiographic evaluation with CT scanning is the best modality to make the definite diagnosis of an abscess and follow its course over time; CT scanning is also valuable as a guide for percutaneous drainage.

The management of diverticular abscesses should be individualized to their size and complexity. Small pericolic abscesses (Stage I) can often be treated conservatively with antibiotics and bowel rest (68). Their favorable prognosis may be attributed to a persistent fistula between the abscess and the colon, permitting spontaneous internal drainage. In cases where surgery is required, a single-stage en bloc resection and primary re-anastomosis can generally be performed.

For patients with distant abscesses (Stage II) or unresolving pericolic abscesses, drainage is indicated. In prior years, surgery was the sole option, and is still widely used; readers are directed to recently published guidelines from the American Society of Colon and Rectal Surgeons (46). In cases where an adequate bowel prep is possible and there is no significant peritoneal contamination, a single-stage resection and reanastomosis can be performed. When this is not possible, a Hartmann resection is indicated. In general, the single-stage procedure is associated with lower morbidity and mortality than a two-stage procedure.

First introduced in the 1980s (69), CT-scan guided percutaneous drainage of abdominal abscesses has assumed a prominent complementary role with surgery. The immediate advantage of percutaneous catheter drainage is rapid control of sepsis and patient stabilization, without the need for and risk of general anesthesia. More generally, it will often eliminate the need for a two-stage procedure with colostomy, instead allowing for temporary palliative drainage and subsequent single-stage resection in 3–4 wk. Two retrospective series have reported success rates of 74% and 80% in stabilizing patients and safely allowing for subsequent single-stage procedures (70, 71). An initial surgical procedure is required in the 20–25% of patients in whom the abscess is multiloculated, anatomically inaccessible for drainage, or not responding to drainage. A single-stage procedure is preferable, although not always possible (72). Successful laparoscopic resections have also been described for treatment of abscesses (52), although this technique is not yet widely applied.

Pyogenic liver abscesses may also occur as a complication of colonic diverticulitis (73–75). Antibiotics, percutaneous drainage, and surgery each have a role in their management.
Fistulas

Recommendation: Diverticular fistulas are generally managed surgically.

When a diverticular phlegmon or abscess extends or ruptures into an adjacent organ, fistulas may occur. In a review of 84 patients with internal fistulas caused by diverticular disease (76), 65% were colovesicular. There was a 2:1 male predominance, attributed to the protection given the bladder by the uterus, and supported by the observation that 50% of women with such fistulas have had a previous hysterectomy. Pneumaturia and fecaluria are common symptoms (77). Cystoscopy, cystography, and BE are useful diagnostically. Single-stage operative resection with fistula closure and primary anastomosis can be performed in ~75% of patients (76, 77).

Colovaginal fistulas are the next most common internal fistula, representing approximately 25% of all cases (76). The passage of stool or flatus per vagina is pathognomonic. Treatment is surgical resection with fistula closure. Colouteric, colouterine, and coloreteral fistulas occur, but much less commonly. Spontaneous colocutaneous fistulas are very rare and more frequently follow prior surgical repair.

Obstruction

Recommendation: Acute obstruction during an episode of acute diverticulitis is usually self-limited and responds well to conservative therapy. Chronic strictures usually require colonoscopy to exclude neoplasia, and if symptomatic, may be managed endoscopically or surgically.

Obstruction may accompany diverticular disease either acutely or chronically. During an attack of acute diverticulitis, partial colonic obstruction can occur because of relative luminal narrowing from the pericolic inflammation and/or compression from abscess formation. Complete obstruction is unusual. Colonic ileus or pseudo-obstruction can also occur. These conditions usually improve with effective medical therapy. Should obstruction fail to resolve, prompt surgical consultation is indicated. Acute diverticulitis can cause small bowel obstruction as well, either mechanically if a loop of small intestine becomes incorporated into the inflammatory mass, or by localized irritation and the development of an ileus. The obstruction should improve as the inflammation subsides. Surgical intervention may be required if persistent.

Recurrent attacks of diverticulitis, which may be subclinical, can initiate progressive fibrosis and strictureting of the colonic wall in the absence of ongoing inflammation. In such cases, high grade or complete obstruction can occur requiring surgical therapy. A more insidious presentation with nonspecific symptoms is not uncommon. Frequently, a stricture is demonstrated on BE, with uncertain etiology. The critical issue is to distinguish between a diverticular stricture and a stenosing neoplasm, as an accurate diagnosis will guide the correct surgical procedure if needed. Colonoscopy has been reported to be diagnostic in up to two of three of such patients (78). Strictures in which malignancy cannot be excluded despite colonoscopic and radiographic examinations should undergo surgical resection. In those in which neoplasm is felt to be sufficiently excluded, a trial of endoscopic therapy can be attempted. A number of reports have described the relative safety and efficacy of such therapy for strictures of various etiologies, utilizing varied techniques such as bouginage, balloon, laser, electrocautery, and a blunt dilating endoscope (79–82).

HEMORRHAGE

Diverticula and vascular ectasias are responsible for the majority of episodes of lower GI bleeding (83–86), although a precise determination of each of these lesions’ respective contributions is difficult. Nonetheless, three recent large series of patients with lower gastrointestinal (GI) bleeding have recently reported their results, comprising over 500 patients in total (87–89). In each study, diverticular bleeding was the most common etiology identified, comprising 24–42% of episodes.

Severe hemorrhage has been reported to occur in 3–5% of all patients with diverticulosis (83, 90). Despite the fact that most diverticula are located in the left colon in Western individuals, a number of series suggest that bleeding diverticula may occur more often in the proximal colon (83, 90–94). Together, these reports argue strongly against empiric left-hemicolectomy or segmental sigmoid-colectomy in patients with severe rectal bleeding in the absence of definitive localization of the bleeding.

The association of nonsteroidal anti-inflammatory drug (NSAID) use with peptic ulcer disease and bleeding is well documented. Recent data have also implicated these agents in diverticular bleeding (95, 96). Whether patients with diverticulosis should be counseled to avoid NSAIDs, as is done for ulcer patients, is still conjecture, as is the potential role of selective COX-2 antagonist NSAIDs.

Pathophysiology

Diverticular bleeding is arterial, and thought to be caused by medial thinning of the vasa recta as it courses over the dome of a diverticulum (91). The factor(s) that initiate this isolated, asymmetric arterial change or the precipitating events leading to its rupture are unknown. Inflammation does not seem to be a contributing factor as it is absent histologically in resected bleeding diverticula. This is in concordance with the general clinical impression that bleeding rarely, if ever, complicates diverticulitis.

Clinical Features

The clinical presentation of patients with diverticular hemorrhage is usually one of an abrupt, painless onset. The patient may have mild lower abdominal cramps and the urge to defecate, followed by the passage of voluminous red or maroon blood or clots. Melena is uncommon. The presence of colonic diverticula should not be considered an adequate
bleeding site is definitively known from a therapeutically
Segmental resection is most commonly performed if the
until medical, endoscopic, or angiographic therapies fail.
though this intervention is promising, more controlled data
studies of endoscopically treated diverticular bleeding re-
peptic ulcers. Cumulative results from 22 patients in nine
have prognostic values, similar to those associated with
(104, 105), and described endoscopic ‘stigmata’ thought to
ulum was ‘unequivocally’ identified as the cause of bleeding
with acute lower GI bleeding in whom a specific divertic-
bleeding diverticula. Foutch recently reported on 13 patients
ries of the heater probe (99), bicap probe (100), injection
prescribed cessation of hemorrhage from an actively bleeding
bleeding is being refined. A case report in 1985 first de-
source.

Diagnosis and Management
Recommendation: The diagnosis and treatment of lower GI
bleeding from diverticula requires a coordinated approach
by gastroenterologists, radiologists, and surgeons. After
resuscitation, diagnostic options include nuclear bleeding
scans, angiography, and colonoscopy; the choice of a par-
ticular modality will depend on the clinical scenario and
local expertise. Angiography and colonoscopy may be ther-
apeutically useful in patients with ongoing bleeding, and
surgery may be required in those in whom these are unsuc-
cessful.
The comprehensive management of patients with lower
GI bleeding is beyond the scope of these guidelines; the
reader is referred to the recently published American Col-
lege of Gastroenterology Practice Guidelines on lower GI
bleeding (97). Fluid and blood product resuscitation requires
immediate attention. Excluding an upper GI source by na-
sogastric lavage or upper endoscopy is warranted, as 10–
15% of patients with hematochezia will have an upper tract
etiology. Urgent flexible sigmoidoscopy is an appropriate
initial approach. If no obvious etiology is found, then further
evaluation with noninvasive (nuclear scintigraphy) or inva-
sive techniques (angiography, colonoscopy) can be under-
taken in an attempt to localize and/or treat the bleeding
source.
The role of endoscopic therapy in acute diverticular
bleeding is being refined. A case report in 1985 first de-
scribed cessation of hemorrhage from an actively bleeding
diverticulum by local irrigation with 1:1000 epinephrine
(98). Later reports have demonstrated the hemostatic abili-
ties of the heater probe (99), bicap probe (100), injection
therapies (101, 102), and fibrin sealant (103) in patients with
bleeding diverticula. Foutch recently reported on 13 patients
with acute lower GI bleeding in whom a specific divertic-
ulum was ‘unequivocally’ identified as the cause of bleeding
(104, 105), and described endoscopic ‘stigmata’ thought to
have prognostic values, similar to those associated with
peptic ulcers. Cumulative results from 22 patients in nine
studies of endoscopically treated diverticular bleeding re-
veal a 95% hemostasis rate with no morbidity (106). Al-
though this intervention is promising, more controlled data
will be required before endoscopic therapy becomes a stan-
dard intervention in this setting.
Surgery in acute lower GI bleeding is usually reserved
until medical, endoscopic, or angiographic therapies fail.
Segmental resection is most commonly performed if the
bleeding site is definitively known from a therapeutically
unsuccessful angiographic or endoscopic procedure. The
rebleeding rate compiled from seven series was 6% in 167
patients who underwent segmental resections for angiog-
raphically documented bleeding sites (107). In patients
with persistent bleeding, and no angiographic or endoscopic
identification of a definite bleeding site, a subtotal colec-
tomy may be required.

Treatment Outcome and Follow-up
Recommendation: Colonoscopy should generally be per-
formed in patients after an episode of lower GI bleeding to
elucidate the bleeding source and exclude neoplasia.
For the majority of patients, diverticular bleeding is self-
limited. Subsequent colonoscopy should generally be per-
fomed to potentially elucidate the bleeding source, but
more importantly to exclude neoplasia. In a review of over
2000 colonoscopies for overt or occult rectal bleeding, neo-
plastic polyps were found in 32% and carcinoma in 19%
(108). Another retrospective study looked at the yield of
colonoscopy in 258 patients with rectal bleeding who had
had negative proctosigmoidoscopies, and single-contrast
BEs that were normal or showed only diverticulosis (109).
The overall incidence of significant findings was 41%, in-
cluding carcinoma in 29 patients (11%) and telangiectasias
in 17 (7%). A more recent prospective study from Ontario
found colonoscopy more sensitive than the combination of
sigmoidoscopy and barium examination for the diagnosis of
adenoma, carcinoma, and angiodysplasia (110). The in-
creased ability to diagnose vascular ectasias and diverticula,
which cause the majority of bleeding, as well as the ther-
apeutic potential of colonoscopy all support its utility as a
primary investigative modality in patients with lower GI
bleeding.

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