Gastrointestinal (GI) diseases are often encountered in the intensive care unit (ICU) setting, either as the major cause of admission or as a comorbid complication of another primary disease process. The consequences of lower gastrointestinal bleeding (LGIB) in the ICU—anemia and hypovolemia—may prolong the ICU course. A summary approach to ICU patients is noted in Table 126.1 and Figure 126.1.

LGIB is defined as a bleeding source distal to the ligament of Treitz, thus involving the small bowel and colon, and accounts for an estimated 20% to 24% of all major GI bleeding (1,2). It has been estimated that the annual incidence of LGIB is approximately 0.03% in the adult population (3). Longstreth (4) estimated the annual incidence of hospitalization for LGIB to be 20 to 30 cases/100,000 persons. LGIB is more common in men than women, and the incidence increases with age, with a greater than 200-fold increase from the third to ninth decades of life (2). The true incidence of LGIB during ICU hospitalization is not precisely clear; the incidence for ICU patients with acquired hemorrhage (not primarily due to LGIB) was reported as 0.94% (5).

LGIB is clinically distinct from upper gastrointestinal bleeding (UGIB) in epidemiology, management, and outcome. LGIB is approximately 20% to 33% as common as UGIB (2,6,7). LGIB generally has a lower mortality rate than does UGIB (8), but mortality is markedly higher in patients who begin bleeding after admission: 2.4% versus 23% (4). Most deaths are not the direct result of uncontrolled bleeding, but rather exacerbation of an underlying disorder or development of a nosocomial complication. Lin et al. (5) noted a 53% mortality in 55 patients, but this outcome was attributable to LGIB in only two patients. In another study, Lin et al. (9) noted that patients with LGIB and comorbid illness had a higher mortality rate than those without: 29.5% versus 4.3%. No matter whether reported in the general population or in an ICU-based study, LGIB remains a difficult diagnostic and treatment problem for several reasons:

- Bleeding can originate from any part of the lower GI tract.
- Blood loss is often intermittent in nature, and it is difficult to identify the source in the absence of active bleeding, especially angiographically.
- The colon preparation before urgent colonoscopy is, obviously, needed but often incomplete (10).
- Recurrent bleeding due to angiodysplasia (7) or diverticula (8,11) may be seen with LGIB.
- Unlike UGIB, there are no evidence-based and effective pharmacologic therapies for LGIB.

Among the many causes of LGIB (Table 126.2), diverticular bleeding, angiodysplasia, colitis, and neoplasm have been reported to be the most frequent (4,12). While the data from most reports are mixed with both non-ICU and ICU patients, the spectrum of LGIB from ICU patients should be different from others. Data from a study limited to medical ICU patients have shown ischemic colitis and acute hemorrhagic rectal ulcers to be the most frequent causes of LGIB, followed by colitis and diverticular bleeding (5). Our unpublished data—from surgical, trauma, and medical ICUs—showed acute hemorrhagic rectal ulcers followed by ischemic colitis to be the most frequently encountered causes (Table 126.3).

Patient age is a very important factor in the differential diagnosis of GI bleeding. Patients younger than 40 years are more likely to suffer from small bowel tumors, such as lymphomas, carcinoid tumors, and adenocarcinomas; anatomic anomalies such as Meckel diverticulum and Dieulafoy lesions; genetic problems such as polyps from a hereditary polyposis syndrome; or Crohn disease and ulcerative colitis (UC), which are common in Western countries and, recently, increasing in Asia. Patients older than 40 years are more prone to bleeding from vascular lesions and neoplasm (12). Lewis et al. (13), while evaluating small bowel bleeding, noted that in patients between 30 and 50 years, tumors were the most common abnormalities; in patients younger than 25 years, Meckel diverticulum was the most common source of small bowel bleeding, whereas vascular ectasias predominated in the elderly.

**Pathophysiology**

**Angiodysplasia**

Angiodysplasia, composed of ectatic, dilated submucosal veins, is the most common vascular anomaly of the GI tract. It includes vascular ectasias, arteriovenous malformations (AVMs), or angiomas. Angiodysplasia is thought to be due to degeneration of the submucosal venules, and thus is seen predominantly in the elderly (14). It has been reported as a common cause of acute major LGIB and slow intermittent blood loss (15,16). The percentage of acute LGIB that has been attributed to angiodysplasia varies from 3% to 40%, depending on the study (17,18). Angiodysplasia is also the most common cause of small bowel bleeding, accounting for 70% to 80% of episodes (19). Angiodysplasia may be clinically challenging, as it frequently has multiple lesions that may be difficult to identify, and bleeding associated with angiodysplasia is more likely to be intermittent than diverticular bleeding. Furthermore, angiodysplasia is the most common cause of recurrent LGIB of the elderly, with recurrent bleeding rates reported between 10% and 30% (7,15,16). The lesions of angiodysplasia are predominantly located in the right colon (cecum and ascending colon, 54%), followed by the sigmoid colon (18%) and rectum (14%) (20); angiodysplasia can be found throughout the small intestine.
CHAPTER 126
Lower Gastrointestinal Bleeding

Colonic Diverticular Bleeding

Colonic diverticular bleeding results from rupture of the intramural branches (vasa recta) of the marginal artery at the dome of a diverticulum or at the antimesenteric margin (21,22). Diverticula are the second most common, if not the most common, source of acute LGIB in some studies, and have been reported to comprise 20% to 55% of all cases of LGIB. Although greater than 75% of diverticula are found in the left colon, the right colon is the source of diverticular bleeding in 50% to 90% of patients. Most of the diverticula are not symptomatic, whereas approximately 20% develop

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TABLE 126.1 Summary of an Approach to Intensive Care Unit Patients with Lower Gastrointestinal Bleeding

1. Immediately assess and stabilize the patient’s hemodynamic status
2. Determine the presence of lower gastrointestinal bleeding: by history, physical examination, and sometimes nasogastric aspiration
3. Arrange appropriate diagnostic and therapeutic interventions to stop any active bleeding
4. Treat any underlying lesions, and monitor and manage the comorbid illness

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TABLE 126.2 Causes of Lower Gastrointestinal Bleeding

<table>
<thead>
<tr>
<th>Causes</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vascular ectasia</td>
<td>26.7</td>
</tr>
<tr>
<td>Diverticulosis</td>
<td>17.1</td>
</tr>
<tr>
<td>Ischemic colitis</td>
<td>8.6</td>
</tr>
<tr>
<td>Acute hemorrhagic rectal ulcer syndrome</td>
<td>6.7</td>
</tr>
<tr>
<td>Neoplasia</td>
<td>5.7</td>
</tr>
<tr>
<td>Postpolypectomy</td>
<td></td>
</tr>
<tr>
<td>Inflammatory bowel disease</td>
<td></td>
</tr>
<tr>
<td>Infectious colitis and ulcer</td>
<td></td>
</tr>
<tr>
<td>NSAID-induced colopathy</td>
<td></td>
</tr>
<tr>
<td>Radiation colitis</td>
<td></td>
</tr>
<tr>
<td>Hemorrhoids</td>
<td></td>
</tr>
<tr>
<td>Dieulafoy lesions</td>
<td></td>
</tr>
<tr>
<td>Colon varices</td>
<td></td>
</tr>
<tr>
<td>Aortoenteric fistula</td>
<td></td>
</tr>
</tbody>
</table>

Small bowel sources

- Vascular ectasia
- Focal active bleeding small bowel tumor:
  - Lymphoma
  - Adenocarcinoma
  - Gastrointestinal stromal tumor
  - Other tumors
- NSAID-induced enteropathy
- Crohn disease
- Meckel diverticulum
- Vasculitis: systemic lupus erythematosus, Behçet disease, Schönlein–Henoch purpura
- Infection-related ulcer: cytomegalovirus etc.
- Small bowel varices
- Aortoenteric fistula

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TABLE 126.3 Causes of Lower Gastrointestinal Bleeding in Surgical, Trauma, and Medical Intensive Care Units

<table>
<thead>
<tr>
<th>Causes</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute hemorrhagic rectal ulcer syndrome (AHRUS)</td>
<td>26.7</td>
</tr>
<tr>
<td>Ischemic colitis</td>
<td>17.1</td>
</tr>
<tr>
<td>Colitis other than ischemia</td>
<td>8.6</td>
</tr>
<tr>
<td>Vascular ectasia (angiodysplasia)</td>
<td>6.7</td>
</tr>
<tr>
<td>Diverticular bleeding</td>
<td>5.7</td>
</tr>
<tr>
<td>Malignancy</td>
<td>5.7</td>
</tr>
<tr>
<td>Colonic polyp</td>
<td>3.8</td>
</tr>
<tr>
<td>Solitary ulcer</td>
<td>3.8</td>
</tr>
<tr>
<td>Hemorrhoid</td>
<td>2.9</td>
</tr>
<tr>
<td>Dieulafoy lesions</td>
<td>1.9</td>
</tr>
<tr>
<td>Radiation colitis</td>
<td>1</td>
</tr>
<tr>
<td>Small bowel bleeding</td>
<td>6.7</td>
</tr>
<tr>
<td>Undetermined</td>
<td>9.4</td>
</tr>
</tbody>
</table>

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FIGURE 126.1 General approach to lower gastrointestinal bleeding. GI, gastrointestinal; CVP, central venous pressure; BP, blood pressure; ECG, electrocardiogram; Pt, patient; CAD, coronary artery disease; Hb, hemoglobin; PT, prothrombin time; PTT, partial thromboplastin time.
diverticulitis and 3% to 5% develop acute severe bloody stool (11). Diverticulosis is rare in patients under 40 years of age; age and nonsteroidal anti-inflammatory drug (NSAID) use have been shown to be associated with diverticular bleeding (23,24). At least 75% of diverticular bleeding will stop spontaneously, but up to 25% will require emergent intervention. Recurrent bleeding from diverticula occurs in 14% to 38% of patients (4,11,25,26).

Ischemic Colitis

Ischemic colitis, resulting from a sudden, often temporary reduction in mesenteric blood flow, is increasingly recognized as a cause of acute LGIB. Ischemic colitis accounts for approximately 1% to 19% of LGIB (27), and may be transient and reversible. Data from a study limited to medical ICU patients have shown that ischemic colitis, not angiodysplasia or diverticula, is one of the most frequent causes of LGIB (5). Ischemic colitis is usually caused by “low-flow states” and occlusion of small, rather than large, vessels. Mesenteric hemodynamics may be compromised by changes in the systemic circulation or by anatomic or functional changes in the mesenteric vasculature. In patients who have undergone aortoiliac reconstructive surgery, the frequency of postoperative colonic ischemia is 1% to 7% (28–30). The typical segments affected by nonocclusive colonic ischemia are the “watershed” areas of the colon: the splenic flexure and the rectosigmoid junction. Clinically, ischemic colitis most frequently involves the splenic flexure, the descending colon, and the sigmoid colon. Ischemic colitis with segmental distribution has an abrupt transition between damaged and normal mucosa at colonoscopy. Conditions that compromise colonic blood flow can lead to ischemia, and include cardiovascular insults; aortic bypass surgery; aneurysmal rupture; vasculitis; inherited or acquired hypercoagulable states, such as pregnancy and oral contraceptives; intense exercise (28); and medications or drugs that reduce colonic motility or blood flow, such as catecholamines. Among them, intense exercise results in blood being shunted from the viscera to the working muscles, resulting in decreased splanchic blood flow by as much as 80% (29).

NSAID-Induced Enteropathy and Colonopathy

NSAID enteropathy and colonopathy are lesions related to the use of NSAIDs. These drugs have been demonstrated to exacerbate inflammatory bowel disease, cause colitis that resembles inflammatory bowel disease, and complicate diverticular diseases by increasing the risk of perforation and severe hematochezia (31,32). The terminal ileum and cecum are particularly susceptible to NSAID-induced injury. This is because the pills may be static for a longer period of time in the terminal ileum and cecum than in other segments of the bowel. History of use of NSAIDs and endoscopy (colonoscopy and enteroscopy) are essential for diagnosing NSAID enteropathy and colonopathy. The diaphragm-like structure is pathognomonic of NSAID injury as a result of a scarring reaction secondary to ulceration. They are most frequently found in the midsection of the small intestine, but have also been reported to occur in the terminal ileum and colon (33–36).

Radiation Colitis

Radiation therapy to the colon may induce inflammatory changes and can produce radiation colitis. A history of prior radiation therapy for prostate or pelvic cancer may indicate radiation proctitis, no matter how distant from radiation exposure.

Dieulafoy Lesions

Dieulafoy lesions are unpredictable and life threatening, because bleeding is often massive and recurrent (37,38). Dieulafoy lesions should always be included in the differential diagnosis of GI bleeding, especially when a definitive source is not found on routine investigation (i.e., in the presence of obscure GI bleeding). In the colon, solid bowel content can contribute to mucosal stercoral ulceration over an abnormally dilated submucosal arteriole and subsequent rupture and bleeding.

Bleeding Caused by Endoscopic Treatments

More endoscopic procedures such as polypectomy, endoscopic mucosal resection (EMR), and endoscopic submucosal dissection (ESD) were applied to colonic lesions. The vessels on the mucosal defect may cause bleeding when adequate postprocedure hemostasis is not achieved. Postpolypectomy bleeding is the cause of 2% to 5% of acute LGIB. A history of recent colonoscopy with polypectomy will lead to the diagnosis of postpolypectomy bleeding as the most likely source; most of this bleeding stops spontaneously. A retrospective review of the medical records showed delayed post-ESD bleeding, defined as bleeding that resulted in overt hematochezia 6 hours to 30 days after ESD, might occur in 4.4% of the patients (39).

Ulcerative Colitis and Crohn Disease

Inflammatory bowel disease (IBD) is characterized by chronic intestinal inflammation and divided into two major types—UC and Crohn disease; the cause of IBD is unknown. Ulcerative colitis is a disease characterized by inflammation and ulcers in the superficial layers of the large intestine, usually in the rectum and distal part of the colon. The inflammation of the bowels usually presents with diarrhea and may be with blood. Ulcers form when inflammation has destroyed the mucosa of the bowels, which causes bleeding (40). Unlike UC, Crohn disease usually occurs in the small intestine and proximal colon; Crohn disease differs from UC in that it causes inflammation throughout the whole thickness of the intestinal walls and then deep ulcers. Bleeding is much more common in Crohn disease than in UC (40).

Acute Hemorrhagic Rectal Ulcer or Acute Hemorrhagic Rectal Ulcer Syndrome

Acute hemorrhagic rectal ulcer (AHRU) or acute hemorrhagic rectal ulcer syndrome (AHRUS) has attracted the attention of ICU practitioners. AHRUS has been reported as one of the most frequent causes of LGIB in the ICU (5). AHRUS was first introduced in 1981, and was recognized as a syndrome later; so far, there are reports only from Japan and Taiwan (41–44). AHRUS accounts for 2.8% of the patients with massive LGIB
bowel bleeding, or slow oozing from the right colon usually present for the GI tract for less than 5 hours is usually red, whereas blood suggestive of the location of bleeding. Blood that has been in appearance, largely dependent on blood transit time, may be dark blood with clots, or, less commonly, melena. The stool LGIB may complain of passing bright red blood per rectum, is always queried. The patient presenting with acute patients with only anemia due to GI bleeding, the history; and history of medications. Except for asymptomatic such as infectious colitis or inflammatory bowel disease. The medical or surgical history may provide clues to the causes of LGIB. A previous history of colonic polyps, diverticulosis, or colonic tumor should be considered as a possible source of LGIB during the initial evaluation. Renal failure is a well-known risk factor for angiodysplasia or AVM (49), as is aortic stenosis (50). Note should be made of patients with renal impairment or who are being dialyzed, as these patients may have platelet abnormalities, resulting in a tendency to bleed if a lesion is present. Ischemic bowel may be present when severe abdominal pain and bloody stool occur in patients with severe atherosclerotic vascular disease, atrial fibrillation, or hypotension. Radiation therapy for prostate or pelvic cancer induces inflammatory changes of the rectum, and can produce radiation proctitis, presenting months or even years after the radiation exposure. A history of recent colonoscopy with polypectomy indicates postpolypectomy bleeding as the likely source. In patients who have undergone aortoiliac reconstructive surgery, the frequency of significant postoperative colonic ischemia ranges between 1% and 7% (51–53).

Medication history is also important. Medications that can damage the GI mucosa or exacerbate bleeding include NSAIDs, alendronate, potassium chloride, and anticoagulants. Patients admitted with GI bleeding were more likely to be taking selective serotonin reuptake inhibitors (SSRIs) than controls; this association exists for LGIB as well as UGIB (54). Concurrent anticoagulation or use of NSAIDs may be important cofactors in potentiating bleeding (55). The use of aspirin or NSAIDs is strongly associated with both LGIB—chiefly from diverticula—and UGIB (23,24). NSAID enteropathy has been increasingly reported, and can be a potential cause of LGIB (56,34). A family history of colon cancer increases the likelihood of a colorectal neoplasm, and generally calls for a complete colonoscopic examination in patients with hematochezia (31,32).

Physical Examination

A thorough physical examination is essential to assess loss of blood volume, a possible bleeding source, and comorbid conditions (especially for ICU patients). The comorbid conditions may affect the suitability for interventions, such as urgent colonoscopy. The physical examination should also include complete vital signs and heart, lung, and abdominal...
assessment, as well as an examination of the conjunctiva and skin. Pale conjunctiva indicate anemia; cutaneous manifestations may suggest disorders causing GI bleeding, those caused by celiac sprue may indicate dermatitis herpetiformis. The polyposis syndromes (Peutz–Jeghers syndrome, Gardner syndrome, and Cronkite–Canada syndrome) often have cutaneous abnormalities, such as lip pigmentation in Peutz–Jeghers syndrome. Orthostatic vital signs are an important complement to standard monitoring in a patient with severe bleeding but without overt hemodynamic instability. Abdominal tenderness on examination may indicate an inflammatory process, such as ischemic colitis or IBD (57). The rectal examination serves to identify anorectal lesions and confirms the stool color described by the patient. In addition, approximately 40% of rectal carcinomas are palpable during a digital rectal examination (58). Regardless of the presenting features and findings on physical examination, most patients with LGIB still warrant a full examination of the colon.

**Laboratory Examination**

Initial laboratory studies should include a complete blood count, serum urea nitrogen, creatinine, coagulation profile (prothrombin time, INR, and partial thromboplastin time), liver tests, blood type and cross-match, and electrolytes. As discussed above, positive fecal occult tests (guaiac-based tests and immunochemical fecal occult blood tests) may favor LGIB. The blood urea nitrogen–to–creatinine ratio has been used as a noninvasive test to help distinguish UGB from colonic sources of bleeding (59–61). In the study of Chalasani et al. (59), a ratio of 33 or higher had a sensitivity of 96% for UGB, although overlap was observed with LGIB, especially in patients with UGB without hematemesis.

In the ICU, patients suspected of having GI blood loss secondary to findings of persistent anemia will have a fecal occult blood study as the first investigative step. While there are numerous types of fecal occult blood tests, the test used determines the location in the GI tract where blood is likely to be detected (62).

**Guaiac-Based Tests**

The classic fecal occult blood study, guaiac-based tests, utilize hemoglobin's pseudoperoxidase activity. Guaiac turns blue after oxidation by oxidants or peroxidases in the presence of an oxygen donor such as hydrogen peroxide. Because hemoglobin is degraded in the GI tract, guaiac-based tests are more sensitive for detecting bleeding in the lower than upper GI tract (63). However, the characteristics of specific guaiac-based tests from different companies vary. Whether a guaiac-based test will be positive or not is related to the quantity of blood present in the stool, which is related to the size and location of the bleeding lesion (64,65). Because bleeding colonic lesions are more likely to lead to undegraded blood and heme in the stool, guaiac-based tests are best at detecting these distal lesions (63). Various factors influence guaiac test results; for example, fecal rehydration affects the reactivity of guaiac-based tests, and may raise sensitivity but reduce specificity (66). Additionally, foods that contain peroxidases or animal hemoglobin can cause false-positive guaiac test results. False-negative guaiac-based tests may be seen with hemoglobin degradation, sample storage, and vitamin C ingestion (61). Orally administered iron, even in large amounts, does not cause a positive guaiac reaction (67). Bismuth-containing antacids and antidiarrheals cause dark stool, which should not be confused with a positive guaiac reaction. Guaiac-based tests are rapid bedside studies.

**Immunochromometric Fecal Occult Blood Tests**

These detect human globin epitopes, and are highly sensitive for the detection of stool blood (68). These tests do not detect UGI blood because globin molecules are degraded by UGI tract enzymes. Theoretically, these tests have a higher specificity for the detection of colonic lesions than guaiac-based tests. However, they are limited by technical problems and the need for more intensive laboratory processing. A false negative may occur from hemoglobin degradation and sample storage.

**Heme–Porphyrin Test**

This study provides a highly accurate determination of total stool hemoglobin based on a spectrofluorometric method that measures porphyrin derived from heme. The heme–porphyrin test is the most sensitive method of detecting occult blood loss of either the upper or lower GI tract. The results of the heme–porphyrin test are neither affected by intraluminal degradation of hemoglobin nor by the interference of peroxidase–producing substances. False positives result from animal hemoglobin and red meats, which contain myoglobin, a heme-containing protein; false negatives are a consequence of sample storage. In summary, guaiac-based tests and immunochromometric fecal occult blood tests focus on LGIB, especially from the colon. The heme–porphyrin tests cannot discriminate between bleeding from the upper and lower GI tracts.

In the cardiac ICU, warfarin or low-dose aspirin is used frequently. Neither of these alone appears to cause positive guaiac-based, fecal occult blood tests (69). A positive fecal occult blood test in this setting should raise the possibility of a GI tract abnormality, and requires appropriate evaluation. Jaffin et al. (70), prospectively evaluating the GI tract in anti-coagulated patients with positive guaiac-based fecal occult blood tests, showed that 20% of these results were associated with malignancy.

**Endoscopic Approach: General**

**Safety of Endoscopic Procedures for Critically Ill Patients.**

Colonoscopy remains the procedure of choice for evaluating patients with acute LGIB, and enteroscopy is considered for proximal small bowel bleeding. However, for ICU patients with acquired bleeding and hemodynamic instability, questions remain due to the possibility of severe comorbid illness, including respiratory distress, aortic aneurysm, life-threatening dysrhythmias, AMI, history of GI tract perforation or operation, severe lower GI obstruction, and bleeding tendency, to list only a few conditions. Colonoscopy complication rates in LGIB of the general population or patients admitted to the ICU primarily for hemorrhage are low, and the bowel preparation itself appears to be safe (71–73). Zuckerman and Prakash (74) reviewed 13 studies and found an overall complication rate of 1.3%. A study of 55 ICU patients with acquired LGIB demonstrated an acceptable diagnostic rate of 67% (37 of 55 cases) without procedure-related complications, suggesting that bedside colonoscopy after preparation is safe for the critically ill (5).
Preparation before Endoscopic Procedures. In patients with massive active bleeding, colonoscopy is often frustrating, nonproductive, and sometimes dangerous. However, some clinicians still consider it the first diagnostic maneuver, even in the patient with severe ongoing bleeding (48,75). Traditionally, colonoscopy for LGIB was delayed because of the need for bowel preparation and the fear of increased procedural complications. Indeed, urgent colonoscopy in an unprepared colon can be challenging, or even dangerous. Good bowel preparation is important for an adequate and sensitive colonoscopy. Studies of urgent colonoscopies performed in an unprepared colon to evaluate for LGIB revealed completion rates as low as 35% (76,77). Jensen et al. (78) studied patients with severe diverticular hemorrhage, noting that completion rates may reach up to 100% if an aggressive bowel preparation is performed before urgent colonoscopy. Because of variable comorbid conditions, such as decreased bowel motility, obstruction, and electrolyte disturbance, colon preparation in ICU patients may not be as thorough as in the general population. There are limited studies of the effectiveness of colon preparation for LGIB in ICU patients. Lin et al. (5) noted that for patients with LGIB occurring after admission to ICU, the reach rate of the cecum with a colonoscope was 38% after enemas or an oral polyethylene glycol (PEG) solution were administered.

In spite of providing a relatively feces-free colon, old methods for colon preparation with clear liquids, laxatives, and enemas or peroral gut lavage 48 to 72 hours before colonoscopy are time consuming, uncomfortable, and inconvenient for patients. For those in the ICU or with active LGIB, these methods are clearly not useful. Peroral gut lavage with saline or balanced electrolyte solutions has been proposed and was found to provide rapid, effective cleansing of the colon; however, the method is not tolerated in 11% of patients due to the high fluid volume—7 to 12 L—and might cause fluid and electrolyte disturbances (79). Recently, development of osmotically balanced solutions may provide minimal water absorption or secretion into the bowel lumen. Generally speaking, there are iso-osmotic preparations, hyperosmotic preparations, and stimulant laxatives for colon cleansing. Polyethylene glycol–electrolyte lavage solution (PEG-ELS) is an isotonic, nonabsorbable electrolyte solution that clears the bowel by washing out ingested fluid without significant fluid and electrolyte shifts. Rapid purge is best accomplished with PEG-based solutions. They can be administered by a nasogastric tube or by drinking 1 L every 30 to 45 minutes, to a median dose of 5.5 L (range 4 to 14 L); 3 to 4 hours are required to cleanse the colon (80). Two liters of PEG-ELS plus bisacodyl or magnesium citrate have also been suggested for colon preparation (81). The studies comparing a standard 4-L PEG-ELS with 2-L PEG-ELS with either a magnesium citrate or bisacodyl preparation have shown equal efficacy for colon cleansing (82–84). With PEG-ELS, 5% to 15% of patients have difficulty drinking the large amounts of fluid, or they develop symptoms such as nausea, vomiting, abdominal fullness, and cramps, leading to incomplete colon preparation (85,86). Hyperosmotic preparations, including monobasic and dibasic sodium phosphate (NaP) and magnesium citrate, draw plasma water into the bowel lumen to promote evacuation. In addition to hyperosmotic action, magnesium citrate also stimulates fluid secretion and intestinal motility through the action of cholecystokinin. Fleet Phospho-Soda (C. B. Fleet Co., Lynchburg, VA) is a poorly absorbed salt that produces intestinal fluid retention due to the osmotic load, and causes fluid evacuation from the bowel. Patients often prefer NaP to PEG-ELS because there is much less fluid to drink. Liquid and tablet forms of NaP are currently available. Stimulant laxatives include bisacodyl and senna extract. The former is a poorly absorbed diphenylmethane that stimulates colonic peristalsis, and the latter contains anthranic derivatives that may be metabolized by colonic bacteria into substances that enhance colonic motility.

The timing of colon preparation varies among institutions. Early methods required preparation 48 to 72 hours before the procedure; of course, this is not ideal for ICU patients who need urgent interventions. Some institutions administer the solution on the day of the examination, even though the manufacturer recommends taking the medication the day before the procedure (81). For the critically ill patient with LGIB, there are no data on the “proper timing” of colon preparation. Further, preparation may be incomplete due to poor motility or ileus. Chiu et al have suggested that PEG-ELS on the day of procedure may be adequate (81).

The safety of colon preparation is important for critically ill patients with comorbid illness; of particular concern are fluid overload and electrolyte disturbances. PEG-ELS causes no significant change in weight, vital signs, serum electrolytes, or complete blood count (87–89). It is a relatively safe colon preparation solution for patients with electrolyte imbalance, advanced liver disease, poorly compensated congestive heart failure, or renal failure, although in the study of Granberry et al. (90), exacerbation of congestive heart failure after PEG-ELS administration was noted. NaP, a hyperosmotic preparation, may cause alterations in serum electrolytes and extracellular fluid status (91,92). Asymptomatic hyperphosphatemia is seen in up to 40% of patients, but clinically significant hyperphosphatemia is rare and usually limited to patients with renal failure (93–95). Twenty percent of patients had abnormally low serum potassium levels after bowel preparation with NaP (91). It is suggested that NaP is contraindicated in patients with renal failure, acute myocardial infarction (MI) or unstable angina, congestive heart failure, ileus, intestinal malabsorption, and significant ascites. Gremsle et al. (95) reported that the degree of asymptomatic hyperphosphatemia in children was greater than in adults, and recommended avoiding NaP in children with renal failure, congestive heart failure, ileus, and ascites.

Colonoscopy for Critically Ill Patients. Three primary diagnostic tools for LGIB are colonoscopy, radionuclide scintigraphy, and mesenteric arteriography. Advances in endoscopic technology have brought colonoscopy to the forefront of the management of LGIB. Colonoscopy as the first choice for occult or stable LGIB is not in dispute. However, for brisk LGIB or LGIB with hemodynamic compromise, whether the attending physicians consider colonoscopy as the first diagnostic maneuver for brisk LGIB or LGIB with hemodynamic compromise is controversial. Colonoscopy in patients with severe hematochezia is impractical because of inadequate visualization caused by brisk blood loss (2,74). Some are reluctant to perform colonoscopy in hemodynamically unstable patients with ongoing bleeding, suggesting that these patients are best served by urgent angiography, perhaps in conjunction with surgical consultation (80,96). However, there is a reason to favor colonoscopy for acute LGIB. In addition to affording
a rapid diagnosis, colonoscopy may indicate specific therapy when (and if) the bleeders are found (78,97–99), although the rate for intervention in an ICU study was low (5). Rapid endoscopic identification of a bleeding source, regardless of whether therapy is administered, may contribute to the clinical management of recurrent bleeding, if it occurs. Finally, compared with angiography, urgent colonoscopy has a higher diagnostic yield and a lower complication rate. In a retrospective study of 107 patients with severe LGIB, colonoscopy was diagnostic in 90% of patients and angiography in 48%; the former was therapeutic in 12% versus 22% for the latter (100). In another study, the diagnostic yield of colonoscopy was 82% versus 12% for angiography (48). Interestingly, most patients undergoing radiographic evaluation for LGIB—regardless of findings and interventions—will subsequently require a colonoscopy to establish the cause of bleeding. In addition to diagnosis, occasional therapy, and management planning, earlier colonoscopy does contribute to a shorter length of hospital stay (101). Hemodynamic instability, higher comorbidity, performance of a tagged red blood cell nuclear scan, and surgery for hemostasis were significantly associated with a decreased likelihood of discharge (101).

While most episodes of LGIB will stop spontaneously, 10% to 15% of patients undergoing urgent colonoscopy received endoscopic therapy. The lesions most amenable to colonoscopic treatment of LGIB, in most studies, are angiodyplasia or diverticulosis. Once it is identified as the source of bleeding, angiodyplasia is usually coagulated by methods including the following (5,78,102,103):

- Injection therapy (epinephrine, saline, or ethanol)
- Heater probe
- Monopolar and multipolar electrocoagulation
- Argon plasma coagulation (APC)
- Hemoclips
- Band ligation

In a study of ICU patients with nonprimary LGB, spontaneous cessation occurred in 53% of patients; 29% achieved hemostasis with endoscopy, but had a higher rate (19%) of recurrent bleeding (5). Other studies, not limited to ICU patients, have reported rebleeding rates of 13% to 53%, and many patients may require more than one treatment (102,103).

**Timing of Colonoscopy**

The use of colonoscopy is controversial for critically ill patients with LGIB. Some believe that colonoscopy is best utilized in patients whose bleeding has stopped or slowed down (80,96), and others agree with early colonoscopy for LGIB. Evidence suggests that earlier intervention leads to more diagnostic and therapeutic opportunities (78,104). It has further been noted that early colonoscopy reduces the length of hospital stay, and therefore should decrease treatment costs (91,92). Urgent colonoscopy after bowel preparation with endoscopic treatment of patients with active diverticular bleeding or stigmata of bleeding has been shown to be highly effective in decreasing the need for surgical intervention (78,80).

In conclusion, prompt intervention may decrease the need for surgical exploration, as well as the rate of recurrent bleeding and length of hospital stay. Who needs urgent colonoscopy? Early identification of high-risk patients would allow the more selective delivery of urgent therapeutic interventions to those who will benefit. Clinical high-risk predictors in the first hour of evaluation in patients with severe LGIB have been proposed, and included an initial hematocrit of no more than 35%, the presence of abnormal vital signs 1 hour after initial medical evaluation, and gross blood on initial rectal examination (6). How early should the urgent colonoscopy be performed? The definition of urgent colonoscopy varies widely in the literature—from within 8 to 24 hours of presentation (5,48,78,105–109). Most definitions consider the procedure within 12 to 24 hours; most recently, the literature defines urgent colonoscopy as within 12 hours (48,78).

**Sigmondoscopy or Colonoscopy?**

In studies of the general population with LGIB, diverticular and angiodysplastic bleeding are the most frequent events. Although anatomically prone to be located in the left colon, bleeding most often occurs in the right colon; thus, most endoscopists prefer a total colonoscopy. Flexible sigmoidoscopy can be performed in the initial evaluation of patients with LGIB, but the diagnostic yield of flexible sigmoidoscopy in LGIB is low, ranging from 9% to 58% (10). Regardless of presentation, flexible sigmoidoscopy may miss serious proximal pathology (110). However, in the study of ICU patients with acquired bleeding, 78% of responsible lesions were in the left colon (5). If the critical situation precludes the use of total colonoscopy, sigmoidoscopy as the first maneuver may be acceptable for this patient group. Nonetheless, unless a definite and compatible bleeding source is identified with flexible sigmoidoscopy, the study of LGIB should proceed to a full colonoscopy in most patients.

In 2005, the ASGE offered the following guidelines regarding LGB (111):

- Colonoscopy is effective in the diagnosis and treatment of LGIB (prospective controls).
- Colonoscopy is recommended in the early evaluation of severe acute LGIB (prospective controls).
- Thermal contact modalities, including heat probe, and bipolar/multipolar coagulation and/or epinephrine injection can be used in the treatment of bleeding diverticula, vascular ectasia, or postpolypectomy bleeding (prospective controls).

**Enteroscopy and Capsule Endoscopy for Critically Ill Patients**

The small bowel has traditionally been a problematic area to evaluate because of the long length, looping, free intraperitoneal location, active contractility, and limits of standard endoscopy. It is estimated that 10% to 25% of LGB originates in the small bowel and can pose a diagnostic dilemma for clinicians (112–114). Small bowel sources account for 0.9% to 7% of cases presenting with blood per rectum (48,100,115), and comprises approximately 5% of obscure GI bleeding (116). Upper endoscopy and colonoscopy appear to have limited roles in the investigation of small bowel bleeding, and are only useful when the bleeding source is the duodenum or the most distal segment of the small intestine (terminal ileum), respectively (55). Some clinicians have utilized peroral intubation with a standard colonoscope, reaching a point 20 to 60 cm distal to the ligament of Treitz; this may increase the diagnostic yield of GI bleeding of obscure origin by 17% to 46%—not an insignificant proportion (13,117–119). Small bowel enteroscopy is currently the best endoscopic investigative modality. Indeed, it has become the cornerstone of management in patients with obscure GI bleeding. Current tools for ruling out small bowel diseases include push-type enteroscopy (PE), double-balloon

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**References**

1. <ref>References and bibliography for the text content</ref>
Enteroscopy (DBE), intraoperative enteroscopy, and capsule endoscopy.

Small bowel evaluation may be performed with PE, which allows endoscopic evaluation of the proximal 60 cm of the jejunum or 150 cm distal to the pylorus. PE is probably the most commonly performed small bowel procedure today, and is often pursued when upper GI endoscopy and colonoscopy have failed to find the source for blood loss. PE may be performed using an enteroscope or pediatric colonoscope. The obvious limitation of push enteroscopy is the inability to reach lesions distal to the middle jejunum. PE can only examine a relatively short portion of the small bowel, even under fluoroscopy, and the true depth of insertion is unreliable. Some experts consider it complementary to capsule endoscopy, and believe that it should be performed only if capsule endoscopy or other modalities are positive for a proximal small bowel lesion. The use of an overtube to prevent looping of the instrument in the stomach increases the insertion depth by 10 to 25 cm (120). Prototype, variable stiffness enteroscopes are emerging in an attempt to achieve maximal insertion depth without the use of an overtube (121,122). Although PE cannot investigate the entire small bowel, an important benefit of PE is the ability to provide diagnostic and therapeutic capabilities with one procedure if the bleeder can be found.

The diagnostic yield of PE is between 38% and 65% of patients in whom upper and lower endoscopies are negative (123). Multivariate analysis in a retrospective, two-center study by Lepère et al. (124) showed that melena and chronic renal failure increase the diagnostic yield of PE in patients with unexplained GI bleeding. The positive findings noted with PE for patients with renal failure were most often in the distal duodenum or jejunum, including ulcers (17%) and AVMs (41%). Others have shown similar results in that most small bowel lesions diagnosed by PE are vascular in nature (angiodysplasia/AVM) (125–127), followed by ulcerations and malignancies (128). A delay between the bleeding and PE (less than or more than 4 days) and a history of recurrent intestinal bleedings before PE were not associated with positive findings; thus, rapid performance of PE may not be necessary, except in patients with continuous active bleeding (124). Another benefit of PE is that it provides a “second look” for lesions that may have been missed on original endoscopy. Interestingly, 25% to 40% of lesions found on PE are within reach of a standard upper endoscope (129,130). Complications of PE are infrequent, occurring in less than 1% of cases. Most complications, including bleeding and perforation, are related to the use of an overtube (131,132). The data of effectiveness and safety of PE for ICU patients are limited.

Even when PE reaches a maximal depth of insertion of 160 cm below the ligament of Treitz, there is still over 250 cm of small intestine remaining unexamined. It is possible to close this gap with a newly developed DBE system (133). The newest modality for imaging the small bowel was introduced in 2001, when Yamamoto et al. (134) reported their results using a double-balloon method in four patients. The DBE represents the first successful provision of both diagnostic and therapeutic intervention to the entire small bowel. The goal is to reach the ileocecal valve, but this often is not possible. The total inspection of the small bowel is usually attainable with the peroral approach and retrograde approach per rectum. On average, approximately 250 cm is achieved via the oral route and 130 cm via the anal route, with a mean examination time of 75 minutes (135). If total enteroscopy is necessary, it can be achieved in 60% to 86% of cases, depending on the experience of the endoscopist (136,137). Yamamoto et al. (136) performed 50% of the studies in an antegrade fashion, with the remainder being retrograde. The bleeding source was found in 76%, and hemostasis using electrocautery was performed successfully in 18%. Multicenter experience with DBE in the United States showed that the mean procedure time was 115 minutes, and the yield of DBE for a GI bleed ranged between 52% and 75% (135,138). Oral DBE requires no specific preparation other than a 6- to 8-hour fast before the procedure. If a retrograde (anal) approach is undertaken, standard colonic preparation is necessary; conscious sedation or general anesthesia may be utilized. Endoscopic hemostasis using injection therapy, APC, electrocautery, and hemo-clipping may be used as is done in routine upper GI endoscopy and colonoscopy. Complications of DBE are noted in 1.1% to 8.5% (136,138), and include aspiration pneumonia, abdominal pain, perforation, and acute pancreatitis (135,136,138–140). The effectiveness and safety of DBE for critically ill patients are unknown.

Before the advent of capsule endoscopy and DBE, intraoperative endoscopy was the only way to detect and treat lesions beyond the reach of PE. Now the role of diagnostic intraoperative endoscopy is likely to decrease with the introduction of the less-invasive capsule endoscopy and DBE; however, it still plays a role in specific clinical situations. Intraoperative endoscopy is performed in conjunction with a surgeon in the operating room, and with the patient under general anesthesia. Intubation may be achieved transorally, transanally, or through an operative enterotomy, depending on the clinical circumstance and physicians’ preference.

During laparotomy combined with intraoperative endoscopy, the endoscopist carefully inspects the intestinal lumen with a push enteroscope, while the surgeon slowly guides the bowel over the endoscope using the air-trapping technique and examines the external wall with palpation and transillumination (141). Lesions can be treated endoscopically or marked with a tattoo for surgical resection. The terminal ileum is reached in more than 90% of patients (142). The yield in detecting bleeding lesions reaches 70% to 100% (55,143), making intraoperative endoscopy the most sensitive method of diagnosing small bowel disorders. However, the high sensitivity comes at the cost of extreme invasiveness, making it a procedure of last resort. The complication rate is estimated at about 3%, including mucosal tears and bleeding of the mesentery due to traction (138).

Capsule endoscopy is a safe and promising diagnostic tool for GI bleeding of unknown origin, focusing especially on the small bowel; it may obviate the need for angiography in some difficult patients. The idea of wireless imaging of the small intestine was conceived simultaneously by Paul Swain, a British gastroenterologist, and Gavriel Iddan, an Israeli scientist. They merged research efforts in 1998 and soon developed a pill-sized camera with sufficient battery life to image the entire small intestine (144). Capsule endoscopy was introduced into clinical practice in 2001 and made it possible for the first time to visualize intraluminal conditions throughout the entire small bowel. The first commercially available video capsule (Given) is composed of three main subsystems: an ingestible capsule endoscope, a data recorder, and a workstation. The capsules are equipped with a miniaturized image-capturing system, battery, light source, and transmitter. After an overnight fast, the
patient swallows the capsule, which travels through the GI tract by means of the actions of normal peristalsis. The capsule device captures two images per second and has a battery life of approximately 8 to 12 hours. Captured images are transmitted by a digital radiofrequency communication channel to an external data recorder unit.

Studies comparing capsule endoscopy with other diagnostic procedures, including enteroclysis, PE, computed tomography (CT) scan, and intraoperative enteroscopy, showed that capsule endoscopy was clearly superior in the diagnosis of occult/obscure/overt small bowel bleeding (132,145–150). Capsule endoscopy has proven superior to enteroclysis (147–149) and PE (146). Van Gossum et al. (151) noted that, with obscure GI bleeding, no significant difference in diagnostic yield was found between push and wireless-capsule endoscopy. Capsule endoscopy, compared to CT scanning, is reported to be superior in detecting small bowel lesions (147,149).

The overall diagnostic yield rate of capsule endoscopy in patients with GI bleeding ranges from 45% to 66% (145,147,152–154). The timing of capsule endoscopy has been addressed in two studies and appears related to diagnostic yield. When administered to patients with ongoing overt bleeding, the diagnostic yield is higher—87% to 92%—than in those with previous overt bleeding or iron deficiency anemia—46% to 56% (152,155). Hartmann et al. (150) noted that capsule endoscopy identified lesions in 100% of patients with ongoing overt bleeding, 67% of patients with previous overt bleeding, and 67% of patients with obscure/occult bleeding. To increase the diagnostic yield of capsule endoscopy, prokinetic agents (156), oral bowel preparation (oral sodium phosphate and polyethylene glycol), simethicone, and erythromycin have been recommended. Prokinetic agents prompt the passage of the capsule and prevent the exhaustion of batteries before study completion. Bowel preparation with oral sodium phosphate has been suggested to offer better visualization than overnight fasting alone, and is associated with fewer disturbances by intraluminal turbid fluid (157). However, there are concerns that increasing bowel motility may result in missing a lesion. Fireman et al. (158) showed that erythromycin markedly reduced gastric emptying time and had a negative effect on the small bowel images. Preparation of elderly subjects with PEG or sodium phosphate also had a negative effect on small bowel transit time. PEG increased the visibility in the proximal small bowel in one study, but had no effect in the second investigation (159,160). Presently, bowel preparation is preferred by most practitioners. Erythromycin leads to faster gastric emptying at the expense of small bowel transit time and poorer visualization (161). Bowel preparation with simethicone, which can decrease intraluminal gas bubbles, resulted in significantly better visibility (162). Simethicone may be added to the routine preparation for capsule endoscopy to improve visualization of the small bowel mucosa. A delay in bowel transit time may result in an incomplete study due to capsule battery drainage.

Despite the higher diagnostic yield, capsule endoscopy limitations are evident: biopsy specimens cannot be obtained, therapeutic intervention cannot be performed, and localization of some lesions is imprecise (163). Capsule endoscopy, however, is regarded as a low-risk procedure that is well tolerated. The primary risk with capsule endoscopy is capsule entrapment within the GI tract; this occurs in 0.75% to 5% of cases. Most entrapment occurs in the small intestine, although case studies report impaction at the cricopharyngeus, tracheal aspiration, and retention in diverticula (10). Risk factors for entrapment include NSAID-induced strictures, prior abdominal radiation, Crohn enteritis, prior major abdominal surgery, and known diverticula. A trapped capsule may be retrieved endoscopically or surgically. In cases where the colon is not visualized on capsule endoscopy and the patient does not see the capsule pass, an abdominal radiograph should be obtained to document passage. Absolute contraindications to its use include GI obstruction and pseudo-obstruction—meaning ileus. Relative contraindications include a history of GI motility disorders, such as gastroparesis; history of intestinal strictures or fistulae; pregnancy; history of multiple small bowel diverticula; history of Zenker diverticulum; history of abdominal surgeries or radiation; and an active swallowing disorder or dysphagia. Although there is concern about the use of capsule endoscopy in patients with pacemakers, new evidence suggests that capsule endoscopy may be safely utilized in these patients (164).

Capsule endoscopy has been reported to change patient management in up to 75% of cases (146), although the studies focused solely on small bowel lesions. Colonic bleeding is difficult to evaluate via capsule endoscopy because of retained stool, limited battery life, and poor visual field due to the colon’s large diameter. A recently developed PillCam Colon capsule endoscopy (152) appears promising for colonic evaluation (165), although in comparison to conventional colonoscopy, false-positive findings were recorded in 33% cases (166).

The use of capsule endoscopy in critically ill patients has been limited. These patients often cannot ingest the capsule by themselves, especially if endotracheally intubated; an endoscopic technique of capsule placement has been described for such patients (167). In addition to swallowing problems, bowel transit time may be delayed due to sepsis, electrolyte imbalance, medication use, and anatomic changes due to surgeries. Abnormal bowel transit time affects the diagnostic yield of capsule endoscopy. The utilization of capsule endoscopy for small bowel or obscure bleeding must be made on a case-by-case basis.

**Nuclear Medicine**

As mentioned previously, for LGIB, endoscopy, nuclear medicine, and mesentry angiography are three main diagnostic modalities. The two techniques of radionuclide scanning commonly use either 99mTc-labeled red blood cells or technetium-99m sulfur colloid. A 99mTc-labeled red blood cell scan is the preferred technique, with images that can be detected for up to 12 to 24 hours after injection. If the rate of bleeding is insufficient to give an immediate positive test, or if the bleeding is intermittent, the labeled red blood cells can sometimes accumulate to detect the site of bleeding—when rescanned—up to 24 hours after injection. This technique can detect bleeding at a rate as low as 0.1 to 0.5 mL/min, and is thought to be a sensitive diagnostic tool for LGIB (25). 99mTc-technetium sulfur colloid is rapidly cleared by the reticuloendothelial system after injection, with a half-life of only 2 to 3 minutes. Therefore, if there is no active bleeding when administered, the 99mTc-technetium sulfur colloid is quickly cleared, with a resultant nondiagnostic test.

**Timing the Use of Radionuclide Scanning**

Radionuclide scanning, often performed repeatedly during a hospital course, may be used as the screening test, followed
by angiography, small bowel enteroscopy, or surgery to definitively localize and treat the bleeding lesion. Because of its high sensitivity—it has the ability to detect bleeding as low as 0.1 to 0.5 mL/min—radioisotope scanning has been utilized as a guide for surgical resection, and as a screening test prior to angiography when colonoscopy fails to find the LGI bleeder. As a guide for surgical resection, localization of the bleeding site is essential. The literature suggests that the localization accuracy of radioisotope scanning is quite variable, ranging from 24% to 94% (168–170). Contrarily, a review by Hunter and Pezim (171) suggested that a localization rate with the red blood cell scan was estimated to be 25% to 75%. In the same study, nearly half of patients studied (42%) underwent an incorrect surgical procedure based on red blood cell scan results (171); other studies have noted that radionuclide scanning did not alter surgical management in any manner (172–174). Thus, most clinicians use radionuclide scanning as a guide for further diagnostic studies, such as enteroscopy/colonoscopy, rather than for surgical intervention (175).

Reportedly requiring 10-fold less hemorrhage to achieve a positive study than angiography, the sensitivity of a radioisotope scan for active bleeding has been noted to be greater than 90%, and is superior to that of angiography (176–178). Pennoyer et al. (179) showed that radionuclide scans increased the yield of angiography from 22% to 53%. Other studies have had contrary results (179–181), and radionuclide scanning may potentially delay therapeutic interventions (182). Therefore, although there is no strong evidence supporting radionuclide scanning prior to mesenteric angiography, it may demonstrate low-flow bleeders, leading to better management.

Another role for radionuclide scanning is in the evaluation for Meckel diverticulum, especially in young patients presenting with LGIB (183). The Meckel scan uses a technetium pertechnetate tracer, which has affinity to accumulate in the gastric mucosa. It is quite useful in the pediatric population, with sensitivity as high as 81% to 90% (184,185). Due to insufficient gastric mucosa in the diverticulum, the sensitivity of the Meckel scan is much lower in the adult population, estimated to be approximately 62% (186,187). Several techniques that are reported to increase the diagnostic yield of the Meckel scan, administered before the study, include pentagastrin, histamine blockers, and saline lavage of the stomach and bladder (188–191).

Angiography

Angiography, first employed in the diagnosis of GI bleeding more than 40 years ago, provides imaging of the entire mesenteric system, localizes the sites of hemorrhage, and affords the opportunity for transcatheter interventions. It now holds an established place in dealing with difficult GI bleeding, both for diagnosis and treatment. Mesenteric angiography is more invasive than technetium-labeled red blood cell scanning, and requires a bleeding rate of at least 0.5 to 1.0 mL/min to detect bleeding (192). Unfortunately, bleeding is frequently intermittent and may occur at a much lower rate, resulting in the inability to detect the causative lesion (193). Angiography is usually undertaken when patients have clinical indicators of severe bleeding (e.g., tachycardia and/or syncope). Although colonoscopy is the diagnostic modality of first choice for LGIB, many endoscopists are reluctant to perform colonoscopy in hemodynamically unstable patients with ongoing bleeding; these patients usually undergo radiographic studies. In addition, the bleeding of colonic lesions, such as vascular abnormalities, can be too massive for colonoscopic visualization, thus precluding the procedure. In some centers, a radionuclide scan is requested before mesenteric angiography, because a negative radionuclide scan is unlikely to have a positive angiogram. Angiography has been reported to be especially useful in patients presenting with postoperative GI hemorrhage (194).

Angiography will localize the site of bleeding in 40% to 86% of patients with LGIB (113,182,195). Even if a bleeding site is identified on angiography, localizing the site intraoperatively can be difficult; angiography has a specificity of 100% but a sensitivity of only 30% to 47% (196). Diverticula and angiodysplasia are the most common findings when angiography is positive, with 50% to 80% of the bowel bleeding sites being supplied by the superior mesenteric artery (197). Diverticular hemorrhage is most likely to produce extravasation on angiography (198). Following the injection of contrast media, bleeding and nonbleeding angiodysplastic lesions are characteristically seen as ecstatic slowly emptying veins, vascular tufts, or small veins, with early filling in the arterial phase (199). Angiography is more sensitive than colonoscopy for detecting angiodysplasia (200), and when angiography identifies a bleeding site, treatment with embolization therapy or directed infusion of vasopressin may be performed. The overall rate of complication for mesenteric angiography is similar to most selective angiography, and is acceptable at less than 5% (201). Complications include hematoma or bleeding at the catheter site; access site thrombosis; contrast reactions; injury to the target vessels, including dissection and distal embolization; and renal failure (202). The injured vessels usually involve the SMA, IMA, and celiac artery.

In addition to its diagnostic role, angiography offers therapeutic possibilities via pharmacologic vasoconstriction or selective embolization (transcatheter arterial embolization [TAE]), and therefore may reduce the need for surgical resection. Once the bleeder is confirmed with contrast injection, embolization of the vessel is performed, usually with one of three embolic agents: microcoils, polyvinyl alcohol sponge particles, or gelatin sponge particles, alone or in combination (203). Pharmacologic vasoconstriction is achieved with intraarterial vasopressin infusion.

TAE may be a more definitive means of controlling bleeding, but is associated with a risk of intestinal infarction. Selective embolization initially controls bleeding in up to 100% of patients, but rebleeding rates have been reported to be 15% to 40% (198,199). The major complication rate was 10% to 20% and included dysrhythmias, pulmonary edema, hypertension, and ischemia (204,205). The bowel infarction or colonic necrosis rate from embolization ranged from 10% to 20% (206–208). Superselective TAE may decrease the incidence of ischemia and rebleeding (207,209,210). A literature review of 144 cases by Kuo et al. (203) showed a minor complication rate of 9% and 0% for major complications.

In the past, embolization has been reserved for treatment of UGIB, whereas LGIB has been controlled with vasopressin infusion. The reason is based on reports in the older literature in which infarction frequently occurred after LGI embolization. With advances in superselective embolization techniques, clinically significant bowel ischemia has become an uncommon complication (211,212). Although the efficacies of vasopressin and embolization are reasonably comparable, embolization allows more rapid completion of therapy and a decreased likelihood of systemic complications. Embolization should be
considered a primary option for LGIB, although vasopressin is still preferable for diffuse lesions and cases in which superselective catheterization is not technically possible.

Pharmacologic vasoconstriction for LGIB involves an intraarterial infusion of vasopressin, started at a rate of 0.2 units/min. If the bleeding continues, the rate of infusion can be increased up to a maximal dose of 0.4 units/min. A repeat angiogram can be performed after 20 to 30 minutes to assess whether the bleeding is continuing or slowing down. If the bleeding seems to stop, infusion continues at the same rate for 12 hours, and subsequently, the dose of vasopressin is decreased by 50% provided that no bleeding recurs. After 12 hours of only saline infusion, the catheters are removed (168). Success rates for hemostasis are variable, with some reports as low as 36% and others as high as 100% (113,182,213,214). Bleeding recurrence is high, and may occur in up to 50% of patients after cessation of the infusion (182). Vasopressin should not be used in patients with significant coronary artery disease (CAD) or peripheral vascular disease; mesenteric thrombosis, intestinal infarction, and death have been reported with its use (113). During the vasopressin infusion, patients need to be in an ICU setting where they can be monitored for myocardial, bowel, and peripheral ischemia; hypertension; dysrhythmias; and hyponatremia. Nitroglycerin reverses the vasopressin-induced coronary vasoconstriction without affecting the therapeutic vasoconstriction of the mesenteric artery (215). If standard angiography is negative, provocative angiography has been suggested with anticoagulants, vasodilators, and thrombolytics; of course, their use may cause bleeding (128) and is not routine. The use of provocative angiography should be reserved for selected patients at competent centers with well-trained radiologists.

For critically ill patients, ensuring the adequacy of intravascular volume is very important before mesenteric angiography. Dehydration may exacerbate the nephrotoxicity of the contrast medium.

Computed Tomography Scan and Magnetic Resonance Imaging

CT scans are not usually considered diagnostic tools for LGIB, except in the context of bleeding bowel tumors. Several recent reports suggest that helical CT scans may be useful (216–218) in that this mode of scanning has the potential to detect hemorrhage rates of 0.5 mL/min or less (219,220)—between 72% and 79% (216,217). In the evaluation of colonic vascular lesions, CT angiography reports 70% sensitivity in the diagnosis of colonic angiodysplasia through the demonstration of vessel accumulation in the colon wall, early filling vein, and enlarged supplying artery (221). Currently, there is no role for the use of magnetic resonance imaging (MRI) in the evaluation of LGIB.

Ultrasound

Ultrasonography is a convenient, noninvasive, nonradiation-emitting, and easily available diagnostic tool in the emergency department and ICU. Data regarding the use of US for LGIB have been limited. Yamaguchi et al. (222) noted that the colonic bleeding site was localized by US in 59 of the 90 (66%) patients compared with 81% by colonoscopy. When the bleeding site was in the rectum, the US detection rate was only 30% (10 of 33 patients), but the US detection rate was 82% to 100% when the bleeding site was elsewhere. These clinicians concluded that rectal and diverticular bleeding were difficult to diagnose by US, but for the other diseases, diagnosis by US was possible in 91% to 100% of cases. In our experience, angiodysplasia cannot be detected by US, while diverticulitis—but not diverticular bleeding—can. Other causes of bleeding—especially due to tumors, enteropathy, and colitis—can also be detected by US. In contrast to Yamaguchi’s study (222), we think rectal lesions may be visualized via US through a urinary bladder window. We have proposed the “ultrasonographic bisection approximation method” to localize and detect GI obstructive lesions. The accuracy of US in predicting obstructive levels in the gastric outlet; duodenum, the jejunum, and ileum; and the colon were 100%, 74%, and 98%, respectively (223).

Other Modalities

Small bowel follow-through (SBFT) and enteroclysis are used to detect small lesions, while barium enema is the image study for the colon. All of these are less sensitive for superficial lesions such as angiodysplasia, a common bleeder of LGIB. SBFT is of little use in evaluating obscure GI bleeding, with a diagnostic yield that may be as low as 0% (224). For patients with a high index of suspicion for the presence of small bowel diseases, such as small bowel tumor or Crohn disease, the diagnostic yield will be higher; SBFT detected 83% of small bowel tumors. In patients with suspected Crohn disease, SBFT may have a sensitivity of over 90% (225,226).

Enteroclysis is a modified form of SBFT in which a 10-French catheter is inserted into the distal duodenum or proximal jejunum under fluoroscopy, followed by the infusion under high pressure of a double-contrast solution with barium and air, water, or methylcellulose. This rapid rate of infusion allows better distention and visualization of the small bowel. Studies revealed that enteroclysis seems superior to SBFT for evaluation of the small bowel (227,228). Small bowel tumors seem to be the most common diagnosis made by enteroclysis, followed by Meckel diverticulum and Crohn disease of the terminal ileum (229,230). Angiodysplasia is not detected by enteroclysis. With the advent of capsule endoscopy, the use of SBFT or enteroclysis for GI bleeding has declined.

Barium enema cannot detect superficial lesions or confirm a definitive bleeding source of the colon. Furthermore, it may complicate subsequent colonoscopy or angiography, and is less useful for critically ill patients with LGIB.

TREATMENT OF LOWER GASTROINTESTINAL BLEEDING

Resuscitation

Approximately 85% of GI bleeding episodes stop spontaneously, whereas the remainder require aggressive resuscitation, diagnostic modalities, and often intense medical and/or surgical management. The first management step for a patient presenting with overt LGIB is resuscitation to restore euvolemia and prevent complications of blood loss in the cardiac, pulmonary, renal, or
neurologic systems. This takes place in parallel with the initial evaluation of the patient; resuscitation must not be withheld or delayed for diagnostic procedures. The patient’s respiratory and heart rates, and blood pressure, including orthostatic measurements, should be assessed. Attention to the airway is important when the LGIB is caused by an obstructive lesion, which may lead to vomiting with the consequent high risk of aspiration. Postural hemodynamic changes, chest pain, palpitations, syncope, pallor, dyspnea, and tachycardia suggest hemodynamic compromise (231); the severity of bleeding is easy to underestimate due to compensatory mechanisms. An orthostatic decrease in systolic blood pressure greater than 10 mmHg or an increase in heart rate greater than 10 beats/min indicates an acute loss of at least 15% of blood volume (232). With hemodynamic compromise, two 16-gauge or larger peripheral intravenous (IV) catheters should be secured immediately; central venous access can be established in unstable patients. Packed red blood cells should be utilized in hemodynamically unstable patients, with the goal of maintaining a hematocrit of approximately 30% in the elderly and in those with heart disease or who are otherwise compromised physiologically, and 20% to 25% in younger patients (45). The initial hematocrit may not be the true value, requiring up to 72 hours for equilibration with the intravascular space (233). The presence of coagulopathy (international normalized ratio [INR] greater than 1.5) or thrombocytopenia (>50,000 cells/μL) should be corrected with fresh frozen plasma or platelet transfusions, respectively. Oxygen should be administered to keep the SpO2 between 93% and 95% at a minimum, and vital signs and urine output should be closely monitored. In the elderly or those with a history of cardiac disease, an ECG and cardiac enzyme analysis should be considered. Approaches for LGIB with hemodynamic instability and hemodynamically stable LGIB are shown in Figures 126.2 and 126.3, respectively.

**Figure 126.2** Approach for lower gastrointestinal bleeding with hemodynamic instability. UGIB, upper gastrointestinal bleeding; Tx, treatment; RBC, red blood cell; PE, push-type enteroscopy; DBE, double-balloon enteroscopy; CT, computed tomography; US, ultrasound; SBFT, small bowel follow-through.
Pharmacologic Therapy

Unlike pharmacologic therapies for UGIB, there are no medications with a strong evidence base for LGIB. The medications for the different causes of LGIB include estrogen/progesterone compounds, octreotide, aminocaproic acid (an antifibrinolytic), and tranexamic acid (an antifibrinolytic, marketed as Cyklokapron in the United States and as Transamin in Asia). Hormonal therapy with estrogen/progesterone compounds, previously used to treat bleeding associated with hereditary hemorrhagic telangiectasia, has been tried in patients with GI bleeding from angiodysplasia. For diffuse ectasias or angiodysplasia refractory to conservative and endoscopic therapy, estrogen/progesterone compound use is controversial, and has been noted to be ineffective in recent studies (234,235). Although the true mechanism is unknown, estrogen/progesterone compounds are thought to improve coagulation, alter microvascular circulation, and improve endothelial integrity. Adverse effects include breast tenderness and vaginal bleeding in women, gynecomastia and loss of libido in men, fluid retention, and stroke (236).

Octreotide has been used in patients with bleeding from diffuse vascular ectasia (236,237). At a dose of 0.05 to 1 mg/d subcutaneously, it was reported to be effective and without adverse effects (236,237). Nardone et al. (237) noted that octreotide may lead to decreased transfusion requirements but, unfortunately, carefully controlled trials are not available. Other agents, including aminocaproic acid and tranexamic acid, may be helpful, but studies with controlled data are not extant.

Steroids, 5-aminosalicylic acid compounds, and sucralfate (per mouth or per rectum) have been used to treat radiation proctitis, but there are little data supporting their effectiveness (238,239).

UC and Crohn disease can cause severe LGIB (40). A recent review of acute major GI hemorrhage in IBD suggests that bleeding is much more common in Crohn disease than UC (40). Bleeding from inflammatory diseases is usually self-limited and responds to medical therapy. An endoscopically treatable lesion is uncommon. Steroid and 5-aminosalicylic acid compounds are frequently used for active lesions. Infliximab, known as a “chimeric monoclonal antibody,” reduces the amount of active
Surgery
Despite the advances of interventional modalities, an emergency surgical procedure for LGIB is ultimately required in 10% to 25% of patients (244), and is indicated for uncontrolled, massive, or recurrent bleeding. An emergency procedure is suggested for patients who require more than 6 units of blood within 24 hours, or a total of 10 units (80). Among the causes of LGIB, the most challenging are vascular ectasias and angiodysplasia. These lesions are usually multiple, and localize in different segments of bowel, making management difficult.

Surgery should be considered in patients in whom a bleeding source has clearly been identified. Blind segmental resection is contraindicated, as it is associated with a rebleeding rate of 42% and excessive rates of morbidity and mortality as high as 83% and 57%, respectively (245). If the bleeder cannot be clearly identified, intraoperative enteroscopy may be a management option. Recurrent bleeding from colon diverticula occurs in 20% to 40% of patients and is generally considered an indication for surgery (11). The operative mortality of diverticular bleeding is 10%, even with accurate localization, and up to 57% with blind subtotal colectomy (114,245,246). Most cases of colonic ischemia resolve with conservative treatment. However, 15% to 20% of patients who develop infarction will require surgical intervention, with a substantial risk of death (30). Until recently, surgery was the only effective management for Dieulafoy lesions in up to 5% of patients (247). Surgery is usually not recommended on the basis of nuclear red blood cell scans alone because of variable accuracy of nuclear red blood cell scans.

CONTROVERSIES

Obscure Lower Gastrointestinal Bleeding
Upper GI endoscopy and colonoscopy are the usual initial evaluation tools for GI bleeding; they will be negative in the patient with a source in the small intestine. If, despite the initial evaluation, no source is found and bleeding continues, the patient meets the definition of obscure GI bleeding, defined as ongoing or recurrent intestinal bleeding without a cause found at original endoscopic studies. Approximately 5% of patients have recurrent bleeding of unclear etiology, and need extensive and repetitive testing (248,249). Furthermore, even after extensive localization studies, approximately 10% of patients require surgical intervention without having identified the
bleeding source (250). A missed diagnosis may occur second-
ary to bleeding that has stopped during endoscopic examina-
tion; very slow or intermittent bleeding leading to negative
endoscopic and nuclear scans; significant anemia and volume
contraction causing lesions to appear less obvious; and lesions
in the small bowel that are not detected by routine examina-
tions (251). When repeated endoscopy of the upper or lower
GI tract is negative, investigation should rapidly focus on the
small intestine. However, before surveying the small bowel,
one needs to ensure that a repeat upper GI endoscopy has been
performed, as 25% to 64% of patients with a negative upper
GI endoscopy and colonoscopy are found to have UGI tract
lesions at the time of repeat UGI endoscopy (252,253). Inter-
estingly, the source of obscure GI bleeding may be identified
in up to 58% of cases within a month from the last bleeding
episode, even if previous investigations did not allow identifi-
cation (254).

Clinically, the age of the patient is very important in the
differential diagnosis of GI bleeding. Patients younger than 40
are more likely to suffer from small bowel tumors, anatomic
anomalies, genetic problems, or Crohn disease/UC. Patients
older than 40 are more prone to bleeding from vascular lesions
and neoplasm (12). A special group of patients may have the
specific causes of LGIB. In populations with immunosuppres-
sion, such as patients with HIV infection, renal transplant, or
pancreatic transplant, LGIB often is caused by CMV ulcers.

Renal failure and aortic valvular stenosis are well-known risk
factors for angiodysplasia (50,49). Radiation colitis should be
considered in patients with a history of radiation therapy
for cervical or prostate cancer. Aortoenteric fistulae may be
considered in patients with obscure GI bleeding and prior
aortic aneurysm repair. The approach to the evaluation of the
obscure bleeder is listed in Table 126.6.

Bleeding from the small intestine that occurs between the
ligament of Treitz and the ileocecal valve represents a chal-
 lenging problem because of the relative inaccessibility of tra-
ditional endoscopy to the long, looping small intestine. Small
bowel bleeding comprises approximately 5% of obscure GI
bleeding (116). The utilization of resources was reported to be
significantly higher in this group of LGI bleeders, with a higher
number of diagnostic procedures and blood transfusions, lon-
ger hospitalization, and a higher cost of hospitalization when
compared with patients with upper or distal lower GI bleeding
(255). Small bowel examination can be divided into radiog-
ographic, endoscopic, and surgical modalities (Table 126.7).
Radiographic techniques include barium studies, such as
SBFT and enteroclysis; radionuclide scanning, such as tagged
red blood cell scans and Meckel scan; cross-sectional imag-
ing, such as CT and MRI; and mesenteric angiography. Endo-
sopic examinations include PE, DBE, and capsule endoscopy.
Surgical procedures include exploratory laparotomy, with and
without assistance of intraoperative enteroscopy. The details
of each diagnostic tool have been given above. Among these
modalities, available data suggest that SBFT has little use in
the evaluation of obscure GI bleeding unless a tumor or Crohn
disease is suspected (224).

The American College of Gastroenterology clinical guide-
line of 2015 related to the diagnosis and management of small
bowel bleeding recommends, after stabilizing the patient with
brisk/massive suspected small bowel bleeding, the priority of
diagnostic modalities is RBC scan or CT angiography first,
then angiography followed by enteroscopy and intraoperative
enteroscopy; no capsule endoscopy is recommended. For sub-
acute ongoing small bowel bleeding, capsule endoscopy or CT
angiography followed by enteroscopy is recommended (236).
However, the European Society of Gastrointestinal Endoscopy
guideline of 2015 suggests that emergency small bowel cap-
sule endoscopy should be considered in patients with ongoing
obtuse GI bleeding, but with a weak recommendation
and only moderate quality evidence (257).

**TABLE 126.6 Approach to the Evaluation of Obscure GI Bleeding**

<table>
<thead>
<tr>
<th>Elderly Patients</th>
<th>Higher Risk for Vascular Lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renal disease</td>
<td></td>
</tr>
<tr>
<td>Aortic valvular stenosis</td>
<td></td>
</tr>
<tr>
<td>Connective tissue disease</td>
<td></td>
</tr>
<tr>
<td>von Willebrand disease</td>
<td></td>
</tr>
<tr>
<td>Surgical patients</td>
<td>Higher risk for anastomotic bleed-ing or aortoenteric fistulae</td>
</tr>
<tr>
<td>NSAID drug use</td>
<td>Increased risk of small bowel ulcerations.</td>
</tr>
<tr>
<td>Immune-compromised patients</td>
<td>Cytomegalovirus ulcers</td>
</tr>
<tr>
<td>History of radiation to pelvis</td>
<td>Radiation colitis</td>
</tr>
</tbody>
</table>

NSAID, nonsteroidal anti-inflammatory drug.

**TABLE 126.7 Imaging Studies for Small Bowel Bleeding**

<table>
<thead>
<tr>
<th>Studies</th>
<th>Tx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiographic techniques</td>
<td></td>
</tr>
<tr>
<td>Barium studies</td>
<td>Small bowel follow-through</td>
</tr>
<tr>
<td>Nuclear studies</td>
<td>Enteroclysis</td>
</tr>
<tr>
<td>Cross-sectional imaging</td>
<td>Tagged red blood cell scans</td>
</tr>
<tr>
<td>Endoscopic techniques</td>
<td>Meckel scan</td>
</tr>
<tr>
<td>Angiography</td>
<td>CT</td>
</tr>
<tr>
<td>Push enteroscopy</td>
<td>MRI</td>
</tr>
<tr>
<td>Double-balloon enteroscopy</td>
<td></td>
</tr>
<tr>
<td>Capsule endoscopy</td>
<td></td>
</tr>
<tr>
<td>Surgical procedures</td>
<td>Yes</td>
</tr>
<tr>
<td>Exploratory laparotomy with and without endoscopic assistance</td>
<td></td>
</tr>
</tbody>
</table>

Tx, treatment; CT, computed tomography; MRI, magnetic resonance imaging.
LOWER GASTROINTESTINAL BLEEDING AND ACUTE MYOCARDIAL INFARCTION

GI bleeding may occur after MI due to both medications and interventions, or it can induce an MI secondary to hemodynamic instability and anemia. For the critical care practitioner, management of coexisting GI bleeding and coronary arterial events includes how to predict and detect an MI that occurs after GI bleeding, how to prevent and manage GI bleeding associated with interventions related to the acute MI, and the necessity/safety/timing of endoscopic procedures.

The prevalence of acute MI in patients with GI bleeding ranges from 1% to 14% (258–261). Conversely, acute MI seen with significant upper or lower GI bleeding occurs in 30% to 49% of patients admitted to the ICU, with an overall mortality rate of 5% to 10% (258,259). Significant GI bleeding deleteriously affects myocardial function, as massive blood loss may cause hypovolemia, hypoperfusion, and decreased oxygen delivery to the myocardium, eventually leading to an acute MI. The elderly and patients with a history of CAD are candidates for acute MI after a significant GI bleed. On occasion, the overt symptoms of GI bleeding may mask the typical symptoms of an evolving MI. Therefore, cardiac enzymes, including troponin-I, and an electrocardiogram are routinely suggested in high-risk patients with GI bleeding, even when the patient has no chest pain, to avoid a delay in diagnosis of myocardial ischemia or acute MI (260). Although GI bleeding occurring after an acute MI carries significant mortality (262), an acute MI after a GI bleed does not seem to alter the risk of in-hospital mortality (258,259).

GI bleeding occurs after an acute MI owing to the use of antiplatelet agents, anticoagulants, and thrombolytic agents. In a recent meta-analysis of 6,300 patients receiving low-dose aspirin (less than 325 mg/d) for secondary prevention of CAD, it was found that the aspirin group was 2.5 times more likely to have GI bleeding than the placebo group (263). Another antiplatelet agent, clopidogrel, was noted to have a significant association with GI bleeding when used in patients with a history of GI bleeding (264); however, clopidogrel incited fewer cases of GI bleeding compared with aspirin in the Clopidogrel versus Aspirin in Patients at Risk of Ischemic Events trial (265). In the study of 3,130 patients by Abbas et al. (263), GI bleeding was more likely to occur in patients over 70 years old. In spite of many studies that evaluated for GI bleeding after acute MI, most lesions were in the upper GI tract; data on LGIB after acute MI are limited. When sigmoidoscopy is performed within 30 days of an MI, ischemic colitis is the most frequent diagnosis of LGIB (266).

Whether LGIB occurs before or after the acute MI, selecting an endoscopic procedure is a dilemma. Although endoscopy has been applied widely in managing GI disorders in the general population, the risks versus benefits of endoscopy must be carefully considered in patients with a recent MI because of the potential for cardiopulmonary complications, including myocardial ischemia, hypotension, cardiac arrhythmias, and hypoxia. Underlying heart disease, lower blood pressure on arrival in the emergency department, lower hemoglobin level on arrival, and persistent shock before endoscopic examination are all associated with higher risk of MI after emergency endoscopy (267). Establishment of stable hemodynamics and oxygen delivery before emergency endoscopy may reduce the risk of procedure-related MI, especially in patients with known heart disease. Sigmoidoscopy, colonoscopy, enteroscopy, and capsule endoscopy may be arranged for LGIB. The safety of enteroscopy and capsule endoscopy for small bowel bleeding complicated by an MI is unknown, although, theoretically, capsule endoscopy should be safer than the enteroscopy, because it is less invasive. Cappell (266) has suggested that sigmoidoscopy is relatively safe and often beneficial after MI, even in moderately ill patients, but should be undertaken with pulse oximetry and continuous electrocardiography. In the same study, the complication rate of sigmoidoscopy was lower than that of UGI endoscopy (7.5%) after an MI, probably because sigmoidoscopy is less invasive, is less painful, and does not affect the airway. Cappell also suggested that sigmoidoscopy should be deferred in unstable patients, such as those in shock, for several weeks after MI unless an emergent indication for the procedure exists. Urgent sigmoidoscopy may be indicated in the patient with LGIB related to anticoagulant or thrombolytic therapy (268,269), or LGIB related to colonic ischemia from systemic hypotension due to MI, myocardial hypoperfusion, and infarction related to massive LGIB, which may be treated endoscopically (259,260). Colonoscopy in patients with a recent MI is associated with a higher rate of minor, transient cardiovascular complications compared with control patients, but is relatively infrequently associated with major complications (270). Colonoscopy may be beneficial after an MI despite a higher risk in certain circumstances. It is also suggested that recent improvements in cardiac interventions, conscious sedation, patient monitoring, and endoscopic instrumentation may render colonoscopy even safer after MI.

Key Points

- The consequences of LGIB in the ICU, anemia, and hypovolemia may prevent weaning and extubation, thus prolonging the ICU length of stay.
- LGIB patients with comorbid illness have higher mortality than those without.
- Studies limited to ICU patients show that ischemic colitis and acute hemorrhagic rectal ulcers are the most frequent causes of LGIB, followed by colitis and diverticula.
- Pallor, fatigue, chest pain, palpitations, dyspnea, tachypnea, tachycardia, posture-related dizziness, and syncope are suggestive of hemodynamic compromise, and demand aggressive care.
- The medical history may help to elucidate a specific bleeding source.
- A rectal examination is essential in LGIB, serving to identify anorectal lesions and confirm the stool color described by the patient.
- Evaluation of the small bowel is indicated for those patients in whom UGI endoscopy and colonoscopy are negative.
- For brisk/massive suspected small bowel bleeding, the priority of diagnostic modalities is RBC scan or CT angiography first, then angiography followed by
enteroscopy and intraoperative enteroscopy (AGA guideline 2015).

- Approximately 85% of GI bleeding episodes stop spontaneously, whereas the remainder requires aggressive resuscitation.
- The first management step for a patient presenting with overt LGIB is resuscitation.
- Treatment modalities for LGIB bleeding include pharmacotherapy, endoscopic/radiologic intervention, and surgery if bleeding cannot be controlled.
- Device-assistant enteroscopy is preferred, rather than capsule endoscopy, for obscure endoscopy for the purpose of treatment.

References

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