Lower gastrointestinal bleeding (LGIB) is anatomically defined as bleeding beyond the ligament of Treitz. The term “lower gastrointestinal bleeding” is therefore a misnomer, and a more appropriate term would be lower intestinal bleeding. Clinically, LGIB represents a diverse range of bleeding sources and severities, ranging from scant hemorrhoidal bleeding to massive blood loss from vascular small bowel tumors. Various terms are used to describe blood emanating from the lower intestinal tract, including hematochezia, rectal bleeding, and bright red blood per rectum. These terms do not indicate the acuity or severity of bleeding, do not always localize the bleeding source, and are not exclusive to bleeding from beyond the ligament of Treitz. The wide clinical spectrum of LGIB and the number of available management strategies present a challenge for clinicians and investigators both. This review focuses on the epidemiology and diagnosis of acute LGIB with an emphasis on bleeding from colonic sources.

**Epidemiology**

**Incidence**

Acute LGIB is one of the most common gastrointestinal indications for hospital admission. The annual incidence of hospitalization for LGIB was estimated to be 20 to 30 per 100,000 persons in a large, southern California health maintenance organization [1]. This rate increased dramatically with advancing age [1]. Consequently, the impact of this disorder promises to increase as the population ages. In comparison, in the same population, the annual incidence of hospitalization for acute upper gastrointestinal bleeding (UGIB) was 100 per 100,000 persons per year [2]. Other studies also indicate that LGIB is approximately one-fifth as common as UGIB [3–5].
Demographics

Lower gastrointestinal bleeding predominantly afflicts an older population with a mean age of more than 65 years in most studies [5–11]. The annual incidence rate of hospitalization increases from 1 per 100,000 patients in the third decade of life to over 200 per 100,000 in patients in the ninth decade [1]. The older age distribution reflects the most common causes of LGIB (eg, diverticulosis, ischemic colitis) that tend to occur with aging. Concurrent with the older age distribution is a significant burden of comorbid illness. Studies reveal that at least 70% of patients with LGIB have at least one coexistent condition (see Refs. [6,10,12,13]).

In the population-based study of LGIB by Longstreth, men were affected significantly more frequently than women [1]. Little information exists regarding racial differences in LGIB. Diverticular disease, the most common cause of LGIB in the United States, is primarily a disease of Western cultures. However, this geographic variation is highly influenced by diet and lifestyle factors [14].

Outcomes

Most patients with LGIB have favorable outcomes despite advanced age and comorbid conditions [15,16]. Major outcomes and their frequency are listed in Table 1. Mortality rates range from 0% to 25% (see Refs. [1,17–19]). Mortality rates greater than 5% are generally found in older studies of severely bleeding patients in which a high percentage underwent emergency surgery [18–20]. As in UGIB, patients who begin bleeding while hospitalized for a separate disease process (inpatient bleeding) have a significantly higher risk of death than those who are admitted with LGIB (23% versus 2.4%) [1]. Most deaths are not the direct result of uncontrolled bleeding but rather exacerbation of an

<table>
<thead>
<tr>
<th>First author/Year</th>
<th>n</th>
<th>Acute rebleeding&lt;sup&gt;a&lt;/sup&gt; (%)</th>
<th>Delayed rebleeding (%)</th>
<th>Surgery (%)</th>
<th>Mortality (%)</th>
<th>PRBC&lt;sup&gt;b&lt;/sup&gt; (mean units)</th>
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<td>-</td>
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<td>2</td>
<td>4</td>
<td>-</td>
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<tr>
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<td>12</td>
<td>11</td>
<td>4</td>
<td>1.8</td>
<td>-</td>
</tr>
</tbody>
</table>

<sup>a</sup>Persistent hemorrhage or recurrent bleeding during the initial hospitalization. Definitions vary across studies.

<sup>b</sup>Packed red blood cells.

<sup>c</sup>Diverticular bleeding only.
underlying disorder or development of a nosocomial complication (see Refs. [1,11,21]). However, all-cause mortality during long-term follow-up is substantial. In a population-based study with 3 years of follow-up, death occurred in 19% of patients. Increasing age, duration of hospital stay, and number of comorbid conditions were independent predictors of all-cause mortality [1].

Most patients with LGIB will stop bleeding spontaneously. Continued or recurrent bleeding during an acute episode occurs in 10% to 40% of patients (see Refs. [1,7,8,10,11,22–24]). Between 5% and 50% of patients with persistent bleeding require surgical hemostasis (see Refs. [7,8,11,17,22,25]). Advances in endoscopic and radiologic hemostasis techniques appear to be decreasing rates of surgical intervention and rebleeding [13,26]. Long-term recurrence is a particular problem for patients with bleeding from diverticulosis or angiodysplasia [1,16]. These disorders will be discussed in subsequent sections.

The economic burden of LGIB on the whole has not been formally assessed but is presumably significant given the prevalence of this disorder and the older, often debilitated, patient population. Using the National Inpatient Sample, the largest, nationwide inpatient database, Thomas and colleagues estimated that diverticular hemorrhage alone cost $1.3 billion in 2001 [27]. In a study of acute LGIB in Ontario, Canada, the average cost for a patient with LGIB was $4,832 Canadian dollars (approximately $3,000 US) with an average length of stay of 7.5 days [28].

Predicting Outcome

Extensive literature exists regarding risk stratification in UGIB. Until recently, little was known about predictors of outcome in LGIB. The BLEED classification system (ongoing bleeding, systolic blood pressure less than 100 mmHg, prothrombin time greater than 1.2 times control, altered mental status, and unstable comorbid disease) was designed to stratify patients with either upper or lower gastrointestinal hemorrhage according to their risk of adverse in-hospital events [3,29]. Das and colleagues developed and validated artificial neural networks (ANNs) for the prediction of recurrent bleeding, need for intervention and death in the context of LGIB [8]. These ANN-based models were highly accurate, particularly when compared with the BLEED classification, and outperformed standard regression models when tested in an external cohort. Strate and colleagues identified seven independent predictors of severity in acute LGIB (hypotension, tachycardia, syncope, nontender abdominal exam, bleeding within 4 hours of presentation, aspirin use, and more than two comorbid diseases) [40]. Based on these factors, patients could be stratified into three risk groups: Patients with more than three risk factors had an 84% risk of severe bleeding, one to three risk factors a 43% risk, and no risk factors a 9% risk. These findings were prospectively validated in a mixed cohort of patients from an academic and a community hospital [30]. Velayos and colleagues prospectively studied patients admitted with LGIB and identified three predictors of severity and adverse outcome (initial hematocrit less than 35%, abnormal vital signs, and gross blood on rectal exam) [5]. Ideally, these predictive tools will
help guide the initial triage of patients with LGIB and a more standardized and cost-effective approach to this disorder.

**DIAGNOSIS**

**Diagnostic Criteria**

Multiple factors make the identification of a precise bleeding source in LGIB challenging. These include the diversity of potential sources, the length of bowel involved, the need for colon cleansing, and the intermittent nature of bleeding. In up to 40% of patients with LGIB, more than one potential bleeding source will be noted [31], and stigmata of recent bleeding in LGIB are infrequently identified (see Refs. [12,13,17]). As a result, no definitive source will be found in a large percentage of patients (see Refs. [6,10,32]). Various authors have attempted to define criteria for diagnosis in LGIB (see Refs. [1,16,33]), but these criteria have not been used consistently. Standardization of reporting on LGIB using such criteria would improve the quality of research and clinical care, as well as our understanding of the epidemiology of this disorder.

**Clinical History**

A thorough history and physical exam should be part of the initial evaluation of all patients presenting with gastrointestinal bleeding and can be done simultaneous with resuscitation efforts. The duration, frequency, and color of blood passed per rectum may help discern the severity and location of bleeding. Characteristically, melena or black, tarry stool, indicates bleeding from an upper gastrointestinal or small bowel source, whereas bright red blood per rectum signifies bleeding from the left colon or rectum. However, patient and physician reports of stool color are often inaccurate and inconsistent [34]. In addition, even with objectively defined bright red bleeding, significant proximal lesions can be found on colonoscopy [35].

The past medical history may also help to elucidate a specific bleeding source. Key points include antecedent constipation or diarrhea (hemorrhoids, colitis), the presence of diverticulosis (diverticular bleeding), receipt of radiation therapy (radiation enteritis), recent polypectomy (postpolypectomy bleeding), and vascular disease/hypotension (ischemic colitis). A family history of colon cancer increases the likelihood of a colorectal neoplasm and generally calls for a complete colonic examination in patients with hematochezia. Nonetheless, even after a detailed history, physicians cannot reliably predict which patients with hematochezia will have significant pathology [36], and a history of bleeding from one source does not eliminate the possibility of bleeding from a different source.

**Physical Examination**

A thorough physical examination is important to assess blood volume loss, a possible bleeding source, and comorbid conditions (which may affect suitability for interventions such as urgent colonoscopy). Orthostatic vital signs are an important complement to standard monitoring in a patient with apparently severe bleeding but without overt hemodynamic instability. The presence of
abdominal tenderness on examination may indicate an inflammatory disorder, such as ischemic colitis or inflammatory bowel disease, in contrast with a vascular source, such as diverticula or angiodysplasia [11]. The rectal exam serves to identify anorectal lesions and confirm stool color. However, positive findings on rectal examination do not preclude a concomitant abnormal finding on colonoscopy [37]. Despite presenting features and findings on physical examination, most patients with LGIB warrant a full examination of the colon.

Exclusion of an Upper Gastrointestinal Source

Several tools in addition to stool color are used to discriminate upper from lower gastrointestinal bleeding. This is an important step because 2% to 15% of patients with presumed LGIB will have UGIB [9]. Nasogastric lavage is a quick and safe procedure, but to avoid unnecessary patient discomfort, it should be reserved for patients with evidence of brisk bleeding in whom an upper endoscopy is not anticipated. Nasogastric lavage containing gross blood, 25% blood-tinged fluid, or strongly guaiac positive dark fluid was found to have 80% sensitivity for bleeding above the ligament of Treitz, and positive and negative predictive values of 93% and 99%, respectively [38]. Some authors believe that the presence of bile increases the sensitivity of nasogastric lavage [9], although the correlation between a bilious appearing aspirate and the true presence of bile acids has been questioned [39]. A nasogastric tube may also aid in the administration of a rapid bowel preparation [13] and should, ideally, be left in place until management decisions have been made. The blood urea nitrogen to creatinine ratio is a noninvasive test also used to help distinguish upper versus colonic sources of bleeding [40–42]. In one study, a ratio of 33 or higher had a sensitivity of 96% for UGIB, although overlap was observed with LGIB, especially in patients with UGIB without hematemesis [40]. Esophagoduodenoscopy remains the gold standard for excluding an UGI source in patients presenting with severe bleeding, especially those with hemodynamic instability.

**DIAGNOSTIC PROCEDURES**

**Colonoscopy**

Advances in endoscopic technology have brought colonoscopy to the forefront of the management of LGIB. Recent studies have shown that colonoscopy, particularly when performed early (within 12 to 24 hours of admission), is safe and effective (see Refs. [7,9,12,13,31]). Colonoscopy is undoubtedly the best test for confirming the source of LGIB and for excluding ominous diagnoses, such as malignancy. The diagnostic yield of colonoscopy ranges from 45% to 95% (Table 2) [6,13]. Discrepancies in diagnostic rates are at least in part the result of the criteria (or lack of) used to confirm a bleeding source (ie, probable versus definitive). In general, comparisons across studies are difficult because of variability in study design, patient selection, timing of exams, bowel preparation, and endoscopic experience.

Various therapeutic interventions (which are discussed in the subsequent chapter) are possible with colonoscopy; therefore, it is an efficient and
presumably cost-effective approach to most patients with LGIB. Early performance of colonoscopy has been shown to reduce length of hospital stay independent of other factors, such as severity of bleeding and comorbid illness (see Refs. [10,12,24,43]) and therefore should decrease treatment costs [44,45]. Reduction in length of stay appears to be related to establishing low-risk diagnoses rather than performance of therapeutic interventions [12]. In comparison, most patients undergoing radiographic evaluation for LGIB regardless of findings and interventions will subsequently require a colonoscopy to establish the cause of bleeding.

The optimal timing of colonoscopic intervention for LGIB remains uncertain. Early reports of emergency colonoscopy designated 24 hours from admission as the time threshold [7,46], whereas more recent literature defines urgent colonoscopy as within 12 hours [9,13]. Evidence suggests, although not overwhelmingly, that earlier performance leads to more diagnostic and therapeutic opportunities [13,47] and reduces length of stay (see Refs. [10,12,24,43]). However, urgent colonoscopy is difficult to orchestrate, and logistical factors, such as time of admission, appear to play a significant role in determining whether a patient will undergo endoscopic or radiographic intervention [48]. A good bowel preparation is important for the adequacy and sensitivity of urgent colonoscopy but is challenging for nursing staff and patients. Early reports of unprepped colonoscopy for LGIB report completion rates as low as 35%
[46,49] compared with 100% in a study using aggressive purges [13]. In the later study, preparation entailed 5 to 6 liters of sulfate purge, and nasogastric tubes in 33% of participants [13]. However, adequate and safe cleansing has been reported using less aggressive measures [31]. Around-the-clock endoscopy facilities and support staff also help to facilitate timely exams, but are not available in all hospitals.

Traditionally, colonoscopic evaluation for LGIB was delayed because of the need for adequate bowel preparation and the fear of increased procedural risks. Indeed urgent colonoscopy in an unprepped colon can be challenging if not dangerous. However, complication rates for colonoscopy in LGIB are low, and bowel preparation itself appears to be safe [31]. Zuckerman and Prakash, in a review of 13 studies, found an overall complication rate of 1.3% [50]. The most commonly reported complications are fluid overload [7,9], bowel perforation (see Refs. [7,10,47,51]), and sepsis [49].

Radionuclide Scintigraphy
Localization of the bleeding source is an important challenge in the management of LGIB. Radionuclide scintigraphy is a method that has been used for this purpose since the 1970s. Two methods exist—one using technetium-99m (Tc-99m) sulfur colloid and the other Tc-99m-labeled red blood cells (tagged red blood cell scan). Sulfur colloid is simple to prepare and is rapidly cleared from the circulation. However, uptake in the spleen, liver, and bone marrow compromise localization of UGIB sources. Radiolabeled red blood cells have a longer half-life, making it possible to perform repeat scans for recurrent bleeding following a single injection. In addition, red cell scans may localize bleeding anywhere outside the splenic area. Despite these theoretical advantages, a comparison of these two techniques found no difference in bleeding detection rates [52].

Among the advantages of radionuclide scanning are its sensitivity for bleeding as low as 0.05 to 0.1 ml/min [53] and its noninvasive nature. In addition, no bowel preparation is required, venous and arterial bleeding can both be detected, and repeat scans can be easily performed in the event of recurrent bleeding. However, radionuclide scanning has variable accuracy, cannot confirm the source of bleeding, and may delay other diagnostic and therapeutic procedures. Therefore, the role of radionuclide scintigraphy in the evaluation of patients with LGIB remains controversial.

Radionuclide scintigraphy is advocated for two primary purposes—as a guide for surgical resection and as a screening test prior to angiography. However, there is wide variability in the reported accuracy and usefulness of radionuclide scintigraphy for these purposes (Table 3) (see Refs. [19–21,54–64]). Radionuclide scintigraphy in some series accurately localized bleeding in more than 90% of patients undergoing emergency surgery [65]. However, other authors describe poor accuracy and a high rate of false positive exams [56,62]. In one study, 42% of patients underwent an incorrect surgical procedure based on scintigraphy results [56]. In addition, several studies have found that regardless of accuracy, scintigraphy did not affect surgical management (see Refs.
Accuracy appears to be best when the scan becomes positive within a short period of time (see Refs. [57,60,65]).

A similar debate exists with regard to the usefulness of radionuclide scintigraphy as a screening test for angiography. In theory, this noninvasive and more sensitive test would be used to select patients for angiography and to guide selective contrast injections. Gunderman and colleagues found that the yield of angiography increased from 22% to 53% after implementation of screening radionuclide scintigraphy [67]. In addition, several studies demonstrate that angiography following a negative radionuclide scan is of low yield [54,58]. However, in other series screening, radionuclide scintigraphy did not increase the rate of positive angiograms [68,69] and potentially delayed other therapeutic interventions [18].

These discrepancies regarding radionuclide scintigraphy may be attributed to several factors. First, selection criteria for studies vary with regard to severity and location of bleeding. Radionuclide scintigraphy is presumably most sensitive to severe bleeding and more accurate for lower gastrointestinal sources (excluding the rectum) (see Refs. [21,54,62,68,70]). Second, criteria for bleeding localization and site confirmation differ across studies. Some studies require precise localization and surgical confirmation, whereas others have much less

<table>
<thead>
<tr>
<th>First author/Year</th>
<th>Total scans (n)</th>
<th>Positive scans (%)</th>
<th>Bleeding site confirmed (%)</th>
<th>Correct localization(^a) (%)</th>
<th>Angiography in patients with positive scans (%)</th>
<th>Positive angiograms (%)</th>
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<td>70</td>
<td>95</td>
<td>47</td>
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<td>51</td>
<td>32</td>
<td>78(^b)</td>
<td>14</td>
<td>44</td>
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<td>26</td>
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<td>90</td>
<td>96</td>
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</table>

\(^a\)Of those patients who had confirmation of the bleeding site.

\(^b\)Localization was 87% if segmental localization versus precise localization was used.

\(^c\)Tc-99m sulfur colloid. Other studies in table used Tc-99m-labeled red blood cells.
rigorous criteria. In addition, imaging techniques in the literature are not standardized. Real-time, continuous dynamic imaging appears to be superior to delayed static imaging [70]. Last, the time to scan positivity [59,71], and the delay before angiography [18], may influence results but are infrequently noted. Prospective, randomized studies of radionuclide scanning in the management of LGIB would help resolve questions regarding its usefulness.

Angiography

Angiography is another radiographic modality used in the management of LGIB. Angiography is less sensitive than radionuclide scanning with the ability to detect bleeding of more than 0.5 ml/min [72]. In addition to its diagnostic role, angiography offers therapeutic possibilities via pharmacologic vasoconstriction or selective microembolization, and therefore may reduce the need for surgical resection. Disadvantages of angiography for LGIB include the potential for serious complications, the need for active bleeding at the time of the exam, and the need for confirmation of the bleeding source.

Bleeding detection rates with angiography range from 20% to 70% (Table 4) (see Refs. [19,47,54,59,69,73–75]). Severity of bleeding at the time of angiography is ostensibly related to the sensitivity of this exam [18,66,69]. Other factors that may affect the sensitivity of angiography include intermittent bleeding, procedural delays, atherosclerotic anatomy, and venous or small vessel bleeding [69,73]. Variability in patient selection and radiographic techniques may account for disparate results across studies. In addition, technologic advances in coaxial catheter and embolization technology have improved the ability to localize and treat LGIB over time.

Angiography has traditionally been used to guide surgical resection [73,74]. Segmental resection is reported in 50% to 95% of patients with positive angiograms (see Table 4) [18,74,75]. However, this represents only 10% to 60% of all patients undergoing angiography. As many as 20% to 50% of patients with negative angiograms will also require surgery [74,75]. Recurrent bleeding following angiographic-guided segmental resection appears to be low. In a collective series of 167 patients, rebleeding occurred in 6% [73]. Vasopressin

<table>
<thead>
<tr>
<th>First author/Year</th>
<th>Total no.</th>
<th>Positive (%)</th>
<th>Guided segmental surgical resection (%)</th>
<th>Complications (%)</th>
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<td>3</td>
</tr>
<tr>
<td>Colacchio 1982 [47]</td>
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infusion may also be used to stabilize patients, allowing for more elective and safer surgery [73]. However, advances in supraselective embolization techniques appear to be replacing vasopressin infusion and decreasing the need for surgical intervention [26].

Complications occur in 0% to 10% of patients undergoing angiography, although adverse events are inconsistently reported in the literature. The most common complications appear to be hematoma or bleeding at the catheter site (see Refs. [47,69,75]). Other potential adverse events include arterial dissection, catheter site infection, loss of pedal pulses, and contrast reaction (see Refs. [47,69,75]). Myocardial and intestinal ischemia, renal failure, and cardiac arrhythmias have been reported with the use of vasopressin infusion (see Refs. [19,43,76]). Localized bowel ischemia and infarction are concerns with therapeutic embolization [19,76]. Technologic advances in coaxial catheter techniques, embolization materials, and nonionic contrast agents promise to reduce complication rates in diagnostic and therapeutic angiography.

Infusion of vasodilators, anticoagulants, and thrombolytics can be used to provoke bleeding prior to angiography in patients with intractable bleeding of unknown origin. Using these techniques, bleeding is detected in 20% to 80% of patients [77–79]. Complications, including hematoma and continued bleeding, occur in 0% to 20% of patients [78]. Data regarding these techniques is limited to small series of patients, and severe complications, including intracranial hemorrhage and uncontrolled bleeding, are possible. Optimal results may depend on technical expertise, type and dosage of provocative agents, and timing of intervention in relation to onset of bleeding [77]. Experienced operators and carefully selected patients are necessary to achieve good results and limit complications [77]. Capsule endoscopy is currently a safer and promising diagnostic test for bleeding of unknown origin, and may obviate the need for provocative angiography in some of these difficult patients.

Studies directly comparing outcomes of radiographic versus colonoscopic interventions for LGIB are limited. Jensen and colleagues performed urgent colonoscopy (less than 12 hours from admission) and angiography on 22 patients with severe bleeding. The diagnostic yield of colonoscopy was 82% compared with 12% for angiography [43]. In a prospective trial of 100 patients randomized to colonoscopy within 8 hours or radionuclide scintigraphy followed by angiography, colonoscopy yielded significantly more diagnoses [80]. No differences were seen in therapeutic interventions, mortality, surgery, blood transfusions, or length of stay. However, there was a trend in favor of colonoscopy, and the study was not adequately powered for these outcomes. The advantages and disadvantages of frequently used interventions for LGIB are outlined in Table 5.

Other Diagnostic Modalities for LGIB
Flexible sigmoidoscopy can be performed expediently and may play a role in the initial evaluation of patients with LGIB [31]. The diagnostic yield of flexible sigmoidoscopy in LGIB ranges from 9% to 58% (see Refs. [6,12,24,35,47,49]).
In studies with favorable results, patients with a high suspicion of a left colon source were preferentially triaged to this strategy [35]. Therapeutic interventions for stigmata of active bleeding are also possible. However, regardless of presentation, flexible sigmoidoscopy may miss serious proximal pathology [35]. Fine and colleagues studied 217 patients with acute or subacute bright red blood per rectum [35]. Eight were found to have proximal cancers, three of which were in young patients without a family history of colorectal cancer. Unless a definite and compatible bleeding source is identified with flexible sigmoidoscopy, workup should proceed with a full colonoscopy in most patients.

With the advent of improved endoscopic technology, barium enema is uncommonly used in the evaluation of LGIB. Barium enema cannot detect superficial lesions or confirm a definitive bleeding source and may miss important pathology [47,81]. In one study, 79 of 173 patients (46%) undergoing barium enema were found to have significant lesions at colonoscopy, including 20 malignancies [81]. Furthermore, barium contrast may complicate subsequent colonoscopy or angiography. Contrast-enhanced computed tomography (CT) and magnetic resonance (MR) angiography are newer radiographic techniques that

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colonoscopy</td>
<td>• Therapeutic possibilities</td>
<td>• Bowel preparation required</td>
</tr>
<tr>
<td></td>
<td>• Diagnostic for all sources of bleeding</td>
<td>• Can be difficult to orchestrate without on-call endoscopy facilities or staff</td>
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<tr>
<td></td>
<td>• Needed to confirm diagnosis in most patients regardless of initial testing</td>
<td>• Invasive</td>
</tr>
<tr>
<td></td>
<td>• Efficient/cost-effective</td>
<td></td>
</tr>
<tr>
<td>Angiography</td>
<td>• No bowel preparation needed</td>
<td>• Requires active bleeding at the time of the exam</td>
</tr>
<tr>
<td></td>
<td>• Therapeutic possibilities</td>
<td>• Less sensitive to venous bleeding</td>
</tr>
<tr>
<td></td>
<td>• May be superior for patients with severe bleeding</td>
<td>• Diagnosis must be confirmed with endoscopy/surgery</td>
</tr>
<tr>
<td>Radionuclide scintigraphy</td>
<td>• Noninvasive</td>
<td>• Serious complications are possible</td>
</tr>
<tr>
<td></td>
<td>• Sensitive to low rates of bleeding</td>
<td>• Variable accuracy (false positives)</td>
</tr>
<tr>
<td></td>
<td>• No bowel preparation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Easily repeated if bleeding recurs</td>
<td></td>
</tr>
<tr>
<td>Flexible sigmoidoscopy</td>
<td>• Diagnostic and therapeutic</td>
<td>• Not therapeutic</td>
</tr>
<tr>
<td></td>
<td>• Minimal bowel preparation</td>
<td>• May delay therapeutic intervention</td>
</tr>
<tr>
<td></td>
<td>• Easy to perform</td>
<td>• Diagnosis must be confirmed with endoscopy/surgery</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Visualizes only the left colon</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Colonoscopy or other test usually necessary to rule out right-sided lesions</td>
</tr>
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</table>

Table 5
Advantages and disadvantages of common diagnostic procedures used in the evaluation of lower gastrointestinal bleeding

In studies with favorable results, patients with a high suspicion of a left colon source were preferentially triaged to this strategy [35]. Therapeutic interventions for stigmata of active bleeding are also possible. However, regardless of presentation, flexible sigmoidoscopy may miss serious proximal pathology [35]. Fine and colleagues studied 217 patients with acute or subacute bright red blood per rectum [35]. Eight were found to have proximal cancers, three of which were in young patients without a family history of colorectal cancer. Unless a definite and compatible bleeding source is identified with flexible sigmoidoscopy, workup should proceed with a full colonoscopy in most patients.

With the advent of improved endoscopic technology, barium enema is uncommonly used in the evaluation of LGIB. Barium enema cannot detect superficial lesions or confirm a definitive bleeding source and may miss important pathology [47,81]. In one study, 79 of 173 patients (46%) undergoing barium enema were found to have significant lesions at colonoscopy, including 20 malignancies [81]. Furthermore, barium contrast may complicate subsequent colonoscopy or angiography. Contrast-enhanced computed tomography (CT) and magnetic resonance (MR) angiography are newer radiographic techniques that
show promise in the evaluation of lower gastrointestinal bleeding and also offer the diagnostic capabilities of cross-sectional imaging [82,83].

Small bowel evaluation is indicated when upper and lower endoscopies fail to identify a source of bleeding. Traditionally, push enteroscopy and small bowel contrast radiography were the procedures of choice. Capsule endoscopy is the newest technology for evaluation of the gastrointestinal tract and plays a clear role in patients with small intestinal or obscure gastrointestinal bleeding. The diagnostic yield in patients with overt bleeding and negative upper and lower endoscopies ranges from 40% to 90% [84,85]. Capsule endoscopy has proven superior to other modalities used for obscure gastrointestinal bleeding. The diagnostic yield of capsule endoscopy ranges from 55% to 70% versus 25% to 30% for push endoscopy [86,87]. Costamagna and colleagues found that a source of obscure bleeding was found in 31% of patients with capsule endoscopy, and only 5% with barium small bowel radiographs [88]. Colonic sources of bleeding are difficult to evaluate via capsule endoscopy because of retained stool, limited battery life, and poor field of vision due to the colon's large diameter. Technological advancements in capsule endoscopy are likely to improve diagnostic accuracy and may facilitate procedural interventions.

**SOURCES OF BLEEDING**

Lower gastrointestinal bleeding arises from a diverse range of sources. Table 6 displays the breakdown of sources from a number of large studies. The spectrum of sources appears to be changing over time [16,89]. In the early 20th century, neoplasia was reported as the predominant source of LGIB, and diverticular bleeding was presumably rare [16]. Angiodysplasia were increasingly recognized as a source of LGIB in the 1960s and 1970s [16]. Currently, diverticular bleeding is the leading source of LGIB. This evolving disease spectrum may reflect a true change in the epidemiology of LGIB as well as improvements in diagnostic techniques and criteria. Common sources of LGIB are briefly discussed in the following sections.

**Diverticular Bleeding**

Diverticular disease currently comprises 20% to 55% of all cases of LGIB (see Refs. [1,10,11,13,46,89]). Diverticulosis is rare in patients under 40 years of age, but is seen in up to 65% of patients over the age of 85 [90]. It is estimated that 3% to 15% of patients with diverticulosis will experience bleeding [25]. Patients with diverticular hemorrhage typically present with the sudden onset of hematochezia and signs and symptoms of significant blood loss. Most patients will stop bleeding spontaneously, but up to 25% will require emergent intervention [25]. Stigmata of recent hemorrhage are infrequently identified [17] but appear to predict recurrent bleeding and the need for surgery in a manner similar to stigmata in UGIB (Fig. 1) [13].

The etiology and pathophysiology of diverticular bleeding is incompletely understood but may be the result of repeated trauma to the vasa recta (nutrient
arteries) that stretch over the diverticular dome. Nonsteroidal anti-inflammatory drugs have shown an association with diverticular complications in several prospective studies [91,92]. Advancing age and right-sided location may also play a role (see Refs. [1,74,93]). Long-term recurrence rates for diverticular bleeding increase from 9% at 1 year to 48% at 10 years [1,93]. After the second episode of bleeding, there is a 50% chance of recurrence [93]. Severity of the index bleed does not appear to predict recurrence [93]. Empiric preventative measures include a high-fiber diet and avoidance of nonsteroidal anti-inflammatories.

Ischemic Colitis

Colonic ischemia is the most common form of intestinal ischemia and in most cases is transient and reversible. This is in contrast to acute mesenteric ischemia, which is a medical emergency. The colon is predisposed to ischemic insult because of its poor collateral circulation, low blood flow, and high bacterial content. The watershed areas of the splenic flexure, rectosigmoid junction, and right colon are commonly involved because of their particularly tenuous blood supply.

Colonic ischemia should be considered in patients presenting with the sudden onset of abdominal pain and bloody diarrhea. Any event or condition that compromises colonic blood flow can lead to ischemia, although most patients have no identifiable cause or discrete vascular lesion. Common precipitants include cardiovascular insults; aortic bypass surgery or aneurysmal

### Table 6

<table>
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<tr>
<td></td>
<td>(%)</td>
<td>(%)</td>
<td>(%)</td>
<td>(%)</td>
<td>(%)</td>
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<tr>
<td>Diverticulosis</td>
<td>35</td>
<td>5</td>
<td>30</td>
<td>42</td>
<td>8</td>
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<td>Ischemia</td>
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<td>18</td>
<td>10</td>
<td>9</td>
<td>17</td>
</tr>
<tr>
<td>Anorectal (^a)</td>
<td>12</td>
<td>9</td>
<td>16</td>
<td>6</td>
<td>16</td>
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<tr>
<td>Neoplasia (^b)</td>
<td>7</td>
<td>3</td>
<td>6</td>
<td>9</td>
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<td>0</td>
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<tr>
<td>Postpolypectomy</td>
<td>3</td>
<td>13</td>
<td>7</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>IBD (^c)</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>—</td>
</tr>
<tr>
<td>Colitis, other (^d)</td>
<td>3</td>
<td>24</td>
<td>8</td>
<td>6</td>
<td>29</td>
</tr>
<tr>
<td>Radiation colitis</td>
<td>2</td>
<td>—</td>
<td>3</td>
<td>1</td>
<td>—</td>
</tr>
<tr>
<td>Small bowel/UGIB</td>
<td>5</td>
<td>5</td>
<td>—</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>9</td>
<td>5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Unknown</td>
<td>23</td>
<td>11</td>
<td>9</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>565</td>
<td>345</td>
<td>252</td>
<td>219</td>
<td>206</td>
</tr>
</tbody>
</table>

Probable and definitive sources.

\(^a\)Anorectal sources include hemorrhoids, anal fissures, rectal/stercoral ulcers.

\(^b\)Neoplasia includes polyps and cancers.

\(^c\)Inflammatory bowel disease (ulcerative colitis and Crohn’s disease).

\(^d\)Infectious colitis, antibiotic associated colitis, colitis of unclear etiology.
rupture; vasculitis; inherited or acquired hypercoagulable states (eg, pregnancy, oral contraceptives); prolonged, strenuous exercise; and medications or drugs that reduce colonic motility (eg, alosetron) or blood flow (catecholamines). Women with irritable bowel syndrome also appear to be at increased risk [94].

Colonoscopy or flexible sigmoidoscopy have replaced barium enema as the test of choice for colonic ischemia. Endoscopy typically reveals edema, hemorrhage, and ulceration with a sharp line of demarcation between normal and abnormal mucosa (Fig. 2). Histologically, submucosal hemorrhages, intravascular thrombus, and hylanization of the lamina propria are seen, in addition to inflammatory infiltrates. These findings are not pathognomonic, change over time, and may be confused with inflammatory bowel disease and infectious colitis. Most cases of colonic ischemia resolve with conservative treatment. The 15% to 20% of patients who develop gangrene will require surgical intervention and have a substantial risk of death [95]. A minority of patients will develop chronic ischemic colitis or stricture.

Angiodysplasia
Angiodysplasia are gastrointestinal vascular ectasias, distinct from vascular malformations and telangiectasias seen in other systemic and hereditary disorders. Estimates of angiodysplasia as a source of acute LGIB vary from 2% to 40% [1,9]. Recent data suggests that angiodysplasia are an uncommon source...
of acute LGIB (see Refs. [1,11,96,97]). Angiodysplasia most commonly result in iron deficiency anemia and occult blood loss, and can be found in a small number of asymptomatic individuals [96,97]. Angiodysplasia are thought to be degenerative lesions of the submucosal venules, and are therefore seen predominately in the elderly [98]. A number of comorbid conditions, including valvular heart disease and renal failure have been associated with angiodysplasia. However, these findings were not confirmed in a systematic literature review or a prospective study [99,100].

Overt bleeding from angiodysplasia is typically brisk, painless, and intermittent. Endoscopically angiodysplasia appear as red, stellate lesions of variable size surrounded by a pale mucosal rim (Fig. 3). The right colon is preferentially involved, although lesions can occur throughout the intestinal tract and are often multiple [101]. Angiography is more sensitive than colonoscopy for detecting angiodysplasia [101]. Bleeding and nonbleeding lesions are characteristically seen as dilated, slowly emptying veins, arterial tufts, or early-filling veins in the arterial phase [102]. Recurrent episodes occur in up to 80% of untreated patients [16]. Fortunately, endoscopic therapy is safe and effective [9].

Postpolypectomy
Clinically relevant bleeding occurs in 1% to 6% of patients undergoing colonoscopic polypectomy [103,104]. Bleeding at the time of polypectomy is amenable to immediate endoscopic hemostasis using various methods. Delayed bleeding typically occurs within 1 week of polypectomy, but can be seen up to 3 weeks following the procedure [104]. Proposed risk factors for postpolypectomy bleeding include large polyps, sessile morphology, and right colon location [105]. The role of aspirin and nonsteroidal anti-inflammatory drugs in postpolypectomy bleeding is controversial. Several large, retrospective studies have found no association [104,106], and current American Society for
Gastrointestinal Endoscopy guidelines state that polypectomy can be performed in patients taking standard doses of these medications [107]. However, the use of anticoagulants, irrespective of the preprocedure international normalized ration (INR), appears to increase the risk of bleeding [106]. Most patients with postpolypectomy bleeding present with mild to moderate blood loss, and many can be managed conservatively [106]. Some patients will have severe hemorrhage requiring emergent intervention and sometimes surgery [104].

Anorectal Sources
Hemorrhoids are the most common anorectal source of acute LGIB and can result in significant hemorrhage. At the time of bleeding, patients often lack other anorectal symptoms, such as pain or pruritis. Anoscopy is superior to flexible endoscopy for detection of hemorrhoids [108]. However, because blood extending beyond the rectal vault can be misleading, endoscopy with retroflexion is also recommended [9]. Most hemorrhoidal bleeding will stop with conservative measures. Patients with significant, refractory hemorrhage may require endoscopic or surgical intervention.

Anorectal fissures, stercoral ulcers, and radiation proctitis are other important anorectal sources of LGIB. Rectal ulcers in particular may result in massive LGIB, and up to 50% are found to have stigmata of recent hemorrhage amenable to endoscopic therapy [109]. Rectal ulcers may be the result of fecal impaction, rectal trauma, or rectal prolapse [109]. Radiation colitis is most often seen in the rectum following radiation therapy for prostate or gynecologic cancer. Radiation colitis typically results in chronic, low-grade bleeding, but
can present with more overt blood loss. Scattered or diffuse telangiectasias are seen on endoscopy.

Other Colonic Sources
Cancer and polyps typically result in chronic blood loss and are the source of acute LGIB in only a small percentage of patients. However, neoplasia is among the most important diagnoses to exclude. Similarly, bleeding is a common symptom in inflammatory bowel disease, although it is rarely acute or severe [110]. Certain infectious agents can also result in bloody diarrhea, including *Escherichia coli* 0157:H7, *Salmonella*, *Clostridia difficile*, *Campylobacter*, *Yersinia*, and *cytomegalovirus*. Rare causes of LGIB include Dieulafoy’s lesions, colonic varices, portal hypertensive enteropathy, Meckel’s diverticulum, prostate biopsy sites, and endometriosis.

Small Bowel Sources
Small intestinal sources comprise between 2% and 15% of cases of LGIB [9]. Angiodysplasia are the predominant cause of bleeding from the small intestine followed by lymphoma, erosions/ulcers, and Crohn’s disease [111]. Enteroscopy, barium contrast radiography, and capsule endoscopy are appropriate diagnostic modalities. The later technique has begun to revolutionize the diagnosis of bleeding in the small intestine. Patients with small intestinal bleeding require more diagnostic procedures, blood transfusions, and hospital days when compared with patients with UGIB or LGIB [111]. Based on these distinct features and outcomes, Prakash and Zuckerman propose that small intestinal bleeding is a distinct clinical entity [111].

SUMMARY
Lower gastrointestinal bleeding is one of the most common gastrointestinal indications for hospital admission, particularly in the elderly. Diverticulosis accounts for up to 50% of cases, followed by ischemic colitis and anorectal lesions. Though most patients stop bleeding spontaneously and have favorable outcomes, long-term recurrence is a substantial problem for patients with bleeding from diverticulosis and angiodysplasia. The management of LGIB is challenging because of the diverse range of bleeding sources, the large extent of bowel involved, the intermittent nature of bleeding, and the various complicated and often invasive investigative modalities. Advances in endoscopic technology have brought colonoscopy to the forefront of the management of LGIB. However, many questions remained to be answered about its usefulness in routine clinical practice. More randomized controlled trials comparing available diagnostic strategies for LGIB are needed.

References


