

**American College of Radiology
ACR Appropriateness Criteria®**

Clinical Condition: Hematemesis

Variant 1: History of alcoholism or liver disease.

Radiologic Procedure	Rating	Comments	RRL*
X-ray chest	8		Min
NUC Tc-99m labeled RBC scan liver	6		Med
INV arteriography visceral	6		Med
US liver with Doppler	6		None
CT abdomen	6		Med
INV wedge venography liver	6		IP
MRI with or without MRA/MRV abdomen	6	MRI maybe substituted for CT once the patient is stabilized.	None
NUC Tc-99m sulfur colloid scan liver	4		Med
CT chest	4		Med
X-ray barium swallow and upper GI series	4		Med
INV splenoportography	2		IP
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

Variant 2: No history of alcoholism or liver disease.

Radiologic Procedure	Rating	Comments	RRL*
INV arteriography visceral	8		Med
X-ray chest	8		Min
NUC Tc-99m labeled RBC scan liver	6		Med
NUC Tc-99m sulfur colloid scan liver	6		Med
X-ray barium swallow and upper GI series	4		Med
US liver with Doppler	4		None
CT abdomen	4		Med
CT chest	4		Med
MRI with or without MRA/MRV abdomen	4	MRI maybe substituted for CT once the patient is stabilized.	None
INV wedge venography liver	4		IP
INV splenoportography	2		IP
Rating Scale: 1=Least appropriate, 9=Most appropriate			*Relative Radiation Level

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HEMATEMESIS

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Summary of Literature Review

Hematemesis, the vomiting of blood, occurs after bleeding into the upper gastrointestinal (UGI) tract—the esophagus, stomach, or upper small bowel proximal to the ligament of Treitz. Hematemesis may be bright red or darker as a result of conversion of hemoglobin by gastric acid. It is frequently associated with melena. Hematochezia usually indicates lower GI bleeding but can be seen with major UGI bleeding due to rapid passage of blood through the GI tract. Despite advances in medical care, the overall mortality from UGI bleeding over the past 40 years has remained constant at approximately 10.8%. Upper gastrointestinal bleeding accounts for 10,000-20,000 deaths per year in the United States. A major factor accounting for this persistent high mortality is the increasing proportion of elderly patients presenting with GI bleeding, many of whom have comorbid conditions [1,2].

In patients with GI bleeding, stabilizing of blood pressure and restoring of intravascular volume are the first priorities. Only then should an attempt be made to identify and arrest the cause of bleeding. A temporary nasogastric tube should be inserted to aspirate gastric contents [3]. The color of the gastric aspirate has prognostic significance, and patients with red blood per gastric aspirate and red blood per rectum have a 30% mortality rate. While the presence of blood in a nasogastric aspirate confirms an UGI source, a nonbloody aspirate occurs in 3%-16% of patients with UGI bleeding [4].

A directed history may suggest the source of the bleeding. In 70%-80% of patients with UGI bleeding, bleeding stops spontaneously. Peptic ulcer disease is the leading cause of UGI bleeding in most series. However, series consisting of inner-city populations show a greater

proportion of erosive gastritis and varices [5]. The American Society of Gastrointestinal Endoscopy (ASGE) survey on UGI bleeding noted the following disease incidences: duodenal ulcer (24.3%), gastric erosions (23.4%), gastric ulcer (21.3%), varices (10.3%), Mallory-Weiss tears (7.2%), esophagitis (6.3%), duodenitis (5.8%), neoplasm (2.9%), stomal marginal ulcer (1.8%), esophageal ulcer (1.7%), and other/miscellaneous including angiodysplasia or vascular malformations (6.8%) [1,2].

The three most important diagnostic techniques in the investigation of UGI bleeding are endoscopy, angiography and radionuclide studies. Endoscopy (esophagogastroduodenoscopy) should be the initial method used to define and treat acutely bleeding lesions. Patients with UGI bleeding that is ongoing or of sufficient magnitude to produce changes in vital signs or require transfusion should undergo emergent endoscopy, which identifies the source of hemorrhage in about 95% of cases. The endoscopic diagnosis provides important prognostic information regarding the risk of rebleeding and mortality. The endoscopic appearance of an ulcer provides prognostic information regarding rebleeding, the need for surgery, the level of hospital care required, and mortality [6]. Early endoscopy (within 24 hours of hospital presentation) has been shown to reduce resource use, decrease transfusion requirements, and shorten hospital stay [7,8]. A second look endoscopy in patients with high-risk ulcer stigmata at the time of initial endoscopy may decrease bleeding rates, surgery, and cost [9].

With rapid bleeding, however, it may not be possible to adequately visualize the site of bleeding. With the exception of the proximal duodenum and distal ileum, upper and lower endoscopy does not visualize the small intestine. Push enteroscopy, double balloon enteroscopy, and capsule endoscopy allow visualization of the small bowel [10].

Endoscopic hemostatic therapy can be grouped into three categories: 1) injection of sclerosants and/or vasoconstrictors, 2) use of thermal coagulation techniques, and 3) mechanical methods such as band ligation and clips.

With bleeding ulcers, thermal devices can stop bleeding 90% of the time. Multipolar electrocoagulation, laser photocoagulation, and heater probe therapy control bleeding equally well; however, the laser probe is used less frequently because of its higher cost. A meta-analysis of trials of therapeutic endoscopy showed that all modalities (laser photocoagulation, multipolar coagulation, heater probe, and injection therapy) are

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effective in reducing risk of rebleeding and the need for emergency surgery [11,12].

With acute hemorrhagic gastritis, endoscopic therapy may be more difficult because of the potential for diffuse mucosal bleeding [13].

Barium studies have no role in the evaluation of acute UGI bleeding. Technically adequate studies may be difficult to obtain in critically ill patients. Barium in the GI tract obscures active extravasation and may interfere with subsequent endoscopy or angiography. In stabilized patients with chronic, slow, or intermittent bleeding, barium studies may have a role in identifying lesions as potential sources of bleeding [14]. Because endoscopy is more accurate than barium studies, it should always precede barium studies in the evaluation of chronic UGI bleeding.

Radionuclide scans are also used in diagnosing gastrointestinal bleeding. Two categories of radiopharmaceuticals are clinically useful: 1) agents that are rapidly cleared from the vascular space by a specific organ, such as Tc-99m sulfur colloid and 2) agents that circulate for an extended period, such as Tc-99m-labeled red blood cells (RBC). Because the Tc-99m sulfur colloid is rapidly cleared from the circulation, the patient must be actively bleeding at the time of injection [15]. Bleeding rates as low as 0.05-0.1 ml/min can be detected using radionuclide techniques [16]. The Tc-99m-labeled RBC study is the method most frequently used for detecting of GI bleeding [13]. Imaging may be performed over a 24-hour period, which may be helpful in detecting of intermittent bleeding [15,17,18]. The need for delayed imaging to identify a bleeding site introduces uncertainty with respect to location because antegrade and retrograde movement of intraluminal red cells can occur [15,19]. Published reports differ in their enthusiasm for red RBC scintigraphy, with some authors reporting high accuracy and others finding it inaccurate [20-22].

Early series reported sensitivities greater than 80% for the detection of bleeding with radionuclide scans, higher than those of arteriography [17]. However, subsequent studies showed errors in localization of the bleeding site in up to 60% of cases. When the value of the scan in predicting a subsequent positive arteriogram was examined, patients had a nearly equal likelihood of having a positive or negative arteriogram regardless of the result of the Tc-99m RBC scan [20]. In a study of 103 patients, of 85 patients with a bleeding site documented by arteriography, surgery, or endoscopy, only 15% of them had a positive Tc-99m RBC scan that correctly localized the bleeding, and the overall sensitivity of the radionuclide study for bleeding was only 20% [22]. Overall, the accuracy of the Tc99m RBC scan in localizing the site of GI bleeding ranges from 41%-94% in the literature [23].

Most of the reported series include scans of both upper and lower GI bleeding. The most common errors in bleeding site localization occur from sources in the stomach, duodenum, and small bowel [17,18,20]. This error in localization was often found to be attributable to rapid transit of blood and insufficient frequency of serial static imaging. The accuracy of the Tc-99m RBC scan is increased when the scan is positive within the first two hours in the continuous phase of the test [21,23]. Most scintigraphy series included a substantial proportion of patients in whom endoscopy would be expected to identify the bleeding site. The successful use of endoscopy initially should leave only a small percentage of patients with UGI bleeding in whom nuclear medicine studies may be of value [24]. The radionuclide techniques may be of more value in diagnosing of lower GI bleeding. For diagnosis of Meckel's diverticulum, scintigraphy with pertechnetate continues to be the most efficient technique.

When acute GI bleeding is intermittent, and endoscopy does not identify the lesion, angiography is often requested. If the patient is not actively bleeding, angiography will have a low yield. Consequently, in practice, the vascular radiologist may defer angiography until a radionuclide study has been performed. If there is evidence of bleeding on the radionuclide study, this affords the angiographer some confidence that the study will have a chance of detecting the offending vessel. It further assists in the timing of angiography. If there is no active bleeding, angiography does not have to be performed on an emergency basis. However, in patients with uncontrolled continual active hemorrhage, delaying angiography for scintigraphy is not warranted. Arteriography may still be indicated, as it may reveal a structural lesion that bleeds intermittently.

Arteriography is used in diagnosing of both acute and chronic bleeding and in treating of GI bleeding [25]. It is indicated when endoscopy is negative or unsuccessful in controlling bleeding. The accuracy of diagnostic arteriography for detecting a bleeding source is increased if there is active bleeding. Visceral arteriography has sensitivity for identifying active hemorrhage at a minimal rate of 0.5 ml/min. Only arterial or capillary bleeding can be detected by selective visceral arteriography; venous bleeding is rarely, if ever, detected on the venous phase of an arteriogram. With variceal hemorrhage, varices can be demonstrated, but the role of angiography in this setting is primarily to rule out a concomitant source of arterial bleeding and to define vascular anatomy.

Arteriography is also indicated in patients with chronic intermittent bleeding of obscure origin in whom all other modalities are unrevealing. In one study by Rollins et al [26], the source of bleeding was established by arteriography in 44% of such patients. Repeat arteriography in patients with continued bleeding following an initially negative angiogram has been shown

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to be diagnostic in 25% of cases. Subselective catheterization of the bleeding vessel at time of arteriography with injection of methylene blue can facilitate intraoperative identification of the bleeding bowel segment.

Selective arterial catheterization can be used to deliver local therapy such as vasopressin infusion or embolization. In patients with gastric mucosal bleeding, selective vasopressin infusion is associated with an overall bleeding control rate of 72% and a bleeding recurrence rate of 18% [27]. Vasopressin is less effective in controlling pyloroduodenal, hepatic, or pancreatic bed bleeding, with control rates of 31%-42% and rebleeding rates of 25%-33%. This is attributed, among other factors, to the dual vascular supply in the duodenum. Small-bowel hemorrhage has been reported to be controlled with intra-arterial vasopressin in 71% of patients [28]. The use of vasopressin infusion has largely been supplanted by transcatheter embolization therapy.

Transcatheter arterial embolization therapy is now the primary radiographic treatment for nonvariceal upper GI bleeding and has a high technical success rate [29,30]. It has been associated with lower complication rates than have been reported with vasopressin [31].

Vascular embolization can be used for virtually all arterial or arteriocapillary bleeding sources in the UGI tract. In patients with prior surgery, the collateral supply should be assessed. Success in controlling duodenal hemorrhage by embolotherapy ranges from 60%-100% [25]. Transcatheter embolization therapy is also of benefit in patients with mesenteric bleeding. A variety of embolic agents are used. Microcoils, alone or in combination with gelatin sponge particles or polyvinyl alcohol sponge particles or hydrogel spheres, or tissue adhesives are effective embolic agents. Neither absolute alcohol nor gelfoam powder is recommended due to distal penetration of these agents [32,33].

Bleeding Due to Portal Hypertension

Although most portal hypertensive bleeds result from ruptured distal esophageal varices, bleeding from other sources such as gastric varices, portal hypertensive gastropathy, and ectopic varices can occur. As with nonvariceal bleeding, prompt resuscitation of the patient is necessary. Lung aspiration of gastric contents is a major concern, especially in encephalopathic patients, and endotracheal intubation is often used in patients at risk for aspiration. Esophageal varices form only when the hepatic vein pressure gradient exceeds 12 mm Hg, and esophageal variceal hemorrhage typically does not occur until the hepatic vein pressure gradient exceeds 12 mm Hg. Gastric varices, however, may bleed at a lower pressure gradient. Endoscopy is indicated to determine the site and activity of bleeding. One-third to one-half of bleeding cirrhotics are not bleeding from varices [34].

Endoscopic therapy is currently the treatment of choice for active variceal hemorrhage. Pharmacologic therapy to reduce portal pressure is a first-line therapy that can be administered emergently while awaiting endoscopy. Balloon tamponade is useful when pharmacologic and endoscopic treatments fail to produce stabilization prior to radiologic intervention or surgery. A variety of pharmacologic agents are available. These include vasopressin and its analogue terlipressin, somatostatin and its analogue octreotide, and nitrovasodilators. Vasopressin infusion has been reported to achieve hemostasis in 70%-85% of patients, but approximately 30%-50% of patients experienced early rebleeding. Somatostatin is more effective than placebo or vasopressin and has fewer cardiovascular side effects than vasopressin, but it is not readily available. Octreotide, a synthetic analogue of somatostatin with a longer half-life, has become the most widely used pharmacologic therapy for acute variceal hemorrhage and is the drug of choice in the United States. Terlipressin, which has fewer side effects than vasopressin and nitroglycerin combined, is comparable to somatostatin and octreotide, but it is not available in the United States [35].

Balloon tamponade has been shown to be initially effective in 84%-92% of patients; however, rebleeding is common after deflation or removal, occurring in 27%-45% of patients [34]. It is largely used as a rescue procedure so that patients can be stabilized for more definitive therapy. Endoscopic treatment is currently the treatment of choice for active variceal hemorrhage. Multiple randomized trials with subsequent meta-analysis have shown endoscopic sclerotherapy (EST) to be superior to or at least as effective as pharmacologic therapy alone or in combination with balloon tamponade in the control of active hemorrhage [36]. A meta-analysis of seven long-term studies suggested that EST when compared with medical therapy reduced mortality by 25% [34]. Endoscopic sclerotherapy may be unsuccessful in 10%-30% of patients, with recurrent bleeding occurring in as many as 30%-50% of patients [37]. Another concern is the high incidence of complications postsclerotherapy, which include bleeding, perforation, and stenosis with an associated 15% mortality rate [35]. Endoscopic variceal ligation (EVL) has been found to be equally effective in controlling acute bleeding and is associated with fewer complications than EST. Therefore, band ligation is recommended as the preferred endoscopic therapy for acute variceal bleeding [38].

The portal venous system can be evaluated using a variety of imaging techniques. Arterial portography, direct transhepatic portal venography, transjugular portal venography, and splenoportography all permit evaluation of portal venous flow patterns, which may aid preoperative shunt planning, detection of varices, and postoperative assessment of shunt patency. Splenoportography is infrequently used. Wedged hepatic

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venography is a useful index of portal venous pressure. Additional noninvasive imaging modalities—including color duplex Doppler ultrasound, computed tomography (CT) and magnetic resonance imaging (MRI) [39]—also allow evaluation of the portal venous system, shunt patency, and liver parenchyma. They frequently replace the invasive procedures.

Percutaneous transcatheter embolization of the coronary vein and esophageal varices has been shown to control variceal bleeding in 83% of patients; however, bleeding recurs in 55% of surviving patients at six months and in 66% at one year. Because recurrent bleeding is a common problem, this technique is no longer widely used [31].

Approximately 10%-20% of patients fail to stop bleeding or rebleed following endoscopic treatment. A second attempt at endoscopic therapy may be successful; however, if it is unsuccessful, alternative therapy is recommended, since when two attempts at hemostasis fail, the risk of mortality is high. Surgical shunt procedures are effective in stopping initial bleeding and preventing rebleeding; however, emergency surgery is associated with an approximately 50% mortality in poor operative candidates [37,40]. The lack of available donor organs precludes the emergency use of liver transplantation for patients with end stage liver disease who develop acute variceal hemorrhage.

The transjugular intrahepatic portosystemic shunt (TIPS) procedure has been shown to effectively stop variceal bleeding unresponsive to endoscopic therapy [41-43]. Numerous studies have shown it to be of benefit in the management of patients with esophageal varices who have failed pharmacologic and endoscopic therapy and who are poor surgical candidates [44,45]. The incidence of rebleeding following TIPS is approximately 16%-30% in late follow-up because of stent stenosis, primarily due to neointimal hyperplasia [46,47]. Shunt patency can usually be restored with angioplasty or additional stents. Therefore, TIPS patency should be monitored with periodic Doppler ultrasound or venography [40]. TIPS is also effective for treatment of refractory bleeding from gastric and ectopic variceal bleeding and prevention of rebleeding in these patients [44,45]. TIPS is also useful in the management of patients with portal hypertensive gastropathy who have failed endoscopic and medical treatment. It has not been shown effective in gastric antral ectasia (GAVE) [48].

Bleeding Due to Hemobilia

Hemobilia has been observed with increasing frequency because of the greater use of percutaneous transhepatic procedures. Upper endoscopy may demonstrate blood from the ampulla, but it does not specify the site or cause of the hemorrhage. Surgical ligations of the main hepatic artery or partial hepatectomy were previously the treatments of choice, but they have been replaced by

selective hepatic arteriography with therapeutic embolization in cases due to hepatic artery bleeding [49]. With biliary venous fistulae associated with percutaneous transhepatic tubes, tube replacement with embolization of the tube tract is useful.

New Techniques

Helical CT after intra-arterial injection of contrast media has been reported to improve the detection of GI bleeding [50].

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® [Radiation Dose Assessment Introduction](#) document.

Relative Radiation Level Designations	
Relative Radiation Level*	Effective Dose Estimate Range
None	0
Minimal	< 0.1 mSv
Low	0.1-1 mSv
Medium	1-10 mSv
High	10-100 mSv
*RRL assignments are not included for some examinations. The RRL assignments for the IP (in progress) exams will be available in future releases.	

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An ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists, and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those exams generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.