

**American College of Radiology  
ACR Appropriateness Criteria®  
Nonvariceal Upper Gastrointestinal Bleeding**

**Variant 1: Endoscopy reveals nonvariceal upper gastrointestinal arterial bleeding source.**

Radiologic Procedure	Rating	Comments	RRL*
Arteriography visceral	9	This procedure is comparable to CTA.	☼ ☼ ☼
CTA abdomen with IV contrast	7	This procedure is comparable to arteriography.	☼ ☼ ☼
CT enterography	5		☼ ☼ ☼ ☼
CT abdomen without IV contrast	4		☼ ☼ ☼
CT abdomen with IV contrast	2		☼ ☼ ☼
CT abdomen without and with IV contrast	2		☼ ☼ ☼ ☼
Tc-99m labeled RBC scan abdomen	2		☼ ☼ ☼
X-ray upper GI series	1		☼ ☼ ☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Variant 2: Endoscopy confirms nonvariceal upper gastrointestinal bleeding without a clear source.**

Radiologic Procedure	Rating	Comments	RRL*
Arteriography visceral	9	This procedure is comparable to CTA.	☼ ☼ ☼
CTA abdomen with IV contrast	8	This procedure is comparable to arteriography.	☼ ☼ ☼
CT enterography	5		☼ ☼ ☼ ☼
Tc-99m labeled RBC scan abdomen	5		☼ ☼ ☼
CT abdomen without IV contrast	4		☼ ☼ ☼
CT abdomen with IV contrast	3		☼ ☼ ☼
CT abdomen without and with IV contrast	3		☼ ☼ ☼ ☼
X-ray upper GI series	1		☼ ☼ ☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Variant 3: Nonvariceal upper gastrointestinal bleeding; negative endoscopy.**

Radiologic Procedure	Rating	Comments	RRL*
Arteriography visceral	8	This procedure is comparable to CTA and CT enterography.	☼ ☼ ☼
CTA abdomen with IV contrast	8	This procedure is comparable to arteriography and is an alternative to CT enterography.	☼ ☼ ☼
CT enterography	7	This procedure is comparable to arteriography and is an alternative to CTA.	☼ ☼ ☼ ☼
CT abdomen without IV contrast	4		☼ ☼ ☼
Tc-99m labeled RBC scan abdomen	4		☼ ☼ ☼
CT abdomen with IV contrast	3		☼ ☼ ☼
CT abdomen without and with IV contrast	3		☼ ☼ ☼ ☼
X-ray upper GI series	1		☼ ☼ ☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Variant 4: Postsurgical and traumatic causes of nonvariceal upper gastrointestinal bleeding; endoscopy contraindicated.**

Radiologic Procedure	Rating	Comments	RRL*
Arteriography visceral	9	This procedure is comparable to CTA and is comparable to CT abdomen with IV contrast.	☼ ☼ ☼
CTA abdomen with IV contrast	8	This procedure is comparable to arteriography and is an alternative to CT abdomen with IV contrast.	☼ ☼ ☼
CT abdomen with IV contrast	7	This procedure is comparable to arteriography and is an alternative to CTA abdomen with IV contrast.	☼ ☼ ☼
CT enterography	5		☼ ☼ ☼ ☼
CT abdomen without IV contrast	4		☼ ☼ ☼
CT abdomen without and with IV contrast	3		☼ ☼ ☼ ☼
Tc-99m labeled RBC scan abdomen	2		☼ ☼ ☼
X-ray upper GI series	1		☼ ☼ ☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

# NONVARICEAL UPPER GASTROINTESTINAL BLEEDING

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## **Summary of Literature Review**

### **Introduction/Background**

Upper gastrointestinal (GI) bleeding (UGIB) by definition occurs proximal to the ligament of Treitz, originating from the esophagus, stomach, or duodenum [1]. Typically, UGIB will present with hematemesis or melena, but UGIB can also result in hematochezia [1,2]. According to the 2015 American College of Gastroenterology practice guidelines, overt GIB refers to patients who present with melena or hematochezia with a source of bleeding that is identified. Occult GIB is defined as patients who present with iron-deficiency anemia with or without guaiac-positive stools who are found to have a source of bleeding. Obscure GIB (OGIB) is reserved when no source is found [3].

Despite evidence of declining incidence and mortality rates in the last decade, UGIB remains a significant cause of morbidity and mortality, with 100 episodes per 100,000 admissions annually in the United States and mortality rates as high as 14% [4,5]. According to the American Society for Gastrointestinal Endoscopy survey on UGIB, the most common etiologies are duodenal ulcer, gastric erosions, gastric ulcer, varices, Mallory-Weiss tears, esophagitis, duodenitis, and neoplasm. Additional bleeding etiologies include pancreatitis [6,7], hepatocellular carcinoma eroding into the duodenum [8], stomal marginal ulcer, esophageal ulcer, angiodysplasia, and vascular malformations, with some patients having multiple sources of bleeding. Iatrogenic causes include endoscopic ultrasound-guided biopsies leading to bleeding [9], endoscopic retrograde cholangiopancreatography-related injury [10], delayed hemorrhage from biliary metallic stenting [11], nitinol esophageal or UGI stent placement for obstruction [12], and extrahepatic arterial injury after pancreatic surgery [13].

Other surveys have reported similar findings, with a relatively higher proportion of variceal hemorrhage and erosive gastritis in inner-city populations [14-17]. Rare entities such as hemobilia and hemosuccus pancreaticus can cause UGIB with the latter estimated to be the responsible etiology in 1 of every 500 cases of UGIB [18]. Aortoenteric fistula is another rare cause of potentially catastrophic GI hemorrhage, estimated in an autopsy series at 0.04% to 0.07% of the general population [19]. An under-recognized but serious cause of UGIB is Dieulafoy lesion, which accounts for 1% to 2% of acute bleeding [20]. Dieulafoy lesion is a tortuous submucosal artery in the GI tract, commonly at the posterior aspect of the stomach, that penetrates through the mucosa over time, causing UGIB.

In patients presenting with substantial UGIB, aggressive volume resuscitation and maintenance of hemodynamic stability are the first priorities [1,4,21]. Only then should an attempt be made to identify and treat the source of hemorrhage. It should be noted that UGIB ceases spontaneously in 75% of cases [2]. A nasogastric aspirate is often obtained to help establish the etiology, although 3% to 16% of patients with UGIB may have a negative aspirate [22]. Two of the most important diagnostic techniques in the investigation of UGIB are upper endoscopy and video capsule endoscopy (VCE), with endoscopy as most appropriate in this clinical scenario. However, since neither is performed as a radiology examination, these are not included in the variant tables.

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This document addresses the indications for imaging UGIB that is nonvariceal and unrelated to portal hypertension. Bleeding secondary to varices and portal hypertension is addressed in separate ACR Appropriateness Criteria® documents.

## **Diagnosis and Management of Nonvariceal Upper Gastrointestinal Bleeding**

With the exception of patients who have a contraindication, such as clinically suspected postsurgical UGIB, patients with presumed UGIB should first be examined by upper endoscopy (esophagogastroduodenoscopy [EGD]). Upper endoscopy successfully identifies the source of hemorrhage in 95% of cases, facilitates intervention to achieve hemostasis, decreases the risk of rebleeding, and provides prognostic information regarding rebleeding, the need for surgery, the level of hospital care required, and mortality. The use of EGD also has been shown to reduce the transfusion requirement and was shown to be the best first choice in a cost-benefit analysis [21,23-26]. Emergency endoscopy is indicated in patients with persistent hemorrhage resulting in deviations of vital signs or requiring repeated transfusions [27,28]. Endoscopy within the emergency department can result in safe discharge in nearly half of all stable patients with subsequent outpatient follow-up. When not performed in the emergency room, endoscopy within 24 hours of admission still effectively reduces resource utilization, decreases transfusion requirements, and shortens hospital stays [1,4,29].

Ulcer disease is a common etiology of UGIB, and EGD can reliably stratify low-risk versus high-risk patient groups to effectively guide treatment, including endoscopic hemostasis [21]. In patients with high-risk ulcer stigmata at the time of initial endoscopy, a second-look endoscopy may help reduce bleeding rates, surgery, and cost [5]. Administration of erythromycin prior to endoscopy has been shown to significantly reduce the requirement for a second endoscopy by accelerating gastric emptying of intraluminal hemorrhage and thereby improving visualization of the gastric mucosa [5]; additionally, the use of erythromycin has been shown to reduce the number of units of blood transfused [5]. The International Consensus Guidelines do not advise routine use but support selective utilization in patients who have recently eaten or may have a large amount of intraluminal hemorrhage [4]. Advances in endoscopy have allowed for control of bleeding in even rare etiologies; therapeutic endoscopy can control 90% of Dieulafoy lesions causing acute hemorrhage [20].

### **Variant and Procedure Information**

The 4 variants are derived with respect to upper endoscopy. For the first 3, it is presumed that upper endoscopy has been performed, with 3 potential initial outcomes: endoscopy reveals arterial bleeding source, endoscopy confirms UGIB without a clear source, and negative endoscopy. The fourth variant, “postsurgical and traumatic causes of UGIB; endoscopy contraindicated” is considered separately since upper endoscopy is not performed.

For the purposes of distinguishing between computed tomography (CT) and CT angiography (CTA), ACR Appropriateness Criteria topics use the definition in the [Practice Parameter for the Performance and Interpretation of Body Computed Tomography Angiography \(CTA\)](#) [30]:

*“CTA uses a thin-section CT acquisition that is timed to coincide with peak arterial or venous enhancement. The resultant volumetric dataset is interpreted using primary transverse reconstructions as well as multiplanar reformations and 3D renderings.”*

All elements are essential: (1) timing, (2) reconstructions/reformats, and (3) 3-D renderings. Standard CT scans with contrast also include timing issues and reconstructions/reformats. Only in CTA, however, is 3-D rendering a **required** element. This corresponds to the definitions that the Centers for Medicare & Medicaid Services have applied to the Current Procedural Terminology codes.

For the purposes of distinguishing CT and CT enterography, CT enterography must include oral ingestion of negative contrast in volumes sufficient to distend the small bowel. Intravenous (IV) contrast is required. Typically, a uniphasic technique is employed in standard CT enterography. However, in the case of GIB evaluation, a multiphasic technique (with IV contrast parameters mimicking those in CTA) can be done. This examination has been called a multiphase CT enterography to distinguish it from the standard uniphasic CT enterography.

### **Variant 1: Endoscopy reveals arterial bleeding source.**

#### *Arteriography visceral*

When there is acute overt hemorrhage in the unstable patient, angiography should be performed on an emergency basis [3]. An advantage of angiography is the ability to perform therapeutic intervention with transarterial embolization at the time of diagnosis. Angiography is not hampered by impaired visualization of the source by intraluminal blood. Visceral arteriography can detect bleeding in the UGI tract at rates as low as 0.5 mL/min [31].

Only arterial or capillary bleeding can be detected by selective visceral arteriography; venous bleeding is rarely detected on the venous phase of an arteriogram. Marking the site of bleeding during endoscopy aids in accurate localization of the bleeding source [32].

However, there are limitations of arteriography that can result in a false negative. If the bleed is intermittent, it can be missed on angiogram, which is a limitation of this diagnostic examination [2,33,34]. Additionally, the cause of bleeding may not be ascertained if there is variant vascular anatomy or if the contrast resolution is not adequate [33].

Ten percent to 15% of patients treated with endoscopy experience rebleeding [35] requiring transcatheter arterial embolization (TAE) or surgery. Treatment of UGIB via TAE has a high technical success rate (69%–100%) and is associated with lower complication rates than transcatheter vasopressin infusion [36-40]. Angiography can identify a bleeding source in up to 80% of cases, with a primary success rate for TAE of 80% [41,42]. Such a high success rate of TAE has resulted in a diminishing need for surgical intervention, which may be used in event of rebleeding [31,43,44]. The number of transfused packed red blood cells (RBCs) in 24 hours prior to angiography and hemodynamic instability positively correlate with active extravasation on angiography [45]. However, the number of transfusions needed prior to and following the TAE has no statistically significant effect on the technical success of the intervention [46]. The choice of best embolic agent is a matter of debate and includes coils, cyanoacrylate glue, particles, and gelatin sponge [36].

TAE has been shown to be efficacious in controlling bleeding related to a wide array of etiologies, including gastric adenocarcinoma [47], nitinol stent placement [12], and life-threatening hemorrhagic pancreatitis [6], and in patients on hemodialysis, who have been shown to have a higher rate of UGIB than the general population [48]. TAE for bleeding related to postendoscopic biliary sphincterotomy results in diminished need for invasive surgical intervention [49]; the posterior pancreaticoduodenal artery is the main origin of the vessels involved with postendoscopic sphincterotomy bleeding.

Although originally relegated only to poor surgical candidates, TAE has been shown to be equally effective at controlling bleeding, with lower overall complication rates and trends toward lower 30-day mortality rates compared with surgical intervention [35,44,50-54]. Long-term clinical success is demonstrated in patients undergoing TAE for UGIB irrespective of whether active contrast extravasation is observed at the time of angiography [38,55-58]. Empirical embolization of the gastroduodenal artery in patients with major UGIB refractory to endoscopic intervention seems to be an effective treatment [8,55,56]. The clinical outcome after technically successful embolotherapy is largely dependent on patient comorbidities [59-61].

#### *CTA abdomen with contrast*

CTA is usually performed to detect the site of active bleeding in cases of acute overt bleeding. This examination has been shown to be able to detect bleeding rates as slow as 0.3 mL/min, compared with 0.5 to 1.0 mL/min for conventional angiography and 0.2 mL/min for Tc-99m labeled RBC scintigraphy [31,62,63]. However, if the bleed is not acute and is intermittent, the sensitivity of CTA decreases to approximately 40% [34,64].

A meta-analysis of 9 studies with 198 patients showed CTA had a pooled sensitivity of 85% in diagnosing acute GIB throughout the GI tract [65]. Additional studies confirm this high sensitivity of CTA in detecting acute GIB [66-69]. Several of these studies showed detection by CTA that was negative by other techniques. CT is widely available and can be performed rapidly during the time of bleeding, which may aid in detection compared with other techniques.

CTA has some limitations. CTA is a diagnostic modality; it does not allow for intervention. In this scenario, because the etiology is known from endoscopy, the clinical utility of CTA is decreased. To detect contrast extravasation, the patient must be actively bleeding at the time of the scan. However, the finding of blood in the lumen or sentinel clot may help to localize the source if the bleeding is subtle or absent. Additionally, CTA has the benefit of identifying a second source of bleeding.

#### *CT enterography*

CT enterography requires administration of large volumes of neutral oral contrast, which can mask bleeding by dilution. In addition, such volumes are often not tolerated by a patient who is acutely ill. Although multiphasic CT enterography can detect bleeding, the primary use of this protocol is directed more to finding a potential bleeding source (ie, small-bowel neoplasm, nonsteroidal anti-inflammatory drug [NSAID] ulcers, or Meckel diverticulum) in the situation of OGIB [70-72].

#### *CT abdomen*

CT is generally used when endoscopic examinations have failed. The primary goal of CT is to determine whether there is ongoing bleeding to better guide management, localize the bleeding focus, and identify the etiology [73].

There is no significant literature supporting the use of nonenhanced CT if endoscopy reveals an arterial bleeding source because CTA is the preferred protocol.

#### *Tc-99m-labeled RBC scan abdomen*

Tc-99m-labeled RBC scintigraphy has low positive yields as well as high incorrect positive and high false-negative rates in patients with acute GIB [63]. Scintigraphy is sensitive but is of poor positive predictive value in determining the precise site of bleeding, and it is also rarely available in an emergency [74]. Scintigraphy can detect lower bleeding rates and there is increased detection of intermittent bleeding [3,75-77]. Wide ranges of sensitivities (33%–93%), specificities (30%–95%), diagnostic yields (26%–87%), and localization accuracy (19%–100%) for scintigraphy have been reported [3,65,74,76-84]; these wide ranges result in controversy on the use of scintigraphy for acute overt GIB [85].

#### *X-ray upper GI series*

Barium examinations of the small bowel have had low yields (3%–17%) for detecting abnormalities in the setting of suspected small-bowel bleeding. Cross-sectional imaging techniques optimized for imaging the small bowel have a larger role in small-bowel imaging [3]. Fluoroscopy with barium or iodinated oral contrast has no role in the evaluation of acute UGIB. Positive oral contrast in the GI tract obscures active hemorrhage and may interfere with subsequent endoscopy, angiography, or CT. For patients with failed endoscopic localization of bleeding, arteriography or multidetector CT (MDCT) angiography has supplanted fluoroscopy in diagnostic algorithms [2,26].

### **Variant 2: Endoscopy confirms upper gastrointestinal bleeding without a clear source.**

#### *Arteriography visceral*

When upper endoscopy is unable to control or localize the source of UGIB, visceral arteriography can be considered as the next test in the algorithm [4,31,86-88]. The accuracy of diagnostic arteriography is increased in active hemorrhage, but it can also reveal structural lesions that bleed intermittently [40].

Angiography and TAE have been shown to have a role in hemobilia, a rare cause of UGIB. Causes of hemobilia include blunt hepatic trauma, laparoscopic cholecystectomy, hepatobiliary intervention, vascular malformations, and hepatic artery pseudoaneurysm [89].

#### *CTA abdomen with contrast*

Besides visceral arteriography, CTA can be considered as the next test in the algorithm. Several recent studies have documented the high sensitivity, specificity, and predictive value of CTA in assessing UGIB [62,64,69,90-92]. CTA was first applied in the evaluation of obscure-origin and lower GIB, and in both instances it compares favorably with endoscopic techniques [33,66,93-95]. Faster acquisition, thinner collimation, 3-D volume rendering, and angiographic capabilities have improved the sensitivity of CTA for detecting active hemorrhage to as low as 0.5 mL/min in a swine model, and *in vitro* models have compared well to digital subtraction angiography in first-order aortic branches, with a detection threshold of 0.35 mL/min [2,96,97].

Despite growing utilization as a first-line imaging tool for lower GIB, CTA is typically reserved for cases where endoscopy is unsuccessful in localizing the bleeding source for patients with UGIB. The sensitivity in patients with UGIB and failed endoscopy was shown to be 81% in high-risk patients (defined as requiring at least 500 mL of transfusion to maintain vital signs), which decreases to 50% in low-risk patients with slower rates of bleeding [98]. Missed diagnoses in studies correlating CTA to angiography and/or surgery have included gastric ulcers and vascular malformations [99]. CTA can show Dieulafoy lesions that are associated with a very high mortality rate [100].

CTA protocol design is critical to diagnostic efficacy for identification of GI hemorrhage. Although IV contrast infusion is essential, positive oral contrast will render the examination nondiagnostic, and oral administration of water can dilute intraluminal hemorrhage [2]. CTA is useful in the acute setting for visualization of the source of hemorrhage and its characterization [2]. Multiple acquisitions are required to distinguish active hemorrhage from other high-density material in the gastric lumen [2,62,101-103]. The overall sensitivity, specificity, accuracy, positive predictive value, and negative predictive value of CTA have been shown to be 79%, 95%, 91%, 86%, and 92%, respectively [99]. CTA gives pertinent information to determine appropriateness of subsequent angiography and TAE; the additional anatomical and pathologic information obtained through CTA allows for more efficient cauterization and embolization of bleeding vessels [2].

### *CT enterography*

As in the previous variant, the utility of CT enterography is debatable in this situation. CT enterography requires administration of large volumes of neutral oral contrast, which can mask bleeding by dilution. In addition, such volumes are often not tolerated by a patient who is acutely ill. Although multiphasic CT enterography can detect bleeding because of technique parameters that can mirror CTA (see above), the primary use of this protocol is directed more to finding a potential bleeding source when bleeding is of slow rate or obscure in nature [70-72].

### *CT abdomen*

MDCT for the evaluation of acute UGIB is rarely described. In 1 study with 34 patients, extravasation of the contrast agent was found in 30 patients (88%) with lower GIB, which correlated to the site of bleed by subsequent endoscopy or surgical evaluation [104]. CT of the abdomen without and with contrast is a diagnostic examination to be considered in patients who are suspected to have hemobilia [89].

There is no significant literature outlining the use of nonenhanced CT examination if endoscopy confirms an upper GI bleed without a clear source.

### *Tc-99m-labeled RBC scan abdomen*

As CTA evaluation is a well-recognized next step in management of UGIB if endoscopy confirms a bleed without identification of a source, there is no significant literature outlining the use of nuclear medicine studies in this clinical context. However, Tc-99m-labeled RBC scanning can be used to localize a low-rate source of bleeding.

### *X-ray upper GI series*

Fluoroscopy with barium or iodinated oral contrast has no role in the evaluation of acute UGIB. Positive oral contrast in the GI tract obscures active hemorrhage and may interfere with subsequent endoscopy, angiography, or CT. For patients with failed endoscopic localization of bleeding, arteriography or CTA has supplanted fluoroscopy in diagnostic algorithms [2,26].

### **Variant 3: Negative endoscopy.**

This variant represents a clinical scenario where the source and presence of blood are not confirmed at endoscopy despite a clinical presentation of bleeding. This suggests intermittent bleeding or bleeding with slow rates. Consequently, besides attempting to directly identify the bleed, which may be difficult in this situation, evaluation is also directed toward identifying potential sources of bleeding, which ultimately may be of higher diagnostic yield.

### *Arteriography visceral*

In patients with negative endoscopy, comparison of VCE to angiography demonstrated that angiography has superior yield, although long-term outcomes including, rebleeding rates, hospitalization rates, and death, did not differ between the 2 groups [105]. Super-selective angiography coupled with intraoperative methylene blue localization is an innovative technique in management of OGIB [106]. As stated in the previous variant, visceral arteriography can detect bleeding in the UGI tract at rates as low as 0.5 mL/min [31]. Thus, arteriography can be limited in situations of negative endoscopy. Only arterial or capillary bleeding can be detected by selective visceral arteriography; venous bleeding is rarely detected on the venous phase of an arteriogram. There are limitations of arteriography that can result in a false negative. If the bleed is intermittent, it can be missed on angiogram and is a limitation of this diagnostic examination [2,33,34]. Additionally, the cause of bleeding may not be ascertained if there is variant vascular anatomy or if the contrast resolution is not adequate [33].

### *CTA abdomen with contrast*

Studies demonstrate that there is no significant clinical difference between CTA and VCE [107,108]; both are effective for the diagnosis of OGIB [98,109]. CTA has been shown to be able to detect bleeding rates as slow as 0.3 mL/min [31,62,63]. As with angiography, intermittent and slow-rate bleeds can be missed, leading to false negatives. As stated in the previous variant, in OGIB, the sensitivity of CTA has been shown to be 81% in high-risk patients (ie, patients requiring 500 mL of transfusion to maintain vital signs), with a sensitivity decreasing to 50% in slower-rate bleeds [98]. CTA and CT enterography (see below) can serve as triage tools in identifying patients who may benefit from double-balloon endoscopy [110,111]. CTA is an important tool in early diagnosis of intestinal hematoma, which is a complication associated with excessive anticoagulation [112].

### *CT enterography*

In the event that endoscopy is negative, CT enterography may be helpful to identify potential bleeding sources. It has been thought to be complementary to VCE where lesions missed on 1 examination are seen by the other and the reverse [2,113,114]. CT enterography has demonstrated detection of possible bleeding sources such as mural-

based small-bowel masses (over that of VCE) [71], and it can detect congenital abnormalities such as a Meckel diverticulum. If multiphase scanning with IV contrast is undertaken (ie, mimicking CTA parameters), CT enterography is useful in detecting vascular abnormalities [70]. CT enterography with multiphase technique showed a sensitivity of 55.2% and a specificity of 100% in 1 small series of OGIB (n =65) [72]. Advantages of CT enterography over VCE include reduced cost, reduced patient suffering, and technical ease of performance.

#### *CT abdomen*

In high-risk patients (defined as patients needing 500 mL of transfused blood to maintain hemodynamic stability), the sensitivity and specificity of MDCT were 70.9% and 73.7%, respectively. Contrast extravasation was the most specific sign of acute GIB [98].

There is no significant literature outlining the use of nonenhanced CT if endoscopy is negative.

#### *Tc-99m-labeled RBC scan abdomen*

Tc-99m-labeled erythrocyte scans (“tagged RBC scans”) can detect bleeding rates as low as 0.05 to 0.1 mL/min. Tc-99m-labeled erythrocyte scans are favored over Tc-99m sulfur colloid scans for diagnosing GIB because of the longer potential imaging interval and corresponding increased sensitivity in the detection and localization of bleeding [115,116]. Reports of diagnostic efficacy are widely variable [63,116-118]. With respect to UGIB, errors in localization often occur when hemorrhage arises from a gastric or duodenal source [117,118]. Tc-99m-labeled RBC scans have high false-positive and high false-negative rates in patients with UGIB [63]. Moreover, most scintigraphy series included a substantial proportion of patients for whom upper endoscopy would be expected to identify the bleeding site, leaving only a small percentage of patients with UGIB for whom nuclear medicine studies would be of value [74,119].

#### *X-ray upper GI series*

Fluoroscopy with barium or iodinated oral contrast has no role in the evaluation of acute UGIB. Positive oral contrast in the GI tract obscures active hemorrhage and may interfere with subsequent endoscopy, angiography, or CT. For patients with failed endoscopic localization of bleeding, arteriography or CTA has supplanted fluoroscopy in diagnostic algorithms [2,26].

### **Variant 4: Postsurgical and traumatic causes of upper gastrointestinal bleeding. Endoscopy contraindicated.**

In patients who suffer from postsurgical UGIB, it is not feasible to have endoscopic evaluation for many reasons, including new anastomotic sites such as in bariatric surgeries or tumor resection, postsurgical edema, and concern for postsurgical perforation. In this clinical context, primary angiographic evaluation should be preferred to primary endoscopic evaluation [120].

#### *Arteriography visceral*

Angiography has been shown to have a positive rate of 81% in identifying postoperative GI hemorrhage, with TAE being a safe tool to manage the postsurgical bleeding [121].

#### *CTA abdomen with contrast*

In event of traumatic UGIB, it is important to safely, efficiently, and effectively identify the source. In this clinical context, it is often not feasible to wait for the gastroenterologist or interventionalist because it may be critical to expeditiously identify the source of bleeding. Multiphase MDCT can effectively identify life-threatening hemorrhage, is a highly available modality, and is minimally invasive [62,122]. Hemorrhage that appears first at arterial or portal venous phase is active and should be considered life-threatening, as opposed to a contained bleed, which is visualized on equilibrium phase [123]. The overall sensitivity of CTA for detecting active acute GI hemorrhage is 85.2% and specificity is 92.1% [62]. CTA is an excellent diagnostic tool for detecting, localizing, and outlining anatomy for further endovascular or surgical management [124].

An additional source of UGIB can be an aortoenteric fistula. For those patients, the etiology is often iatrogenic, and CTA is the examination of choice; evidence of a fistula is suggested by gas in periprosthetic fluid collection, retraction of the intestinal walls in contact, or presence of a false aneurysm. Rarely, extravasation of contrast agent into the intestinal lumen is diagnostic of aortoenteric fistula [125].

#### *CT enterography*

CT enterography requires administration of large volumes of neutral oral contrast, which can mask bleeding by dilution. It may or may not be helpful in this variant, depending on the severity of bleeding. In addition, large volumes are often not tolerated by patients when acutely ill. Although CT enterography can detect bleeding because of technique parameters that can mirror CTA (see above), a primary use of this protocol is directed



toward finding a potential bleeding source (ie, small-bowel neoplasm, angioectasia/other vascular lesions, NSAID ulcers, Meckel diverticulum, etc) when bleeding is slow or obscure in nature.

#### *CT abdomen*

In evaluation of an aortoenteric fistula, a CT scan is considered the most effective examination, with sensitivity and specificity depending on the series (sensitivity of 40% to 90% and specificity of 33% to 100%) [125]. The acquisition protocol consists of without-contrast injection, arterial phase, and portal venous delayed phase. Oral opacification can mask extravasation from the aorta into the bowel and therefore is not recommended [125]. Additionally, MDCT is very accurate in identifying life-threatening mesenteric hemorrhage or transmural bowel injuries. Mesenteric contrast extravasation had a 73.5% positive likelihood ratio and 75% sensitivity for active mesenteric hemorrhage, which was first noted on arterial and portal phases [123].

There is no significant literature outlining the use of nonenhanced CT.

#### *Tc-99m-labeled RBC scan abdomen*

There is no significant literature outlining the use of Tc-99m-labeled RBC scanning when endoscopy is contraindicated.

#### *X-ray upper GI series*

Fluoroscopy with barium or iodinated oral contrast has no role in the evaluation of acute UGIB. Positive oral contrast in the GI tract obscures active hemorrhage and may interfere with subsequent endoscopy, angiography, or CT. For patients with failed endoscopic localization of bleeding, arteriography or CTA has supplanted fluoroscopy in diagnostic algorithms [2,26].

### **Summary of Recommendations**

- When endoscopy identifies the presence and location of bleeding but bleeding cannot be controlled endoscopically, catheter-based arteriography with treatment is an appropriate next study. CTA is comparable to angiography as a diagnostic next step.
- If endoscopy demonstrates a bleed but the endoscopist cannot identify the bleeding source, angiography or CTA can be typically performed and both are considered appropriate.
- In the event of an obscure UGIB, angiography and CTA have been shown to be equivalent in identifying the bleeding source; CT enterography may be an alternative to CTA to find an intermittent bleeding source.
- In the postoperative or traumatic setting when endoscopy is contraindicated, primary angiography, CTA, and CT with IV contrast are considered appropriate.

### **Summary of Evidence**

Of the 125 references cited in the *ACR Appropriateness Criteria® Nonvariceal Upper Gastrointestinal Bleeding* document, 40 are categorized as therapeutic references, including 14 good-quality studies and 3 quality studies that may have design limitations. Additionally, 80 references are categorized as diagnostic references, including 1 well-designed study, 8 good-quality studies, and 24 quality studies that may have design limitations. There are 70 references that may not be useful as primary evidence. There are 5 references that are meta-analysis studies.

The 125 references cited in the *ACR Appropriateness Criteria® Nonvariceal Upper Gastrointestinal Bleeding* document were published from 1977 to 2015.

Although there are references that report on studies with design limitations, 23 well-designed or good-quality studies provide good evidence.

### **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. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults (see Table below). 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*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
○	0 mSv	0 mSv
⊛	<0.1 mSv	<0.03 mSv
⊛ ⊛	0.1-1 mSv	0.03-0.3 mSv
⊛ ⊛ ⊛	1-10 mSv	0.3-3 mSv
⊛ ⊛ ⊛ ⊛	10-30 mSv	3-10 mSv
⊛ ⊛ ⊛ ⊛ ⊛	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as “Varies”.		

### Supporting Documents

For additional information on the Appropriateness Criteria methodology and other supporting documents go to [www.acr.org/ac](http://www.acr.org/ac).

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The 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 examinations 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.