

# ACR Appropriateness Criteria<sup>®</sup>

## Nonvariceal Upper Gastrointestinal Bleeding: 2024 Update

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### Abstract

This document summarizes the relevant literature for the selection of the initial imaging in five clinical scenarios in patients with suspected or known nonvariceal upper gastrointestinal bleeding (UGIB). These clinical scenarios include suspected nonvariceal UGIB without endoscopy performed; endoscopically confirmed nonvariceal UGIB with clear source but treatment not possible or continued

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Disclaimer: 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.

bleeding after endoscopic treatment; endoscopically confirmed nonvariceal UGIB without a confirmed source; suspected nonvariceal UGIB with negative endoscopy; and postsurgical or post-traumatic nonvariceal UGIB when endoscopy is contraindicated. The appropriateness of imaging modalities as they apply to each clinical scenario is rated as usually appropriate, may be appropriate, and usually not appropriate to assist the selection of the most appropriate imaging modality in the corresponding clinical scenarios of nonvariceal UGIB.

The American College of Radiology Appropriateness Criteria are evidence-based guidelines for specific clinical conditions that are reviewed annually by a multidisciplinary expert panel. The guideline development and revision process support the systematic analysis of the medical literature from peer reviewed journals. Established methodology principles such as Grading of Recommendations Assessment, Development, and Evaluation or GRADE are adapted to evaluate the evidence. The RAND/UCLA Appropriateness Method User Manual provides the methodology to determine the appropriateness of imaging and treatment procedures for specific clinical scenarios. In those instances where peer reviewed literature is lacking or equivocal, experts may be the primary evidentiary source available to formulate a recommendation.

**Key Words:** Appropriateness Criteria, appropriate use criteria, AUC, CT angiography, imaging, nonvariceal bleeding, occult gastrointestinal bleeding, upper gastrointestinal bleeding (UGIB)

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ACR Appropriateness Criteria® Nonvariceal Upper Gastrointestinal Bleeding: 2024 Update. [Variants 1 to 5](#) and [Tables 1 and 2](#).

**Variant 1. Adult. Suspected nonvariceal upper gastrointestinal bleeding; no endoscopy performed. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CTA abdomen and pelvis without and with IV contrast	Usually Appropriate	⦿⦿⦿⦿
Arteriography visceral	May Be Appropriate	⦿⦿⦿
Fluoroscopy upper GI series	Usually Not Appropriate	⦿⦿⦿
MR enterography	Usually Not Appropriate	○
CT abdomen and pelvis with IV contrast	Usually Not Appropriate	⦿⦿⦿
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	⦿⦿⦿
CT abdomen with IV contrast	Usually Not Appropriate	⦿⦿⦿
CT abdomen without IV contrast	Usually Not Appropriate	⦿⦿⦿
CTA abdomen with IV contrast	Usually Not Appropriate	⦿⦿⦿
CTA chest with IV contrast	Usually Not Appropriate	⦿⦿⦿
CTA chest without and with IV contrast	Usually Not Appropriate	⦿⦿⦿
RBC scan abdomen and pelvis	Usually Not Appropriate	⦿⦿⦿
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	⦿⦿⦿⦿
CT abdomen without and with IV contrast	Usually Not Appropriate	⦿⦿⦿⦿
CT enterography	Usually Not Appropriate	⦿⦿⦿⦿
CTA abdomen and pelvis with IV contrast	Usually Not Appropriate	⦿⦿⦿⦿
CTA abdomen without and with IV contrast	Usually Not Appropriate	⦿⦿⦿⦿

**Variant 2.** Adult. Endoscopy confirms nonvariceal upper gastrointestinal bleeding with a clear source, but treatment not possible or continued bleeding after endoscopic treatment. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Arteriography visceral	Usually Appropriate	⚙️⚙️⚙️
CTA abdomen and pelvis without and with IV contrast	Usually Appropriate	⚙️⚙️⚙️⚙️
CTA chest without and with IV contrast	May Be Appropriate	⚙️⚙️⚙️
CTA abdomen without and with IV contrast	May Be Appropriate	
Fluoroscopy upper GI series	Usually Not Appropriate	⚙️⚙️⚙️
MR enterography	Usually Not Appropriate	○
CT abdomen and pelvis with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
CT abdomen with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
CT abdomen without IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
CTA abdomen with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
CTA chest with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
RBC scan abdomen and pelvis	Usually Not Appropriate	⚙️⚙️⚙️
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️⚙️
CT abdomen without and with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️⚙️
CT enterography	Usually Not Appropriate	⚙️⚙️⚙️⚙️
CTA abdomen and pelvis with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️⚙️

**Variant 3.** Adult. Endoscopy confirms nonvariceal upper gastrointestinal bleeding without a clear source. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
CTA abdomen and pelvis without and with IV contrast	Usually Appropriate	⚙️⚙️⚙️⚙️
Arteriography visceral	May Be Appropriate	⚙️⚙️⚙️
CTA chest without and with IV contrast	May Be Appropriate	⚙️⚙️⚙️
RBC scan abdomen and pelvis	May Be Appropriate	⚙️⚙️⚙️
CT enterography	May Be Appropriate	⚙️⚙️⚙️⚙️
Fluoroscopy upper GI series	Usually Not Appropriate	⚙️⚙️⚙️
MR enterography	Usually Not Appropriate	○
CT abdomen and pelvis with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
CT abdomen with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
CT abdomen without IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
CTA abdomen with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
CTA chest with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️⚙️
CT abdomen without and with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️⚙️
CTA abdomen and pelvis with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️⚙️
CTA abdomen without and with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️⚙️

**Variant 4. Adult. Nonvariceal upper gastrointestinal bleeding; negative endoscopy. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CT enterography	Usually Appropriate	⚙️⚙️⚙️⚙️
CTA abdomen and pelvis without and with IV contrast	Usually Appropriate	⚙️⚙️⚙️⚙️
MR enterography	May Be Appropriate	0
RBC scan abdomen and pelvis	May Be Appropriate	⚙️⚙️⚙️
CT abdomen and pelvis without and with IV contrast	May Be Appropriate	⚙️⚙️⚙️⚙️
CTA abdomen without and with IV contrast	May Be Appropriate (Disagreement)	⚙️⚙️⚙️⚙️
Arteriography visceral	Usually Not Appropriate	⚙️⚙️⚙️
Fluoroscopy upper GI series	Usually Not Appropriate	⚙️⚙️⚙️
CT abdomen and pelvis with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
CT abdomen with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
CT abdomen without IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
CTA abdomen with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
CTA chest with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
CTA chest without and with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
CT abdomen without and with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️⚙️
CTA abdomen and pelvis with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️⚙️

**Variant 5. Adult. Postsurgical or traumatic causes of nonvariceal upper gastrointestinal bleeding. Endoscopy is contraindicated. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
Arteriography visceral	Usually Appropriate	⚙️⚙️⚙️
CTA abdomen and pelvis without and with IV contrast	Usually Appropriate	⚙️⚙️⚙️⚙️
CT abdomen and pelvis with IV contrast	May Be Appropriate	⚙️⚙️⚙️
CTA chest without and with IV contrast	May Be Appropriate	⚙️⚙️⚙️
CT abdomen and pelvis without and with IV contrast	May Be Appropriate	⚙️⚙️⚙️⚙️
CT enterography	May Be Appropriate	⚙️⚙️⚙️⚙️
Fluoroscopy upper GI series	Usually Not Appropriate	⚙️⚙️⚙️
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
CT abdomen with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
CT abdomen without IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
CTA abdomen with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
CTA chest with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️
RBC scan abdomen and pelvis	Usually Not Appropriate	⚙️⚙️⚙️
CT abdomen without and with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️⚙️
CTA abdomen and pelvis with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️⚙️
CTA abdomen without and with IV contrast	Usually Not Appropriate	⚙️⚙️⚙️⚙️

**Table 1.** Appropriateness category names and definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

**Table 2.** Relative radiation level designations

RRL	Adult Effective Dose Estimate Range (mSv)	Pediatric Effective Dose Estimate Range (mSv)
○	0	0
⦿	<0.1	<0.03
⦿⦿	0.1-1	0.03-0.3
⦿⦿⦿	1-10	0.3-3
⦿⦿⦿⦿	10-30	3-10
⦿⦿⦿⦿⦿	30-100	10-30

Note: Relative radiation level (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."

## SUMMARY OF LITERATURE REVIEW

### Introduction/Background

Upper gastrointestinal (GI) bleeding (UGIB) refers to bleeding occurring proximal to the ligament of Treitz, from the esophagus, stomach, or duodenum [1,2]. The incidence of nonvariceal UGIB is almost 5 times higher than that of variceal UGIB [1]. Peptic ulcer disease caused by *Helicobacter pylori* infection or nonsteroidal anti-inflammatory drug use is the most common cause of nonvariceal UGIB. The other causes of nonvariceal UGIB include Mallory-Weiss tears, esophagitis, pancreatitis, trauma, iatrogenic, or neoplastic [1]. Some rare causes of nonvariceal UGIB include hemobilia, hemosuccus pancreaticus, and aortoenteric fistula [3,4]. UGIB frequently presents with hematemesis or melena. However, a minority of patients can present with hematochezia [2]. GI bleeding (GIB) is either overt or occult. Patients with overt GIB present with signs of visible bleeding such as hematemesis, hematochezia, or melena. Patients with occult GIB have guaiac-positive stools or iron deficiency anemia, without visible blood loss. Obscure GIB refers to

bleeding with unknown source despite complete GI tract imaging and endoscopic evaluation [2,5]. Clinically, obscure GIB can be overt (manifests as continued passage of visible blood) or occult (no visible blood).

Nonvariceal causes of UGIB had an incidence of approximately 61 to 78 cases per 100,000 persons in the United States in 2009 to 2012, with an estimated mortality of 2% to 10% [1,6]. The initial management of nonvariceal UGIB focuses on resuscitation, maintenance of hemodynamic stability, and triage (in-patient versus intensive care unit care). This is typically followed by identification of the source of bleeding and bleeding control [6]. Although 80% to 85% of cases of UGIB cease spontaneously, there is a high risk of rebleeding, massive hemorrhage, and death [7]. As per recent American College of Gastroenterology practice guidelines and an American Gastroenterological Association expert statement, esophagogastroduodenoscopy is the usual first-line diagnostic and therapeutic investigation [6,8]. Video capsule endoscopy is also sometimes used, especially if the bleeding site is suspected to be below the ligament of

Treitz. Because esophagogastroduodenoscopy and video capsule endoscopy are not radiologic imaging tests, these are not included in the variant tables and are not discussed in detail in this document. This document focuses on the usefulness of radiologic imaging for nonvariceal UGIB (unrelated to cirrhosis and portal hypertension). Bleeding secondary to varices and portal hypertension is addressed in the ACR Appropriateness Criteria® topics on “Radiologic Management of Gastric Varices” [9] and “Radiologic Management of Portal Hypertension” [10].

## Special Imaging Considerations

Multiphase CT is used in the evaluation of patients with overt GIB, including noncontrast, late arterial, and venous phases of contrast administration [5]. With dual-energy CT, virtual noncontrast images can replace a true noncontrast acquisition [11]. Because the virtual noncontrast images are derived from the contrast-enhanced data set, these images are perfectly aligned, which can aid interpretation. The conspicuity of active GIB can also be increased by the use of low-keV virtual monoenergetic or iodine-only images [12]. In a study on the use of dual-energy CT imaging for patients presenting with clinical overt GIB, dual-energy CT images improved the radiologist confidence in appropriate diagnosis, especially in patients without findings of bleeding on CT [12]. Additionally, low-keV images can be used to reduce the volume of intravenous (IV) contrast used. However, the use of these virtual unenhanced images in place of true unenhanced images is still limited to certain sites and remains a user-specific preference [5]. Hence, considerations specific to virtual noncontrast images are not discussed in this document.

For the purposes of distinguishing between CT and CT angiography (CTA), ACR Appropriateness Criteria topics use the definition in the ACR–NASCI–SIR–SPR Practice Parameter for the Performance and Interpretation of Body Computed Tomography Angiography (CTA) [13]:

*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 3-D renderings.*

All elements are essential: 1) timing, 2) reconstructions/reformats, and 3) 3-D renderings. Standard CTs 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 CMS has applied to the Current Procedural Terminology codes.

## Initial Imaging Definition

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient’s care)  
OR
- There are complementary procedures (ie, more than one procedure is ordered as a set or simultaneously where each procedure provides unique clinical information to effectively manage the patient’s care).

## DISCUSSION OF PROCEDURES BY VARIANT

### Variant 1: Adult. Suspected nonvariceal upper gastrointestinal bleeding; no endoscopy performed. Initial imaging

Endoscopy is the usual first test in patients presenting with overt or occult UGIB [6]. This variant is applicable to a clinical scenario in which a patient presents clinically with overt UGIB and initial endoscopy was not performed due to large volume bleeding or clinical instability.

**Arteriography Visceral.** If there is overt large bleeding in an unstable patient or if it is unclear if the bleeding is above or below the ligament of Treitz, visceral angiography (VA) can be helpful on an emergent basis [2]. VA detects bleeding if the rate of bleeding is  $\geq 0.5$  mL/min [14]. VA allows simultaneous treatment by embolization, the success of which can be confirmed by looking for postintervention contrast extravasation. There are some limitations of angiography. Venous bleeding can be missed because the contrast resolution of the venous phase of an angiogram is relatively poor. The angiogram may be false-negative if the bleeding is intermittent [14]. In a study of 158 patients with clinical or CT-diagnosed overt nonvariceal UGIB, angiography was able to confirm bleeding in 72% of patients. Further similar studies have demonstrated identification of UGIB in up to 80% of cases [15–17]. Early performance of angiography (first 5 hours of patient presentation) is associated with significantly higher angiographic visualization of extravasation [15].

**CT Abdomen and Pelvis With IV Contrast.** There is no significant literature supporting the use of CT abdomen and pelvis with IV contrast. (Note: CTA is a separate procedure distinct from CT abdomen and pelvis with IV contrast.)

**CT Abdomen and Pelvis Without and With IV Contrast.** There is no significant literature supporting the use of CT abdomen and pelvis without and with IV



contrast. (Note: CTA is a separate procedure distinct from CT abdomen and pelvis with IV contrast.)

**CT Abdomen and Pelvis Without IV Contrast.** There is no significant literature supporting the use of CT abdomen and pelvis without IV contrast. (Note: CTA is a separate procedure distinct from CT abdomen and pelvis with IV contrast.)

**CT Abdomen With IV Contrast.** There is no significant literature supporting the use of CT abdomen with IV contrast. (Note: CTA is a separate procedure distinct from CT abdomen and pelvis with IV contrast.)

**CT Abdomen Without and With IV Contrast.** There is no significant literature supporting the use of CT abdomen without and with IV contrast. (Note: CTA is a separate procedure distinct from CT abdomen and pelvis with IV contrast.)

**CT Abdomen Without IV Contrast.** There is no significant literature supporting the use of CT abdomen without IV contrast. (Note: CTA is a separate procedure distinct from CT abdomen and pelvis with IV contrast.)

**CT Enterography.** There is no significant literature supporting the use of CT enterography in patients with overt UGIB. CT enterography requires the administration of large volumes of neutral oral contrast, which can mask GIB by dilution. Additionally, a large volume of oral contrast is often not tolerated by acutely ill patients. CT enterography is recommended by the Society of Abdominal Radiology Gastrointestinal Bleeding Disease-Focused Panel for patients with occult GIB or suspected small bowel bleeding, which often uses a multiphase technique [5].

**CTA Abdomen and Pelvis With IV Contrast.** There is no significant literature supporting the use of CTA abdomen and pelvis with IV contrast only. The literature primarily reflects studies with CTA examinations without and with IV contrast. Dual-energy CT allows for the generation of virtual noncontrast images from a CTA data set. However, the use of these virtual unenhanced images in place of true unenhanced images is still limited to certain sites and remains a user-specific preference. So, they are not discussed in this document.

**CTA Abdomen and Pelvis Without and With IV Contrast.** CTA without and with IV contrast can help with the detection of a source for GIB [7,18]. CTA 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 red

blood cell (RBC) scintigraphy [19]. Faster acquisition, thin collimation, and greater availability have led to greater utilization of this study. The noncontrast images are useful for the detection of intraluminal high-attenuation material that may mimic intraluminal blood on contrast-enhanced images and may be necessary for the identification of sentinel clot [7]. The Society of Abdominal Radiology Gastrointestinal Bleeding Disease-Focused Panel published a consensus on CT imaging protocols for the detection of overt GIB [20]. With a 100% consensus, the experts recommended noncontrast images for CTA performed on single-energy CT. This can be replaced by virtual noncontrast reconstructions with dual-energy CT [20,21]. In a meta-analysis of 22 studies evaluating accuracy of CTA for the diagnosis of active GIB (total of 672 patients), CTA had a sensitivity and specificity of 85% and 92%, respectively. Frequently, multiphase acquisition is performed, with a portal venous or a delayed phase (typically acquired during 70-90 sec window after the initiation of the contrast bolus injection) in addition to the angiographic phase [7,20]. In a study evaluating different CT imaging protocols, multiphase CT protocols (unenhanced + arterial + portal venous phase) had the highest sensitivity of 92% for the detection of GIB compared with 83% for unenhanced phase with arterial or portal venous phase alone [18]. Oral contrast is usually not given for GIB studies because a positive oral contrast will render the examination nondiagnostic, and oral water can dilute intraluminal hemorrhage [7]. In an 8-year follow-up study after initial negative CT for suspected GIB, nearly 60% of patients with suspected UGIB and nearly 77% patients with suspected lower GIB did not rebleed, suggesting relatively higher odds of rebleeding for UGIB compared with lower GIB despite a negative CTA [22]. In a retrospective study among patients with positive CTA for GIB, greater contrast extravasation volume on CT was significantly correlated with use of hemostatic therapy, intraprocedural active bleeding, and massive transfusion. The extravasation volume, however, did not correlate with patient mortality [23]. CTA may still be underused for the diagnosis of GIB [24]. Compared with Tc-99m-labeled RBC scintigraphy, CTA can lead to faster triage of patients toward definitive treatment by angiography [25]. Likewise, the use of CTA as the first test leads to faster triage of patients in the emergency room when compared with endoscopy for GI bleed [24].

**CTA Abdomen With IV Contrast.** Although CTA can detect GIB, typically both the abdomen and pelvis are imaged, because the site of bleeding is unclear without endoscopy. There is no significant literature supporting the use of CTA abdomen with IV contrast only.

**CTA Abdomen Without and With IV Contrast.** Although CTA can detect GIB, typically both the abdomen and pelvis are imaged, because the site of bleeding is unclear without endoscopy. There is no significant literature supporting the use of CTA abdomen without and with IV contrast only.

**CTA Chest With IV Contrast.** Although esophageal bleed (which can be localized on CTA chest) can present as UGIB, the literature supports CTA of abdomen and pelvis if the site of bleeding is unclear without endoscopy. There is no significant literature supporting the use of CTA chest with IV contrast.

**CTA Chest Without and With IV Contrast.** Although esophageal bleed (which can be localized to CTA chest) can present as UGIB, the literature supports CTA of abdomen and pelvis without and with IV contrast, if the site of bleeding is unclear without endoscopy. There is no significant literature supporting the use of CTA chest without and with IV contrast.

**Fluoroscopy Upper GI Series.** Barium or iodine upper GI series has no role in the diagnosis of acute UGIB in a modern-day practice.

**MR Enterography.** There is no significant literature supporting the use of MR enterography in patients with overt UGIB.

**RBC Scan Abdomen and Pelvis.** There is no significant literature to support the use of a Tc-99m–labeled RBC scan of the abdomen and pelvis for the initial imaging of suspected overt UGIB (without endoscopy performed).

### **Variant 2: Adult. Endoscopy confirms nonvariceal upper gastrointestinal bleeding with a clear source, but treatment not possible or continued bleeding after endoscopic treatment. Initial imaging**

This variant is applicable in a clinical scenario when the patient had endoscopy performed, which diagnosed the upper GI tract as the source of bleed, but definitive treatment of the bleeding was not possible or there is continued bleeding after treatment.

**Arteriography Visceral.** There is an 88% to 100% success rate of VA for diagnosis of endoscopically refractory bleeding from the esophagus due to inflammatory or neoplastic pathology [26,27] or periesophageal pseudoaneurysm [28]. In a study among patients with postesophagectomy gastric conduit hemorrhage [29], VA identified the source of active bleeding in 85% of patients. In a study among patients with gastric cancer refractory to

endoscopy, angiography could diagnose active bleeding in 22.4% (13/58) of patients [30]. In other studies in patients with bleeding GI tumors, VA showed active bleeding in 25% to 55% of patients [31,32]. Among patients with pancreatic cancer presenting with endoscopically refractory UGIB, angiography detected active bleeding in 81% of patients [33,34]. Although there is more literature on clinical success of angiographic embolization for treatment of gastric and duodenal ulcers refractory to endoscopic treatment [34–37], duodenal fistula [38], and iatrogenic bleeding following laparoscopic cholecystectomy or endoscopic pancreaticobiliary drainage [4,39,40], the literature on diagnostic accuracy for bleeding is limited in these studies.

**CT Abdomen and Pelvis With IV Contrast.** There is no significant literature supporting the use of CT abdomen and pelvis with IV contrast. (Note: CTA is a separate procedure distinct from CT abdomen and pelvis with IV contrast.)

**CT Abdomen and Pelvis Without and With IV Contrast.** There is no significant literature supporting the use of CT abdomen and pelvis without and with IV contrast. (Note: CTA is a separate procedure distinct from CT abdomen and pelvis without and with IV contrast.)

**CT Abdomen and Pelvis Without IV Contrast.** There is no significant literature supporting the use of CT abdomen and pelvis without IV contrast. (Note: CTA is a separate procedure distinct from CT abdomen and pelvis without IV contrast.)

**CT Abdomen With IV Contrast.** There is no significant literature supporting the use of CT abdomen with IV contrast. (Note: CTA is a separate procedure distinct from CT abdomen with IV contrast.)

**CT Abdomen Without and With IV Contrast.** There is no significant literature supporting the use of CT abdomen without and with IV contrast. (Note: CTA is a separate procedure distinct from CT abdomen without and with IV contrast.)

**CT Abdomen Without IV Contrast.** There is no significant literature supporting the use of CT abdomen without IV contrast. (Note: CTA is a separate procedure distinct from CT abdomen without IV contrast.)

**CT Enterography.** There is no significant literature supporting the use of CT enterography as an imaging test for overt UGIB, which is untreatable by endoscopy. Although multiphasic CT enterography can detect bleeding because of technique parameters that can mirror CTA, the primary use of this protocol is directed more at finding a potential bleeding source when bleeding is of a



slow rate [41] in patients with occult GI or suspected small bowel bleeding [5].

**CTA Abdomen and Pelvis With IV Contrast.** Although CTA can detect overt GIB, performance with IV contrast only may not be as helpful. There is no significant literature supporting the use of CTA abdomen and pelvis with IV contrast. Noncontrast images can aid in the identification of a sentinel clot. Dual-energy CT allows for the generation of virtual noncontrast images from a CTA data set. However, the use of these virtual unenhanced images in place of true unenhanced images is still limited to certain sites and remains a user-specific preference. So, they are not discussed in this document.

**CTA Abdomen and Pelvis Without and With IV Contrast.** Although there is no literature to discuss the difference between diagnostic accuracy of CTA abdomen and pelvis without and with IV contrast versus CTA abdomen without and with IV contrast or CTA chest without and with IV contrast, in patients with a known source of bleeding that cannot be controlled endoscopically, the imaging should be tailored to include the site of the bleeding. Overall, CTA has good accuracy for the detection of tumor bleeding, vascular malformations, or diverticular bleeding [7,42,43].

**CTA Abdomen With IV Contrast.** There is no significant literature supporting the use of CTA abdomen with IV contrast.

**CTA Abdomen Without and With IV Contrast.** There is no significant literature comparing the use of CTA abdomen and pelvis without and with IV contrast for UGIB. However, as highlighted earlier in this document, if the known source of bleeding is localized to abdomen, this test may be helpful. CTA pelvis may be ordered simultaneously; however, the primary role would be for vascular access mapping.

**CTA Chest With IV Contrast.** There is no significant literature supporting the use of CTA chest with IV contrast.

**CTA Chest Without and With IV Contrast.** There is no significant literature comparing the use of CTA chest without and with IV contrast for UGIB. However, as highlighted earlier in this document, if the known source of bleeding is localized to the chest, this test may be helpful.

**Fluoroscopy Upper GI Series.** Barium or iodine upper GI series has no role in the diagnosis of acute UGIB.

**MR Enterography.** There is no significant literature supporting the use of MR enterography as an imaging test for overt UGIB, which is untreatable by endoscopy.

**RBC Scan Abdomen and Pelvis.** There is no significant literature to support the use of a Tc-99m–labeled RBC scan of the abdomen and pelvis for the diagnosis of GIB when the source of bleeding is obvious but unmanageable on endoscopy.

### Variant 3: Adult. Endoscopy confirms nonvariceal upper gastrointestinal bleeding without a clear source. Initial imaging

This variant is applicable to clinical scenario in which endoscopy shows UGIB but the site or source of the bleeding cannot be determined on endoscopy. Clinically, these patients typically present with overt GIB.

**Arteriography Visceral.** VA can be attempted in such cases; however, it also has the limitation that if the bleeding is not active, it may not be seen. VA has the advantage of assessing the entire mesenteric circulation. Provocation techniques including intraprocedure heparin administration, intra-arterial nitroglycerin administration, and low-dose tissue plasminogen activator administration have been shown to increase the sensitivity of VA for the detection of GIB [44]. However, the literature on safety of these maneuvers and the effect on patient outcomes is limited. The other methods described in the literature that can enhance detection of bleeding on VA are glucagon and hyoscine butylbromide administration (to decrease bowel motility and artifacts), the use of carbon dioxide as a contrast medium, and longer injection durations [45]. Limitations include its invasive nature and higher bleeding rate threshold to diagnose obscure bleeding [46].

**CT Abdomen and Pelvis With IV Contrast.** There is no significant literature supporting the use of CT abdomen and pelvis with IV contrast. (Note: CTA is a separate procedure distinct from CT abdomen and pelvis with IV contrast.)

**CT Abdomen and Pelvis Without and With IV Contrast.** There is no significant literature supporting the use of CT abdomen and pelvis without and with IV contrast. (Note: CTA is a separate procedure distinct from CT abdomen and pelvis without and with IV contrast.)

**CT Abdomen and Pelvis Without IV Contrast.** There is no significant literature supporting the use of CT abdomen and pelvis without IV contrast. (Note: CTA is a separate procedure distinct from CT abdomen and pelvis without IV contrast.)

**CT Abdomen With IV Contrast.** There is no significant literature supporting the use of CT abdomen with IV contrast. (Note: CTA is a separate procedure distinct from CT abdomen with IV contrast.)

**CT Abdomen Without and With IV Contrast.** There is no significant literature supporting the use of CT abdomen without and with IV contrast. (Note: CTA is a separate procedure distinct from CT abdomen without and with IV contrast.)

**CT Abdomen Without IV Contrast.** There is no significant literature supporting the use of CT abdomen without IV contrast. (Note: CTA is a separate procedure distinct from CT abdomen without IV contrast.)

**CT Enterography.** CT enterography requires the administration of large volumes of neutral oral contrast, which can mask bleeding by dilution. Although multiphasic CT enterography can detect bleeding because of technique parameters that can mirror CTA, the primary use of this protocol is directed more to finding a potential bleeding source when bleeding is of a slow rate, suspected in the small bowel, or occult in nature [41].

**CTA Abdomen and Pelvis With IV Contrast.** There is no significant literature supporting the use of CTA abdomen and pelvis with IV contrast. Dual-energy CT allows for the generation of virtual noncontrast images from a CTA data set. However, the use of these virtual unenhanced images in place of true unenhanced images is still limited to certain sites and remains a user-specific preference. So, they are not discussed in this document.

**CTA Abdomen and Pelvis Without and With IV Contrast.** Besides angiography, CTA abdomen and pelvis without and with IV contrast may become useful when endoscopy shows nonvariceal UGIB without a clear source. As highlighted in previous variants, CTA without and with IV contrast has high accuracy for the detection of GIB. CTA can detect small bowel lesions that may be difficult to see on traditional esophagogastroduodenoscopy but may be better visualized by push enteroscopy [43]. Because CTA can identify a slower bleeding rate than angiography, CTA has been demonstrated to have significantly higher detection of active bleeding as well as localization of the culprit lesion [46]. CTA can also show Dieulafoy lesions that have a very high mortality rate [47,48].

**CTA Abdomen With IV Contrast.** There is no significant literature supporting the use of CTA abdomen with IV contrast.

**CTA Abdomen Without and With IV Contrast.** There is no significant literature supporting the use of CTA abdomen without and with IV contrast, because lesions not clearly seen on endoscopy may be localized to small bowel, which often requires inclusion of the pelvis.

**CTA Chest With IV Contrast.** There is no significant literature supporting the use of CTA chest with IV contrast.

**CTA Chest Without and With IV Contrast.** There is no significant literature supporting the use of CTA chest without and with IV contrast.

**Fluoroscopy Upper GI Series.** Barium or iodine upper GI series has no role in the diagnosis of acute UGIB.

**MR Enterography.** There is no significant literature supporting the use of MR enterography as an imaging test for UGIB, which is confirmed on endoscopy but without a clear source.

**RBC Scan Abdomen and Pelvis.** Because CTA evaluation is a well-recognized next step in the management of UGIB if endoscopy confirms bleeding 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.

#### **Variant 4: Adult. Nonvariceal upper gastrointestinal bleeding; negative endoscopy. Initial imaging**

This variant is applicable to patients with no clear source of bleeding despite complete endoscopic evaluation. Clinically, these patients can have obscure bleeding (which may be noted in the form of visible passage of blood or melena or occult bleeding, unexplained iron deficiency anemia, or guaiac-positive stools without visible passage of blood). Small bowel pathology is the frequent source of bleeding in these patients.

**Arteriography Visceral.** VA, due to a lower sensitivity for the detection of bleeding and its invasive nature, is considered lower on the diagnostic algorithm compared with more sensitive noninvasive testing [49,50]. Super-selective angiography with intraoperative methylene blue localization may help to diagnose and effectively control bleeding in patients with obscure GIB [51]. In patients with negative endoscopy, VA has false-negative results, because the bleeding is typically detected when the rate is at least 0.5 mL/min. It has been shown that there is no benefit of performing angiography in patients with occult GIB who have a negative CTA study [50].

**CT Abdomen and Pelvis With IV Contrast.** In endoscopy-negative patients, there is no significant literature for CT abdomen and pelvis with IV contrast for GIB evaluation. However, CT may be performed primarily for the evaluation of GI masses rather than the demonstration of bleeding. (Note: CTA is a separate procedure distinct from CT abdomen and pelvis with IV contrast.)

**CT Abdomen and Pelvis Without and With IV Contrast.** In endoscopy-negative patients, there is no significant literature for CT abdomen and pelvis without and with IV

contrast for GIB evaluation. Although there is not enough literature supporting its use, the test may serve as an initial test for patients with obscure or occult bleeding, especially if an alternative is needed for CTA or enterography. (Note: CTA is a separate procedure distinct from CT abdomen and pelvis without and with IV contrast.)

**CT Abdomen and Pelvis Without IV Contrast.** In endoscopy-negative patients, there is no significant literature for CT abdomen and pelvis without IV contrast for GIB evaluation. (Note: CTA is a separate procedure distinct from CT abdomen and pelvis without IV contrast.)

**CT Abdomen With IV Contrast.** In endoscopy-negative patients, there is no significant literature for CT abdomen with IV contrast for GIB evaluation. (Note: CTA is a separate procedure distinct from CT abdomen with IV contrast.)

**CT Abdomen Without and With IV Contrast.** In endoscopy-negative patients, there is no significant literature for CT abdomen without and with IV contrast for GIB evaluation. (Note: CTA is a separate procedure distinct from CT abdomen without and with IV contrast.)

**CT Abdomen Without IV Contrast.** In endoscopy-negative patients, there is no significant literature for CT abdomen without IV contrast for GIB evaluation. (Note: CTA is a separate procedure distinct from CT abdomen without IV contrast.)

**CT Enterography.** Although CT enterography is not considered useful for detection of acute bleeding due to the dilution of bleeding from oral contrast, it may be helpful in patients with negative endoscopy to identify a small bowel source of GIB. The sensitivity for detection of the cause of occult GIB is typically low, with measured sensitivity of 25% compared with capsule endoscopy (sensitivity of 87%) and 33% when compared with clinical follow-up in patients with nondiagnostic capsule endoscopy [52,53]. However, a study showed a higher sensitivity of CT enterography (88%) for the diagnosis of etiology of occult GIB, significantly higher than capsule endoscopy (sensitivity 38%) in their study population [54]. Advantages of CT enterography over capsule endoscopy are ease of performance and better patient satisfaction [5].

**CTA Abdomen and Pelvis With IV Contrast.** In endoscopy-negative patients, there is no significant literature for CT abdomen and pelvis with IV contrast for GIB evaluation. Dual-energy CT allows for the generation of virtual noncontrast images from a CTA data set. However, the use of these virtual unenhanced images in place of true unenhanced images is still limited to certain sites and remains a user-specific preference. So, they are not discussed in this document.

**CTA Abdomen and Pelvis Without and With IV Contrast.** Both CTA and CT enterography are effective imaging tests for the diagnosis of UGIB with negative endoscopy. Studies have demonstrated that there is no significant clinical difference between accuracy of CTA and enterography for endoscopy-negative GIB [55,56]. CTA can detect bleeding rates as slow as 0.3 mL/min [19]. But, as with angiography, intermittent and slow bleeding can be missed, leading to false-negatives. 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), which decreases to 50% in patients with a slow bleed [57]. The portal venous or delayed phase of multiphasic CT may be more useful for detection of GI masses. CTA and CT enterography can serve as triage tools for identifying patients who may benefit from double-balloon endoscopy [58].

**CTA Abdomen With IV Contrast.** In endoscopy-negative patients, there is no significant literature for CTA abdomen with IV contrast for GIB evaluation.

**CTA Abdomen Without and With IV Contrast.** In endoscopy-negative patients, there is no significant literature for CTA abdomen without and with IV contrast for GIB evaluation. Because the pathology can be located anywhere in the small bowel, it is more appropriate to image both the abdomen and pelvis.

**CTA Chest With IV Contrast.** In endoscopy-negative patients, there is no significant literature for CTA chest with IV contrast for GIB evaluation.

**CTA Chest Without and With IV Contrast.** In endoscopy-negative patients, there is no significant literature for CTA chest without and with IV contrast for GIB evaluation.

**Fluoroscopy Upper GI Series.** Barium or iodine upper GI series has no role in diagnosis of acute UGIB.

**MR Enterography.** Similar to CT enterography, MR enterography requires oral administration of oral contrast that can obscure bleeding. But MR enterography has been used to identify small bowel sources of bleeding in pediatric patients. In a study of 25 pediatric patients with occult GIB, MR enterography was shown to be diagnostic in 79% patients, with a sensitivity and specificity of 86% and 100%, respectively [59]. Few other studies have also compared capsule with MR enterography and demonstrated better diagnostic yields for capsule endoscopy [60,61]. However, there is not enough direct evidence to suggest that MR enterography has an advantage over CT enterography or capsule endoscopy in patients with UGIB and negative endoscopy, particularly in adults.

**RBC Scan Abdomen and Pelvis.** Tc-99m–labeled RBC scans can detect bleeding rates as low as 0.05 to 0.1 mL/min. Although there is prior literature on the use of RBC abdomen and pelvis scan, no recent studies have compared the accuracy of RBC scan to CTA or angiography for occult UGIB. Prior reports had suggested variable efficacy for the diagnosis of GIB with localization errors, especially when bleeding arises from the stomach and duodenum [62,63]. However, the use of single-photon emission CT (SPECT) and SPECT/CT have made the anatomical position of the uptake clear and contributed to the improved localization of the site of GIB [64].

### **Variant 5: Adult. Postsurgical or traumatic causes of nonvariceal upper gastrointestinal bleeding. Endoscopy is contraindicated. Initial imaging**

This variant is applicable to postsurgical or trauma patients with UGIB, contraindicated to upper GI endoscopy.

**Arteriography Visceral.** VA is primarily reserved for unstable patients with UGIB and contraindicated for endoscopy, because it can be used for diagnosis and simultaneous treatment [27,65]. Typically, unstable patients with traumatic hemobilia and bleeding after mucosal or submucosal endoscopic mass resection may require VA [4,39,65]. In stable patients, VA may be performed after CTA, which can show the site of bleeding or a pseudoaneurysm [4,39].

**CT Abdomen and Pelvis With IV Contrast.** There is no significant literature supporting the use of CT abdomen and pelvis with IV contrast for postsurgical or post-traumatic UGIB. However, in general, CT of the abdomen and pelvis with IV contrast is routinely used in trauma patients to assess for intra-abdominal injury. In a meta-analysis of 16 studies enrolling 12,514 patients, CT of the abdomen and pelvis had a sensitivity and specificity of 68% and 97%, respectively, for the diagnosis of traumatic hollow viscus injury [66]. (Note: CTA is a separate procedure distinct from CT abdomen and pelvis with IV contrast.)

**CT Abdomen and Pelvis Without and With IV Contrast.** There is no significant literature supporting the use of CT abdomen and pelvis without and with IV contrast for postsurgical or post-traumatic UGIB. (Note: CTA is a separate procedure distinct from CT abdomen and pelvis without and with IV contrast.)

**CT Abdomen and Pelvis Without IV Contrast.** There is no significant literature supporting the use of CT abdomen and pelvis without IV contrast for postsurgical or post-traumatic UGIB. (Note: CTA is a separate procedure distinct from CT abdomen and pelvis without IV contrast.)

**CT Abdomen With IV Contrast.** There is no significant literature supporting the use of CT abdomen with IV contrast for postsurgical or post-traumatic UGIB. (Note: CTA is a separate procedure distinct from CT abdomen with IV contrast.)

**CT Abdomen Without and With IV Contrast.** There is no significant literature supporting the use of CT abdomen without and with IV contrast for postsurgical or post-traumatic UGIB. However, CT of the abdomen without and with IV contrast may be considered in patients who are suspected to have postsurgical UGIB or hemobilia [67]. In a study of postlaparoscopic sleeve gastrectomy patients presenting with UGIB, CT was able to diagnose all patients with surgical site pseudoaneurysm who were successfully treated by surgery or transcatheter arterial embolization [68]. The patients with poststent ulceration or mucosal diseases are, however, often undiagnosed by CT [68].

**CT Abdomen Without IV Contrast.** There is no significant literature supporting the use of CT abdomen without IV contrast for postsurgical or post-traumatic UGIB.

**CT Enterography.** There is no significant literature supporting the use of CT enterography for postsurgical or post-traumatic UGIB. CT enterography requires the administration of large volumes of neutral oral contrast, which can mask GIB by dilution. Additionally, a large volume of oral contrast is often not tolerated by patients when acutely ill. However, CT enterography can detect GIB because of technique parameters that can mirror CTA and is useful for patients with occult GI or suspected small bowel bleeding [5].

**CTA Abdomen and Pelvis With IV Contrast.** Although CTA can detect arterial post-traumatic bleeding, performance with IV contrast only may not be as helpful. Without contrast images are important to identify sentinel clot and inherently hyperdense intraluminal material. Dual-energy CT allows for the generation of virtual noncontrast images from a CTA data set. However, the use of these virtual unenhanced images in place of true unenhanced images is still limited to certain sites and remains a user-specific preference. So, they are not discussed in this document. There is no significant literature supporting the use of CTA abdomen and pelvis with IV contrast only.

**CTA Abdomen and Pelvis Without and With IV Contrast.** In traumatic UGIB, it is important to identify the source quickly, safely, and effectively. CT is frequently performed in patients with trauma to assess for visceral injuries. In patients with UGIB, multiphase CTA can



effectively and quickly evaluate abdominal vasculature, GIB, and visceral injuries simultaneously. Mesenteric contrast extravasation has a 75% sensitivity for mesenteric injury [69]. CT can help in triage and prognostication, with active bleeding in the arterial or portal venous phase more likely to be life-threatening versus bleeding that first appears in the equilibrium phase [69]. A rare but life-threatening cause of postsurgical or iatrogenic UGIB can be aortoenteric fistula. CTA is the examination of choice [70]. Evidence of a fistula is suggested by gas in a periprosthetic fluid collection, retraction of the contacting intestinal walls, or the presence of a false aneurysm. Extravasation of contrast into the intestinal lumen is diagnostic of aortoenteric fistula but rarely occurs. Even in patients that can undergo endoscopy, CTA is superior and more sensitive compared with endoscopy for the diagnosis of aortoenteric fistula [71].

**CTA Abdomen With IV Contrast.** There is no significant literature supporting the use of CTA abdomen with IV contrast for postsurgical or post-traumatic UGIB.

**CTA Abdomen Without and With IV Contrast.** There is no significant literature supporting the use of CTA abdomen without and with IV contrast for postsurgical or post-traumatic UGIB.

**CTA Chest With IV Contrast.** There is no significant literature supporting the use of CTA chest with IV contrast for postsurgical or post-traumatic UGIB.

**CTA Chest Without and With IV Contrast.** There is no significant literature comparing the use of CTA chest without and with IV contrast for UGIB. However, as highlighted earlier in this document, if the trauma or prior surgery is localized to the chest, this test may be helpful.

**Fluoroscopy Upper GI Series.** Barium or iodine upper GI series has no role in the diagnosis of acute UGIB.

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

## SUMMARY OF RECOMMENDATIONS

- **Variant 1:** CTA of the abdomen and pelvis without and with IV contrast is usually appropriate for the initial imaging in an adult with suspected nonvariceal UGIB and no endoscopy performed.
- **Variant 2:** Visceral arteriography or CTA of the abdomen and pelvis without and with IV contrast is usually appropriate for the initial imaging in an adult who has nonvariceal UGIB with a clear source confirmed by endoscopy, although treatment is not

possible or there is continued bleeding after endoscopic treatment. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).

- **Variant 3:** CTA of the abdomen and pelvis without and with IV contrast is usually appropriate for the initial imaging in an adult who has nonvariceal UGIB without a clear source, which has been confirmed by endoscopy.
- **Variant 4:** CT enterography or CTA of the abdomen and pelvis without and with IV contrast is usually appropriate for the initial imaging in an adult with nonvariceal UGIB and negative endoscopy. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).
- **Variant 5:** Visceral arteriography or CTA of the abdomen and pelvis without and with IV contrast is usually appropriate for the initial imaging in an adult with postsurgical or traumatic causes of nonvariceal UGIB; however, endoscopy is contraindicated. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care). The panel did not agree on recommending CTA of the abdomen without and with IV contrast. There is insufficient medical literature to conclude whether or not these patients would benefit from this option in this clinical scenario. Imaging with this option in this patient population is controversial but may be appropriate.

## SUPPORTING DOCUMENTS

The evidence table, literature search, and appendix for this topic are available at <https://acsearch.acr.org/list>. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

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

## 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, because of both 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 with those specified for adults (see Table 2). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document [72].

## REFERENCES

1. Lanas A, Dumonceau JM, Hunt RH, et al. Non-variceal upper gastrointestinal bleeding. *Nat Rev Dis Primers* 2018;4:18020.
2. Gerson LB, Fidler JL, Cave DR, Leighton JA. ACG clinical guideline: diagnosis and management of small bowel bleeding. *Am J Gastroenterol* 2015;110:1265-87; quiz 88.
3. Ichita C, Sasaki A, Sumida C, et al. Clinical and endoscopic features of aorto-duodenal fistula resulting in its definitive diagnosis: an observational study. *BMC Gastroenterol* 2021;21:45.
4. Feng W, Yue D, ZaiMing L, ZhaoYu L, Wei L, Qiyong G. Hemobilia following laparoscopic cholecystectomy: computed tomography findings and clinical outcome of transcatheter arterial embolization. *Acta Radiol* 2017;58:46-52.
5. Guglielmo FF, Wells ML, Bruining DH, et al. Gastrointestinal bleeding at CT angiography and CT enterography: imaging atlas and glossary of terms. *Radiographics* 2021;41:1632-56.
6. Mullady DK, Wang AY, Waschke KA. AGA Clinical practice update on endoscopic therapies for non-variceal upper gastrointestinal bleeding: expert review. *Gastroenterology* 2020;159:1120-8.
7. Wells ML, Hansel SL, Bruining DH, et al. CT for Evaluation of acute gastrointestinal bleeding. *Radiographics* 2018;38:1089-107.
8. Laine L, Barkun AN, Saltzman JR, Martel M, Leontiadis GI. Correction to: ACG clinical guideline: upper gastrointestinal and ulcer bleeding. *Am J Gastroenterol* 2021;116:2309.
9. Kim CY, Pinchot JW, Ahmed O, et al. ACR Appropriateness Criteria® Radiologic management of gastric varices. *J Am Coll Radiol* 2020;17:S239-54.
10. Pinchot JW, Kalva SP, Majdalany BS, et al. ACR Appropriateness Criteria® Radiologic management of portal hypertension. *J Am Coll Radiol* 2021;18:S153-73.
11. Trabzonlu TA, Mozaffary A, Kim D, Yaghai V. Dual-energy CT evaluation of gastrointestinal bleeding. *Abdom Radiol (NY)* 2020;45:1-14.
12. Mohammadinejad P, Kwapisz L, Fidler JL, et al. The utility of a dual-phase, dual-energy CT protocol in patients presenting with overt gastrointestinal bleeding. *Acta Radiol Open* 2021;10:20584601211030658.
13. American College of Radiology. ACR-NASCI-SIR-SPR practice parameter for the performance and interpretation of body computed tomography angiography (CTA). Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/body-cta.pdf>. Accessed March 29, 2024.
14. Kim G, Soto JA, Morrison T. Radiologic assessment of gastrointestinal bleeding. *Gastroenterol Clin North Am* 2018;47:501-14.
15. Choi C, Lim H, Kim MJ, et al. Relationship between angiography timing and angiographic visualization of extravasation in patients with acute non-variceal gastrointestinal bleeding. *BMC Gastroenterol* 2020;20:426.
16. Chevallier O, Comby PO, Guillen K, et al. Efficacy, safety and outcomes of transcatheter arterial embolization with N-butyl cyanoacrylate glue for non-variceal gastrointestinal bleeding: a systematic review and meta-analysis. *Diagn Interv Imaging* 2021;102:479-87.
17. Lai HY, Wu KT, Liu Y, Zeng ZF, Zhang B. Angiography and transcatheter arterial embolization for non-variceal gastrointestinal bleeding. *Scand J Gastroenterol* 2020;55:931-40.
18. Shotar E, Soyer P, Barat M, et al. Diagnosis of acute overt gastrointestinal bleeding with CT-angiography: Comparison of the diagnostic performance of individual acquisition phases. *Diagn Interv Imaging* 2017;98:857-63.
19. Garcia-Blazquez V, Vicente-Bartulos A, Olavarria-Delgado A, et al. Accuracy of CT angiography in the diagnosis of acute gastrointestinal bleeding: systematic review and meta-analysis. *Eur Radiol* 2013;23:1181-90.
20. Fidler JL, Gunn ML, Soto JA, et al. Society of abdominal radiology gastrointestinal bleeding disease-focused panel consensus recommendations for CTA technical parameters in the evaluation of acute overt gastrointestinal bleeding. *Abdom Radiol (NY)* 2019;44:2957-62.
21. Sun H, Hou XY, Xue HD, et al. Dual-source dual-energy CT angiography with virtual non-enhanced images and iodine map for active gastrointestinal bleeding: image quality, radiation dose and diagnostic performance. *Eur J Radiol* 2015;84:884-91.
22. Chan V, Tse D, Dixon S, et al. Outcome following a negative CT angiogram for gastrointestinal hemorrhage. *Cardiovasc Intervent Radiol* 2015;38:329-35.
23. Tse JR, Shen J, Shah R, Fleischmann D, Kamaya A. Extravasation volume at computed tomography angiography correlates with bleeding rate and prognosis in patients with overt gastrointestinal bleeding. *Invest Radiol* 2021;56:394-400.
24. Stewart K, Sharma AK. The utilization of CTA in management of gastrointestinal bleeding in a tertiary care center ED. Are we using it enough? *Am J Emerg Med* 2021;39:60-4.
25. Hsu MJ, Dinh DC, Shah NA, et al. Time to conventional angiography in gastrointestinal bleeding: CT angiography compared to tagged RBC scan. *Abdom Radiol (NY)* 2020;45:307-11.
26. Alrashidi I, Kim TH, Shin JH, Alreshidi M, Park M, Jang EB. Efficacy and safety of transcatheter arterial embolization for active arterial esophageal bleeding: a single-center experience. *Diagn Interv Radiol* 2021;27:519-23.
27. Aoki M, Tokue H, Koyama Y, Tsushima Y, Oshima K. Transcatheter arterial embolization with N-butyl cyanoacrylate for arterial esophageal bleeding in esophageal cancer patients. *World J Surg Oncol* 2016;14:54.
28. Kohli DR, Shah RD, Komorowski DJ, Smallfield GB. Periesophageal pseudoaneurysms: rare cause of refractory bleeding treated with transarterial embolization. *Case Rep Gastrointest Med* 2016;2016:1456949.
29. Zheng L, Lee IJ, Shin JH, Chu HH, Li HL. Endovascular management of gastric conduit hemorrhage following transthoracic esophagectomy. *J Vasc Interv Radiol* 2021;32:1144-9.
30. Cho SB, Hur S, Kim HC, et al. Transcatheter arterial embolization for advanced gastric cancer bleeding: a single-center experience with 58 patients. *Medicine (Baltimore)* 2020;99:e19630.
31. Koo HJ, Shin JH, Shin S, Yoon HK, Ko GY, Gwon DI. Efficacy and clinical outcomes of transcatheter arterial embolization for gastrointestinal bleeding from gastrointestinal stromal tumor. *J Vasc Interv Radiol* 2015;26:1297-12304.e1.
32. Sun CJ, Wang CE, Wang YH, Xie LL, Liu TH, Ren WC. Transcatheter arterial embolization of acute gastrointestinal tumor hemorrhage with Onyx. *Indian J Cancer* 2015;51(Suppl 2):e56-9.
33. Lee SM, Jeong SY, Shin JH, et al. Transcatheter arterial embolization for gastrointestinal bleeding related to pancreatic adenocarcinoma: clinical efficacy and predictors of clinical outcome. *Eur J Radiol* 2020;123:108787.
34. Zandrino F, Tettoni SM, Gallesio I, Summa M. Emergency arterial embolization of upper gastrointestinal and jejunal tumors: an analysis

- of 12 patients with severe bleeding. *Diagn Interv Imaging* 2017;98:51-6.
35. Nykanen T, Peltola E, Kylanpää L, Udd M. Bleeding gastric and duodenal ulcers: case-control study comparing angioembolization and surgery. *Scand J Gastroenterol* 2017;52:523-30.
  36. Laursen SB, Jakobsen M, Nielsen MM, Hovendal C, Schaffalitzky de Muckadell OB. Transcatheter arterial embolization is the first-line therapy of choice in peptic ulcer bleeding not responding to endoscopic therapy. *Scand J Gastroenterol* 2015;50:264-71.
  37. Mille M, Huber J, Wlasak R, et al. Prophylactic transcatheter arterial embolization after successful endoscopic hemostasis in the management of bleeding duodenal ulcer. *J Clin Gastroenterol* 2015;49:738-45.
  38. Yao Z, Tian W, Xu X, et al. Transcatheter arterial embolization in the treatment of abdominal bleeding in patients being treated with open abdomen due to duodenal fistula. *World J Surg* 2020;44:2562-71.
  39. Wen F, Dong Y, Lu ZM, Liu ZY, Li W, Guo QY. Hemobilia after laparoscopic cholecystectomy: imaging features and management of an unusual complication. *Surg Laparosc Endosc Percutan Tech* 2016;26:e18-24.
  40. Lee NJ, Shin JH, Lee SS, Park DH, Lee SK, Yoon HK. Transcatheter arterial embolization for iatrogenic bleeding after endoscopic ultrasound-guided pancreaticobiliary drainage. *Diagn Interv Imaging* 2018;99:717-24.
  41. Huprich JE, Barlow JM, Hansel SL, Alexander JA, Fidler JL. Multiphase CT enterography evaluation of small-bowel vascular lesions. *AJR Am J Roentgenol* 2013;201:65-72.
  42. Zhang GMY, Sun H, Xue HD, Li XG, Jin ZY. Computed tomography signs for active severe gastrointestinal bleeding. *Zhongguo Yi Xue Ke Xue Yuan Xue Bao* 2016;38:322-6.
  43. Tseng CM, Lin IC, Chang CY, et al. Role of computed tomography angiography on the management of overt obscure gastrointestinal bleeding. *PLoS One* 2017;12:e0172754.
  44. Kokoroskos N, Naar L, Peponis T, et al. Provocative angiography, followed by therapeutic interventions, in the management of hard-to-diagnose gastrointestinal bleeding. *World J Surg* 2020;44:2944-9.
  45. Shin JH. Refractory gastrointestinal bleeding: role of angiographic intervention. *Clin Endosc* 2013;46:486-91.
  46. Wildgruber M, Wrede CE, Zorger N, et al. Computed tomography versus digital subtraction angiography for the diagnosis of obscure gastrointestinal bleeding. *Eur J Radiol* 2017;88:8-14.
  47. Kawabata H, Kawakatsu Y, Sone D, et al. A rare case of Goodpasture syndrome concomitant with bleeding jejunal Dieulafoy's lesion. *Clin J Gastroenterol* 2020;13:382-5.
  48. Batouli A, Kazemi A, Hartman MS, Heller MT, Midian R, Lupetin AR. Dieulafoy lesion: CT diagnosis of this lesser-known cause of gastrointestinal bleeding. *Clin Radiol* 2015;70:661-6.
  49. Aksoy T. Obscure and occult gastrointestinal bleeding: role of radionuclide imaging. *Abdom Imaging* 2012;37:309-10. author reply 11-12.
  50. Shukla PA, Zybulewski A, Kolber MK, Berkowitz E, Silberzweig J, Hayim M. No catheter angiography is needed in patients with an obscure acute gastrointestinal bleed and negative CTA. *Clin Imaging* 2017;43:106-9.
  51. Pai M, Frampton AE, Virk JS, et al. Preoperative superselective mesenteric angiography and methylene blue injection for localization of obscure gastrointestinal bleeding. *JAMA Surg* 2013;148:665-8.
  52. Agrawal JR, Travis AC, Mortele KJ, et al. Diagnostic yield of dual-phase computed tomography enterography in patients with obscure gastrointestinal bleeding and a non-diagnostic capsule endoscopy. *J Gastroenterol Hepatol* 2012;27:751-9.
  53. Chu Y, Wu S, Qian Y, et al. Complimentary imaging modalities for investigating obscure gastrointestinal bleeding: capsule endoscopy, double-balloon enteroscopy, and computed tomographic enterography. *Gastroenterol Res Pract* 2016;2016:8367519.
  54. Huprich JE, Fletcher JG, Fidler JL, et al. Prospective blinded comparison of wireless capsule endoscopy and multiphase CT enterography in obscure gastrointestinal bleeding. *Radiology* 2011;260:744-51.
  55. Jeon SR, Jin-Oh K, Gun KH, et al. Is there a difference between capsule endoscopy and computed tomography as a first-line study in obscure gastrointestinal bleeding? *Turk J Gastroenterol* 2014;25:257-63.
  56. He B, Gong S, Hu C, et al. Obscure gastrointestinal bleeding: diagnostic performance of 64-section multiphase CT enterography and CT angiography compared with capsule endoscopy. *Br J Radiol* 2014;87:20140229.
  57. Chang WC, Tsai SH, Chang WK, et al. The value of multidetector-row computed tomography for localization of obscure acute gastrointestinal bleeding. *Eur J Radiol* 2011;80:229-35.
  58. Yen HH, Chen YY, Yang CW, Liu CK, Soon MS. Clinical impact of multidetector computed tomography before double-balloon enteroscopy for obscure gastrointestinal bleeding. *World J Gastroenterol* 2012;18:692-7.
  59. Casciani E, Nardo GD, Chin S, et al. MR Enterography in paediatric patients with obscure gastrointestinal bleeding. *Eur J Radiol* 2017;93:209-16.
  60. Bocker U, Dinter D, Litterer C, et al. Comparison of magnetic resonance imaging and video capsule enteroscopy in diagnosing small-bowel pathology: localization-dependent diagnostic yield. *Scand J Gastroenterol* 2010;45:490-500.
  61. Wiarda BM, Heine DG, Mensink P, et al. Comparison of magnetic resonance enteroclysis and capsule endoscopy with balloon-assisted enteroscopy in patients with obscure gastrointestinal bleeding. *Endoscopy* 2012;44:668-73.
  62. Tabibian JH, Wong Kee Song LM, Enders FB, Aguet JC, Tabibian N. Technetium-labeled erythrocyte scintigraphy in acute gastrointestinal bleeding. *Int J Colorectal Dis* 2013;28:1099-105.
  63. Dolezal J, Vizda J, Kopacova M. Single-photon emission computed tomography enhanced Tc-99m-pertechnetate disodium-labelled red blood cell scintigraphy in the localization of small intestine bleeding: a single-centre twelve-year study. *Digestion* 2011;84:207-11.
  64. Otomi Y, Otsuka H, Terazawa K, et al. The diagnostic ability of SPECT/CT fusion imaging for gastrointestinal bleeding: a retrospective study. *BMC Gastroenterol* 2018;18:183.
  65. Park S, Jeong B, Shin JH, Jang EH, Hwang JH, Kim JH. Transarterial embolisation for gastroduodenal bleeding following endoscopic resection. *Br J Radiol* 2021;94:20210062.
  66. Hsia CC, Wang CY, Huang JF, et al. Diagnostic accuracy of computed tomography for the prediction of the need for laparotomy for traumatic hollow viscus injury: systematic review and meta-analysis. *J Pers Med* 2021;11:1269.
  67. Murugesan SD, Sathyanesan J, Lakshmanan A, et al. Massive hemobilia: a diagnostic and therapeutic challenge. *World J Surg* 2014;38:1755-62.
  68. Rebibo L, Fuks D, Blot C, et al. Gastrointestinal bleeding complication of gastric fistula after sleeve gastrectomy: consider pseudoaneurysms. *Surg Endosc* 2013;27:2849-55.
  69. Wu CH, Wang LJ, Wong YC, et al. Contrast-enhanced multiphase computed tomography for identifying life-threatening mesenteric hemorrhage and transmural bowel injuries. *J Trauma* 2011;71:543-8.
  70. Luo J, Tang W, Wang M, Xiao Y, Tan M, Jiang C. Case series of aortoenteric fistulas: a rare cause of gastrointestinal bleeding. *BMC Gastroenterol* 2021;21:49.
  71. Deijen CL, Smulders YM, Coveliers HME, Wisselink W, Rauwerda JA, Hoksbergen AWJ. The importance of early diagnosis and treatment of patients with aortoenteric fistulas presenting with herald bleeds. *Ann Vasc Surg* 2016;36:28-34.
  72. American College of Radiology. ACR Appropriateness Criteria® Radiation dose assessment introduction. Available at: <https://www.acr.org/-/media/ACR/Files/Appropriateness-Criteria/RadiationDoseAssessmentIntro.pdf>. Accessed March 29, 2024.