

ACR Appropriateness Criteria®

Gastrointestinal Bleeding-Child

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Abstract

Gastrointestinal (GI) bleeding is a relatively common presenting complaint in pediatric practices and may arise from either the upper or lower GI tract. Many common causes of GI bleed are benign and self-limited, often requiring only supportive care with no imaging necessary. When indicated, the goal of imaging is to diagnose and localize the source of bleeding to help guide timely, targeted interventions. Abdominal radiography is often the initial imaging study obtained for patients presenting with GI bleeding. Although it is usually unable to precisely localize the site of bleeding, it may provide clues to the diagnosis. Nuclear medicine imaging studies including pertechnetate (Meckel scan) and tagged red blood cell studies can help localize the site of bleeding, occasionally providing a specific diagnosis. CT angiography of the abdomen and pelvis may be appropriate in many scenarios; however, in unstable patients CT angiography is usually appropriate as initial imaging. Visceral angiography may also be used.

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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.

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 (CTA), gastrointestinal bleeding (GIB), hematemesis, Meckel diverticulum, melena, pertechnetate scan

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ACR Appropriateness Criteria[®] Gastrointestinal Bleeding-Child. [Variants 1 to 4](#) and [Tables 1 and 2](#)

Variant 1. Child. Hematemesis. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography chest	May Be Appropriate	⦿
Radiography abdomen	May Be Appropriate	⦿⦿
CTA abdomen without and with IV contrast	May Be Appropriate	⦿⦿⦿⦿⦿
US abdomen	Usually Not Appropriate	○
MRA abdomen and pelvis without and with IV contrast	Usually Not Appropriate	○
MRA chest abdomen pelvis without and with IV contrast	Usually Not Appropriate	○
CT abdomen and pelvis with IV contrast	Usually Not Appropriate	⦿⦿⦿⦿
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	⦿⦿⦿⦿
CT chest with IV contrast	Usually Not Appropriate	⦿⦿⦿⦿
CT chest without and with IV contrast	Usually Not Appropriate	⦿⦿⦿⦿
CT chest 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	⦿⦿⦿
RBC scan with SPECT or SPECT/CT abdomen and pelvis	Usually Not Appropriate	⦿⦿⦿
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	⦿⦿⦿⦿⦿
CT chest abdomen pelvis with IV contrast	Usually Not Appropriate	⦿⦿⦿⦿
CT chest abdomen pelvis without and with IV contrast	Usually Not Appropriate	⦿⦿⦿⦿⦿
CT chest abdomen pelvis without IV contrast	Usually Not Appropriate	⦿⦿⦿⦿

Variation 2. Child. Suspected GI bleed. Melena, or bright red blood per rectum, or positive fecal occult blood test. Stable patient. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
Radiography abdomen	Usually Appropriate	☼☼
US abdomen	May Be Appropriate	○
Pertechnetate scan abdomen and pelvis	May Be Appropriate (Disagreement)	☼☼☼
Pertechnetate scan with SPECT or SPECT/CT abdomen and pelvis	May Be Appropriate (Disagreement)	☼☼☼
RBC scan abdomen and pelvis	May Be Appropriate (Disagreement)	☼☼☼
RBC scan with SPECT or SPECT/CT abdomen and pelvis	May Be Appropriate	☼☼☼
CTA abdomen and pelvis with IV contrast	May Be Appropriate (Disagreement)	☼☼☼☼☼
CTA abdomen and pelvis without and with IV contrast	May Be Appropriate (Disagreement)	☼☼☼☼☼
MRA abdomen and pelvis without and with IV contrast	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 and pelvis without and with IV contrast	Usually Not Appropriate	☼☼☼☼☼

Variation 3. Child. Suspected GI bleed. Melena, or bright red blood per rectum, or positive fecal occult blood test. Stable patient. Initial imaging negative. Next imaging study.

Procedure	Appropriateness Category	Relative Radiation Level
Pertechnetate scan abdomen and pelvis	Usually Appropriate	☼☼☼
Pertechnetate scan with SPECT or SPECT/CT abdomen and pelvis	Usually Appropriate	☼☼☼
RBC scan abdomen and pelvis	Usually Appropriate	☼☼☼
RBC scan with SPECT or SPECT/CT abdomen and pelvis	Usually Appropriate	☼☼☼
US abdomen	May Be Appropriate	○
Arteriography visceral	May Be Appropriate (Disagreement)	☼☼☼☼☼
MR enterography	May Be Appropriate	○
MRA abdomen and pelvis without and with IV contrast	May Be Appropriate	○
CT enterography	May Be Appropriate	☼☼☼☼
CTA abdomen and pelvis with IV contrast	May Be Appropriate	☼☼☼☼☼
CTA abdomen and pelvis without and with IV contrast	May Be Appropriate (Disagreement)	☼☼☼☼☼
Arteriography abdomen and pelvis	Usually Not Appropriate	Varies
Arteriography chest abdomen pelvis	Usually Not Appropriate	Varies
CT abdomen and pelvis with IV contrast	Usually Not Appropriate	☼☼☼☼
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	☼☼☼☼
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	☼☼☼☼☼

Variation 4. Child. Suspected GI bleed. Melena, or bright red blood per rectum, or positive fecal occult blood test. Unstable patient. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
CTA abdomen and pelvis without and with IV contrast	Usually Appropriate	⚠⚠⚠⚠⚠
Radiography abdomen	May Be Appropriate	⚠⚠
Arteriography visceral	May Be Appropriate (Disagreement)	⚠⚠⚠⚠⚠
CTA abdomen and pelvis with IV contrast	May Be Appropriate	⚠⚠⚠⚠⚠
Arteriography abdomen and pelvis	Usually Not Appropriate	Varies
Arteriography chest abdomen pelvis	Usually Not Appropriate	Varies
MRA abdomen and pelvis without and with IV contrast	Usually Not Appropriate	0
CT abdomen and pelvis with IV contrast	Usually Not Appropriate	⚠⚠⚠⚠
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	⚠⚠⚠⚠
Pertechnetate scan abdomen and pelvis	Usually Not Appropriate	⚠⚠⚠
Pertechnetate scan with SPECT or SPECT/CT abdomen and pelvis	Usually Not Appropriate	⚠⚠⚠
RBC scan abdomen and pelvis	Usually Not Appropriate	⚠⚠⚠
RBC scan with SPECT or SPECT/CT abdomen and pelvis	Usually Not Appropriate	⚠⚠⚠
CT abdomen and pelvis 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
⊕	<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

Gastrointestinal bleeding (GIB) is a relatively common presenting complaint in pediatric practices. Although GIB can be an alarming experience for patients and families, it is important to remember that the majority of patients presenting for evaluation of GIB have a benign, often self-limited course [1-3]. As such, most patients do not require imaging or intervention beyond supportive care. In general, rectal bleeding is more commonly encountered than hematemesis. Hematemesis is usually the result of a bleeding source from the upper GI (UGI) tract proximal to the duodenal jejunal junction, which can help focus the diagnostic evaluation of these patients. In contrast, only about one-third of pediatric patients presenting with rectal bleeding have a lower GI (LGI) source, with the remaining two-thirds having an UGI or unspecified source [2]. There are little data regarding the epidemiology of GIB in the pediatric population with a few studies reporting an overall incidence of 6.4% [4,5].

Results from the nationwide emergency department sample from 2006 to 2010 showed that the majority of pediatric patients presenting to the emergency department with a complaint of GIB had an unspecified bleeding site, whereas approximately 30% of patients had LGIB and 20% had UGIB source [2]. In the same study, it was reported that the majority (approximately 80%) of patients presenting to the emergency department with GIB were discharged, which suggests that a majority of GIB in the pediatric population are self-limited or resolve with supportive care only.

Mortality as a result of UGIB or LGIB in pediatric patients, however, can range as high as 5% to 15% in certain subpopulations of children [5]. Factors associated with increased mortality include coexisting severe medical disorder, coagulation disorder, failure to identify the bleeding site, hemoglobin level <7 g/dL and/or hematocrit value of <20% at presentation,

and >85 mL/kg blood loss without surgical intervention [1]. The most common causes of GIB in pediatric patients depend on the presumed site of bleeding (UGI versus LGI tract), and the clinical severity of bleeding, which are outlined in the following paragraphs adapted from Piccirillo et al [3]:

- In ill-appearing infants with UGI tract hemorrhage, the most common causes of bleeding are hemorrhagic gastritis and stress ulcers. In well-appearing infants with UGI tract hemorrhage, the most common causes of bleeding are reflux esophagitis, reactive gastritis, and vitamin K deficiency. In ill-appearing infants with LGI tract hemorrhage, the most common causes are infectious colitis, necrotizing enterocolitis, Hirschsprung enterocolitis, and volvulus. In well-appearing infants with LGI tract hemorrhage, the most common causes are anal fissures, eosinophilic colitis, infectious colitis, and nodular lymphoid hyperplasia.
- In ill-appearing children with UGI tract hemorrhage, the most common causes are esophageal varices, hemorrhagic gastritis, and stress ulcers. In well-appearing children with UGI tract hemorrhage and a high rate of bleeding, the most common causes of bleeding are esophageal varices and gastric/duodenal ulcers. In well-appearing children with UGI tract hemorrhage and a low rate of bleeding, the most common causes of bleeding are Mallory-Weiss tear, gastritis, and reflux esophagitis. In ill-appearing children with LGI tract hemorrhage, the most common causes are intussusception, volvulus, Henoch-Schönlein purpura, and hemolytic uremic syndrome. In well-appearing children with LGI tract hemorrhage and a high rate of bleeding, the most common causes are Meckel diverticulum, sloughed juvenile polyp, and ulcerative colitis (UC). In well-appearing children with LGI tract hemorrhage and a low rate of bleeding, the most common causes are infectious colitis, juvenile polyp, nodular lymphoid hyperplasia, UC/Crohn disease, perianal cellulitis, rectal prolapse, and rectal ulcer.

■ In ill-appearing older children with UGI tract hemorrhage, the most common causes are esophageal varices and hemorrhagic gastritis. In well-appearing older children with UGI tract hemorrhage and a high rate of bleeding, the most common causes of bleeding are esophageal varices, ulcers, Dieulafoy lesion (an abnormally large, tortuous artery in the gastric submucosa that erodes through the mucosa), and hemobilia. In well-appearing older children with UGI tract hemorrhage and a low rate of bleeding, the most common causes of bleeding are Mallory-Weiss tear, reflux esophagitis, and reactive gastritis. In ill-appearing older children with LGI tract hemorrhage, the most common causes are infectious colitis, UC/Crohn disease, Henoch-Schönlein purpura, and intestinal ischemia. In well-appearing older children with LGI tract hemorrhage and a high rate of bleeding, the most common causes are UC and Meckel diverticulum. In well-appearing children with LGI tract hemorrhage and a low rate of bleeding, the most common causes are infectious colitis, UC/Crohn disease, juvenile polyp, and hemorrhoids.

Other important potential causes of LGIB that are independent of age include coagulopathy, vascular malformations, enteric duplication cysts, trauma (accidental and nonaccidental), and iatrogenic. It is also important to note that melena and hematochezia can both be a result of UGIB, with hematochezia in this setting typically a result of brisk UGIB.

The initial clinical evaluation of patients with GIB includes thorough history, physical examination with an assessment of hemodynamic stability, and resuscitation when necessary. This should be followed by laboratory evaluation tailored to the most likely causes of bleeding in a given clinical scenario, typically including complete blood count, coagulation panel, and type and cross match in the event transfusion is required during resuscitation. Imaging tests can be helpful in certain clinical settings, which will be discussed in more detail to follow. Endoscopy is often indicated for UGIB and LGIB and can be both diagnostic and therapeutic. Further discussion regarding the specific clinical indications for endoscopic diagnosis and treatment is outside the scope of this document.

Special Imaging Considerations

To increase the diagnostic sensitivity of a pertechnetate (Meckel) scan, the patient should fast for 3 to 4 hours before imaging. Pretreatment with histamine H2 blockers, proton pump inhibitors (to reduce gastric secretion and improve tracer uptake in ectopic gastric mucosa), or rarely, glucagon, is highly recommended [6]. The addition of single-photon emission CT (SPECT) or SPECT/CT can

be helpful in cases with high clinical suspicion and negative, equivocal, or atypical findings on planar imaging [6]. The use of SPECT or SPECT/CT increases imaging time resulting in the potential need for patient sedation with its inherent risks. Thus, judicious use of SPECT and SPECT/CT, tailored to each individual case, is an important technical consideration [6].

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) [7]:

“CTA uses a thin-section CT acquisition that is timed to coincide with peak arterial and/or venous enhancement, depending on the vascular structures to be analyzed. The resultant volumetric data set 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.

CTA shows high diagnostic accuracy in the adult population [8]. CTA can be a useful tool for evaluation of patients with persistent or severe GIB in whom the etiology is unclear after thorough clinical evaluation or after negative or failed endoscopic evaluation. CTA can detect bleeding at rates as low as 0.3 mL/min [8]. When positive for GIB, CTA can increase positive yield on visceral angiography. Detection rates with CTA increase when patients have evidence of severe bleeding, hemodynamic instability, or transfusion requirement of at least 4 units in 24 hours [9,10].

Dual-energy CT can provide enhanced-diagnostic information and facilitate faster scans [11]. With dual-energy CT, virtual noncontrast images can replace a true noncontrast acquisition [12]. Because the virtual noncontrast images are derived from the contrast-enhanced data set, these images are 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 [13].

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 wherein each procedure provides unique clinical information to effectively manage the patient's care).

DISCUSSION OF PROCEDURES BY VARIANT

Variant 1: Child. Hematemesis. Initial imaging

The goal of imaging is to diagnose and localize the site of hemorrhage in children with hematemesis. This imaging information improves patient outcomes by allowing timely, targeted treatment of bleeding. Imaging, therefore, benefits the patient by reducing delay in treatment and hastening recovery.

Esophagogastroduodenoscopy (EGD) is often considered the first-line diagnostic procedure of choice for UGIB, and the site and the cause of bleeding can be identified in 85% to 90% of the patients [1]. Endoscopy is also potentially therapeutic and generally should not be delayed to obtain radiologic imaging. Furthermore, second-look endoscopy may be indicated if the initial endoscopy was negative or if imaging studies fail to elucidate an etiology for bleeding.

Careful reassessment is especially important in patients with hemodynamic instability or continued transfusion requirements despite negative imaging results. Full discussion of EGD is beyond the scope of this document. There is little role for imaging studies in the setting of UGIB with a few exceptions including suspected ingested foreign body [14], or when upper endoscopy is not feasible or yields inconclusive results [10]. It is important to note that evaluation of GIB associated specifically with button battery ingestion is outside the scope of this document (see the ACR Appropriateness Criteria[®] topic on "Ingested or Aspirated Foreign Body-Child" [15]). Any imaging studies requested should focus on the most likely etiology of bleeding for a given patient (please refer to the Introduction/Background section for a list of the most common etiologies based on age and clinical severity). This variant is applicable to a clinical scenario in which a patient presents with hematemesis and upper endoscopy was not or could not be performed for clinical reasons, or endoscopy was performed and was negative.

Radiography Chest. Despite a paucity of evidence to support its use, a chest radiograph (usually in combination with an abdominal radiograph) is often the first imaging study obtained in infants and children presenting with hematemesis. Chest radiography may be indicated if there is

clinical suspicion for ingested foreign body causing hematemesis, but otherwise has little role in the evaluation of hematemesis.

Radiography Abdomen. Despite a paucity of evidence to support its use, an abdominal radiograph (usually in combination with a chest radiograph) is often the first imaging study obtained in infants and children presenting with hematemesis. Abdominal radiography may be indicated if there is clinical suspicion for ingested foreign body causing hematemesis, but otherwise has little role in the evaluation of hematemesis.

CTA Abdomen Without and With IV Contrast. In adults, CTA has potential for use in the evaluation of UGIB after failed or nondiagnostic endoscopy [10]. CTA can detect bleeding at rates as low as 0.3 mL/min [8]. Detection rates with CTA increase when patients have evidence of severe bleeding, hemodynamic instability, or transfusion requirement of at least 4 units in 24 hours [10]. Some common causes of bleeding in the esophagus and UGI tract, such as peptic ulcer disease, cannot be optimally evaluated with CT. If no active extravasation is observed, CTA may still suggest a source of bleed via location of intraabdominal hematoma, mass, or vascular abnormality. The usefulness of CTA for evaluation of GIB in adults is well established, with clear guidance on indications and technique based on multiple society consensus guidelines and strong evidence. Unfortunately, pediatric-specific literature regarding the use of CTA abdomen and pelvis with IV contrast is less robust and pediatric clinical practice is based on extrapolation of the adult literature supplemented by pediatric case reports and small case series [16].

US Abdomen. There is no relevant contemporary pediatric literature supporting the use of ultrasound (US) abdomen in the setting of hematemesis. However, many centers will perform abdominal US with Doppler to evaluate for signs of portal hypertension if variceal bleeding is suspected.

MRA Abdomen and Pelvis Without and With IV Contrast. With only a single pediatric case report on the use of MR angiography (MRA) with blood pool contrast agent in the setting of acute UGIB [17], there is limited evidence to support the use of MRA in the setting of acute GIB given its lower spatial resolution compared with CTA, artifact from bowel peristalsis, and long acquisition time [18].

MRA Chest Abdomen Pelvis Without and With IV Contrast. With only a single pediatric case report on the use of MRA with blood pool contrast agent in the setting of acute UGIB [17], there is limited evidence to

support the use of MRA in the setting of acute GIB given its lower spatial resolution compared with CTA, artifact from bowel peristalsis, and long acquisition time [18].

CT Abdomen and Pelvis With IV Contrast. There is no relevant pediatric literature supporting the use of CT abdomen and pelvis with intravenous (IV) contrast in the setting of hematemesis. Some common causes of bleeding in the esophagus and UGI tract, such as peptic ulcer disease, can occasionally be identified, but are not optimally evaluated with CT.

CT Abdomen and Pelvis Without IV Contrast. There is no relevant pediatric literature supporting the use of CT abdomen and pelvis without IV contrast in the setting of hematemesis.

CT Chest With IV Contrast. There is no relevant pediatric literature supporting the use of CT chest with IV contrast in the setting of hematemesis. Some common causes of bleeding in the esophagus and UGI tract, such as peptic ulcer disease, can occasionally be identified, but are not optimally evaluated with CT.

CT Chest Without and With IV Contrast. There is no relevant pediatric literature supporting the use of CT chest without and with IV contrast in the setting of hematemesis. Some common causes of bleeding in the esophagus and UGI tract, such as peptic ulcer disease, can occasionally be identified, but are not optimally evaluated with CT.

CT Chest Without IV Contrast. There is no relevant pediatric literature supporting the use of CT chest without IV contrast in the setting of hematemesis.

CTA Abdomen With IV Contrast. There is no relevant pediatric literature supporting the use of CTA abdomen with IV contrast only, aside from dual-energy CT, which allows for the generation of virtual noncontrast images from a CTA data set. Limited pediatric literature primarily reflects studies including CTA examinations without and with IV contrast.

CTA Chest With IV Contrast. There is no relevant pediatric literature supporting the use of CTA chest with IV contrast only, aside from dual-energy CT, which allows for the generation of virtual noncontrast images from a CTA data set. Limited pediatric literature primarily reflects studies including CTA examinations without and with IV contrast.

CTA Chest Without and With IV Contrast. In adults, CTA has potential for use in the evaluation of UGIB after failed or nondiagnostic endoscopy [10,19,20]. CTA can detect bleeding at rates as low as 0.3 mL/min [8]. Detection rates with CTA increase when patients have

evidence of severe bleeding, hemodynamic instability, or transfusion requirement of at least 4 units in 24 hours [10]. Some common causes of bleeding in the esophagus and UGI tract, such as peptic ulcer disease, cannot be optimally evaluated with CT. If no active extravasation is observed, CTA may still suggest a source of bleed via location of intraabdominal hematoma, mass, or vascular abnormality. The usefulness of CTA for evaluation of GIB in adults is well established with clear guidance on indications and technique based on multiple society consensus guidelines and strong evidence. Pediatric-specific literature regarding the use of CTA abdomen and pelvis with IV contrast is less robust and pediatric clinical practice is based on extrapolation of the adult literature supplemented by pediatric case reports and small case series [16]. Due to a paucity of evidence for CTA chest in children combined with practice expertise, the panel determined that CTA of the chest is usually not an appropriate initial imaging study in the setting of hematemesis.

RBC Scan Abdomen and Pelvis. There is limited evidence to support the use of a Tc-99m red blood cell (RBC) scan in the setting of hematemesis. Radionuclide scintigraphy has a false localization rate of approximately 22%, which limits its value as a diagnostic test, and the diagnostic sensitivity of the scans in a retrospective study was 39.1% [21]. These forms of scintigraphy may be helpful in risk-stratifying patients and planning radiological and surgical interventions [1], but are usually not appropriate as the initial imaging study in the setting of hematemesis.

RBC Scan With SPECT or SPECT/CT Abdomen and Pelvis. There is limited evidence to support use of a Tc-99m RBC scan with SPECT or SPECT/CT in the setting of hematemesis. However, the addition of SPECT or SPECT/CT can help in localizing the source of bleeding in a positive study [22], but is usually not appropriate as the initial imaging study in the setting of hematemesis.

CT Abdomen and Pelvis Without and With IV Contrast. There is no relevant pediatric literature supporting the use of CT abdomen and pelvis without and with IV contrast in the setting of hematemesis. Some common causes of bleeding in the esophagus and UGI tract, such as peptic ulcer disease, can occasionally be identified, but are not optimally evaluated with contrast-enhanced CT.

CT Chest Abdomen Pelvis With IV Contrast. There is no relevant pediatric literature supporting the use of CT chest, abdomen, and pelvis with IV contrast in the setting of hematemesis. Some common causes of bleeding in the esophagus and UGI tract, such as peptic ulcer disease, can occasionally be identified, but are not optimally evaluated with contrast-enhanced CT.

CT Chest Abdomen Pelvis Without and With IV Contrast. There is no relevant pediatric literature supporting the use of CT chest, abdomen, and pelvis without and with IV contrast. Some common causes of bleeding in the esophagus and UGI tract, such as peptic ulcer disease, can occasionally be identified, but are not optimally evaluated with contrast-enhanced CT.

CT Chest Abdomen Pelvis Without IV Contrast. There is no relevant pediatric literature supporting the use of CT chest, abdomen, and pelvis without IV contrast in the setting of hematemesis.

Variant 2: Child. Suspected GI bleed. Melena, or bright red blood per rectum, or positive fecal occult blood test. Stable patient. Initial imaging

LGIB can be acute or chronic. In patients presenting with melena, the origin of bleeding may be anywhere from the UGI or LGI tract. For patients presenting with bright red blood per rectum (BRBPR), bleeding is usually from an LGI source but can be a result of a brisk UGIB. Fortunately, the majority of patients presenting with LGIB have self-limited bleeding [5]. The initial approach to the pediatric patient presenting with melena or BRBPR is determination of hemodynamic stability and adequate resuscitation, when necessary, followed by a thorough clinical examination to determine the most likely etiology. It is also important to determine the severity of bleeding as this will give clues to the most likely etiology based on patient age. The initial diagnostic tests for identification of the bleeding source are typically EGD and colonoscopy, and the decision of which to perform first will depend on the degree of suspicion for an UGI source based on history and/or a positive aspirate for blood from nasogastric tube lavage [2]. Endoscopy EGD and colonoscopy are currently considered the first-line diagnostic procedures of choice for UGIB and LGIB, respectively. Endoscopy is also potentially therapeutic and generally should not be delayed to obtain radiologic imaging. Furthermore, second-look endoscopy may be indicated if the initial endoscopy was negative or if imaging studies fail to elucidate an etiology for bleeding.

Careful reassessment is especially important in patients with hemodynamic instability or continued transfusion requirements despite negative imaging results. Further endoscopy discussion is beyond the scope of this document. In certain clinical scenarios, particularly in the setting of a stable patient with painless bleeding, diagnostic imaging studies may be performed either before or after endoscopy to help establish a diagnosis and guide treatment. Any imaging studies requested should focus on the most likely etiology of bleeding for a given patient (please refer to the Introduction/

Background section for a list of the most common etiologies based on age and clinical severity). This variant is applicable to a clinical scenario in which a patient presents with melena, BRBPR, or positive fecal occult blood test (FOBT) and endoscopy was not or could not be performed for clinical reasons, or endoscopy was performed and was negative.

Radiography Abdomen. Although there is no relevant pediatric literature to support the use of abdominal radiography for patients presenting with GIB, it is often one of the first imaging studies ordered for patients presenting to the emergency department. Most causes of GIB cannot be sufficiently imaged with abdominal radiographs alone, although there are some radiographic signs that can point to possible diagnoses. An abdominal radiograph may be indicated if there is clinical suspicion for ingested foreign body causing melena, BRBPR, or positive FOBT, especially if there is associated dysphagia [3]. Abdominal radiography is also indicated for infants with acute hematochezia to evaluate for intestinal obstruction and pneumatosis intestinalis related to necrotizing enterocolitis, and for older children with inflammatory bowel disease to evaluate for toxic megacolon.

US Abdomen. Sonographic evaluation of the abdomen can be useful in certain patients presenting with GIB, particularly those with suspected intussusception [23]. Although US is not intended to replace endoscopy in the diagnostic workup of intestinal polyps in young patients, it can play an important role in the detection of intestinal polyps, and a specific diagnosis is possible in many cases, as most polyps have a characteristic appearance [24]. Sonographic findings for a variety of diseases that can present with GIB in children have been described, but US is rarely considered the first-line diagnostic imaging modality in the setting of GIB unless intussusception is suspected. There is also emerging evidence to support abdominal US in the evaluation of suspected malrotation and volvulus, which can present with GIB [25]. It is also important to include color and spectral Doppler evaluation of the portal circulation to evaluate for signs of portal hypertension if variceal bleed is suspected.

Pertechnetate Scan Abdomen and Pelvis. Meckel diverticulum is a common enough diagnosis that a Tc-99m pertechnetate (Meckel) scan should be considered early in the workup of a well-appearing patient with moderate to severe bleeding when there is reasonable clinical suspicion for Meckel diverticulum, usually prior to endoscopy. In the pediatric population, pertechnetate scan has an accuracy of 90%, and sensitivity and specificity of up to 100% when properly performed [6,26]. A pertechnetate scan is the initial modality of choice for evaluating children with unexplained intermittent LGIB after excluding systemic and local causes of LGIB, and

when complicated Meckel diverticulum is suspected [6]. Perchnetate scintigraphy is seldom of value in children with no history of rectal bleeding [26]. Repeat perchnetate scans in patients with equivocal findings on the first study or a negative result with a high clinical suspicion for Meckel diverticulum are useful especially in cases in which the first study had been done without appropriate preparation (see the Special Imaging Considerations section) [27]. Final disagreement rating centered upon discussion of initial versus follow-up imaging steps without unequivocal literature on optimal sequencing.

Perchnetate Scan With SPECT or SPECT/CT Abdomen and Pelvis. The addition of SPECT to a perchnetate scan can be helpful in cases with high clinical suspicion and negative, equivocal, or atypical findings on planar images, or when a distended urinary bladder might obscure a Meckel diverticulum. A simultaneously acquired low-dose CT scan (SPECT/CT) helps co-register SPECT finding to anatomical structures, thus increasing diagnostic accuracy [6]. Final disagreement rating centered upon discussion of initial versus follow-up imaging steps without unequivocal literature on optimal sequencing.

RBC Scan Abdomen and Pelvis. The Tc-99m RBC scan is a sensitive, but nonspecific, method for detecting GIB that is often considered as a second-line test when other diagnostic imaging tests are negative, but can be considered as a first-line imaging study to localize bleeding in patients with ongoing bleeding and negative endoscopy. The location of a lesion as indicated by a positive scan within 2 hours is helpful for guiding surgical intervention and angiography, although a definitive diagnosis should be made with other methods, particularly laparotomy [21]. Delayed imaging is important when evaluating GIB with a Tc-99m RBC scan, and one of the main advantages of using Tc-99m RBC scan is that doing so permits visualization of GIB over the course of several hours. Bleeding rates as low as 0.1 mL/min to 0.4 mL/min may be detected [28]. Final disagreement rating centered upon discussion of initial versus follow-up imaging steps without unequivocal literature on optimal sequencing.

RBC Scan With SPECT or SPECT/CT Abdomen and Pelvis. The Tc-99m RBC scan with the addition of SPECT with multiplanar reconstruction may yield more accurate localization of a GIB site [22]. The addition of SPECT/CT to RBC scan can be helpful in the setting of slow GIB, and to clarify mimics of GIB on planar imaging. However, no data exist on the use of SPECT/CT when planar GIB scintigraphy shows no evidence of GIB [22].

CTA Abdomen and Pelvis With IV Contrast. A meta-analysis of data from 672 adults with acute GIB revealed an

overall sensitivity of 83% and a specificity of 92% for detecting the bleeding site. The detection rates with CTA increase when patients have evidence of severe bleeding or hemodynamic instability [8,10,29]. CTA is more sensitive than fluoroscopic angiography for detection of active extravasation but less sensitive than RBC scanning, being able to depict bleeding at a rate of 0.3 to 0.5 mL/min [10]. If no active extravasation is observed, CTA can be performed to detect bowel wall disease such as intraabdominal hematoma, mass, or vascular malformations [30]. However, compared with multiphase CT enterography (CTE), it is relatively limited in the assessment of the bowel wall and intraluminal contents [10]. The usefulness of CTA for evaluation of GIB in adults is well established, with clear guidance on indications and technique based on multiple society consensus guidelines and strong evidence, almost all of which recommend CTA without and with IV contrast [31]. Unfortunately, pediatric-specific literature regarding the use of CTA abdomen and pelvis with IV contrast as a first-line imaging study is less robust and pediatric clinical practice is based on extrapolation of the adult literature supplemented by pediatric case reports and small case series [16]. Final disagreement rating primarily centered upon discussion of initial versus follow-up imaging steps without unequivocal literature on optimal sequencing as well as single arterial versus two phase (with noncontrast) CTA.

CTA Abdomen and Pelvis Without and With IV Contrast. A meta-analysis of data from 672 adults with acute GIB revealed an overall sensitivity of 83% and a specificity of 92% for detecting the bleeding site. The detection rates with CTA increase when patients have evidence of severe bleeding or hemodynamic instability [8,10,29]. CTA is more sensitive than fluoroscopic angiography for detection of active extravasation but less sensitive than RBC scanning, being able to depict bleeding at a rate of 0.3 to 0.5 mL/min [10]. If no active extravasation is observed, CTA can be performed to detect bowel wall disease such as intraabdominal hematoma, mass, or vascular malformations [30]. However, compared with multiphase CTE, it is relatively limited in the assessment of the bowel wall and intraluminal contents [10]. The usefulness of CTA for evaluation of GIB in adults is well established with clear guidance on indications and technique based on multiple society consensus guidelines and strong evidence, almost all of which recommend CTA without and with IV contrast [31]. Unfortunately, pediatric-specific literature regarding the use of CTA abdomen and pelvis without and with IV contrast as a first-line imaging study is less robust and pediatric clinical practice is based on extrapolation of the adult literature supplemented by pediatric case reports and small case series [16]. Final disagreement rating primarily centered upon discussion of initial versus follow-up imaging steps without unequivocal literature on

optimal sequencing as well as single arterial versus two phase (with noncontrast) CTA.

MRA Abdomen and Pelvis Without and With IV Contrast. MRA is an emerging imaging option in pediatrics, but there are currently very little data on its use in the setting of GIB. One study in pediatric patients concluded that MRA is a safe and accurate imaging modality in the evaluation of pediatric LGIB, and its diagnostic capability is comparable to current evidence for capsule endoscopy in this patient group [32]. For chronic or obscure GIB, bleeding due to portal hypertension, or suspected vascular malformation, MRA has been used for evaluation with varying levels of evidence to support its use [18,33]. However, with only a small adult case series and single pediatric case report on the use of MRA with blood pool contrast agent in the setting of acute GIB [17], there is no strong evidence to support the use of MRA in the setting of acute GIB given its lower spatial resolution compared with CTA, artifact from bowel peristalsis, and long acquisition time [18].

CT Abdomen and Pelvis With IV Contrast. There is no relevant pediatric literature supporting the use of CT abdomen and pelvis with IV contrast. Some common causes of bleeding in the esophagus and UGI tract, such as peptic ulcer disease, can occasionally be identified, but are not optimally evaluated with CT.

CT Abdomen and Pelvis Without IV Contrast. There is no relevant pediatric literature supporting the use of CT abdomen and pelvis without IV contrast. Noncontrast CT can occasionally show hyperdense material in the bowel lumen in the setting of GIB. However, the primary role for noncontrast CT is as part of a multiphase CTA examination to identify and differentiate hyperattenuating material existing in the bowel lumen prior to contrast administration, which decreases false-positive CTA examinations.

CT Abdomen and Pelvis Without and With IV Contrast. There is no relevant pediatric literature supporting the use of CT abdomen and pelvis without and with IV contrast. The addition of a noncontrast phase to a standard portal venous phase CT scan does little to increase accuracy of this imaging study in the setting of melena, BRBPR, or positive FOBT. Some common causes of bleeding in the esophagus and UGI tract, such as peptic ulcer disease, can occasionally be identified, but are not optimally evaluated with CT.

Variant 3: Child. Suspected GI bleed. Melena, or bright red blood per rectum, or positive fecal occult blood test. Stable patient. Initial imaging negative. Next imaging study

The goal of imaging is to diagnose and localize the site of hemorrhage in children with suspected GIB for whom

initial imaging is negative or inconclusive. This imaging information improves patient outcomes by allowing timely, targeted treatment of bleeding. Imaging information benefits the patient by reducing delay in treatment and hastening recovery.

LGIB can be acute or chronic. In patients presenting with melena, the origin of bleeding may be anywhere from the UGI or LGI tract. For patients presenting with BRBPR, bleeding is usually from an LGI source but can be a result of a brisk UGIB. The initial approach to the pediatric patient presenting with melena or BRBPR is determination of hemodynamic stability and adequate resuscitation, when necessary, followed by a thorough clinical examination to determine the most likely etiology. It is also important to determine the severity of bleeding as this will give clues to the most likely etiology based on patient age. The initial diagnostic tests for identification of the bleeding source are typically EGD and colonoscopy, and the decision of which to perform first will depend on the degree of suspicion for an UGI source based on history and/or a positive aspirate for blood from nasogastric tube lavage [2]. Endoscopy EGD and colonoscopy are currently considered the first-line diagnostic procedures of choice for UGIB and LGIB, respectively. Endoscopy is also potentially therapeutic and generally should not be delayed to obtain radiologic imaging. Furthermore, second-look endoscopy may be indicated if the initial endoscopy was negative or if imaging studies fail to elucidate an etiology for bleeding.

Careful reassessment is especially important in patients with hemodynamic instability or continued transfusion requirements despite negative imaging results. Further endoscopy discussion is beyond the scope of this document. In certain clinical scenarios, particularly in the setting of a stable patient with painless bleeding, diagnostic imaging studies may be performed either before or after endoscopy to help establish a diagnosis and guide treatment. Any imaging studies requested after initial negative imaging should focus on the most likely etiology of bleeding for a given patient (please refer to the Introduction/Background section for a list of the most common etiologies based on age and clinical severity). This variant is applicable to a clinical scenario in which a patient presents with melena, BRBPR, or positive FOBT and initial imaging was either negative or showed findings that require additional imaging and/or image-guided therapy.

Pertechnetate Scan Abdomen and Pelvis. Meckel diverticulum is a common enough diagnosis that a Tc-99m pertechnetate (Meckel) scan should be considered early in the workup of a well-appearing patient with moderate to severe bleeding, usually prior to endoscopy. In the pediatric population, pertechnetate scan has an accuracy of 90%, and

sensitivity and specificity of up to 100% when properly performed [6,26]. A pertechnetate scan is the initial modality of choice for evaluating children with unexplained intermittent LGIB after excluding systemic and local causes of LGIB, and when complicated Meckel diverticulum is suspected [6]. Pertechnetate scintigraphy is seldom of value in children with no history of rectal bleeding [26]. Repeat Tc-99m pertechnetate (Meckel) scan in patients with equivocal findings on the first study or a negative result with a high clinical suspicion for Meckel diverticulum are useful especially in cases in which the first study had been done without appropriate preparation [27].

Pertechnetate Scan With SPECT or SPECT/CT Abdomen and Pelvis. The addition of SPECT to a pertechnetate scan can be helpful to localize bleeding and is usually appropriate in cases with high clinical suspicion and negative, equivocal, or atypical findings on planar (standard 2-D) images, or when a distended urinary bladder might obscure a Meckel diverticulum. A simultaneously acquired low-dose CT scan (SPECT/CT) helps co-register SPECT finding to anatomical structures, thus increasing diagnostic accuracy [6].

RBC Scan Abdomen and Pelvis. The Tc-99m RBC scan is a sensitive, but nonspecific, method for detecting GIB that is considered usually appropriate as a second-line test when other diagnostic imaging tests are negative. The location of a lesion as indicated by a positive scan within 2 hours is helpful for guiding surgical intervention and angiography, although a definitive diagnosis should be made with other methods, particularly laparotomy [21]. Delayed imaging is important when evaluating GIB with Tc-99m RBC scan, and one of the main advantages of using 99mTc RBCs is that doing so permits visualization of GIB over the course of several hours. Bleeding rates as low as 0.1 mL/min to 0.4 mL/min may be detected [28].

RBC Scan With SPECT or SPECT/CT Abdomen and Pelvis. The Tc-99m RBC scan with the addition of SPECT with multiplanar reconstruction may yield more accurate localization of a GIB site [22], and the addition of SPECT/CT to RBC scan can be helpful in the setting of slow GIB, and to clarify mimics of GIB on planar imaging. Both of these adjuncts to planar (standard 2-D) imaging are usually appropriate as second-line imaging studies in the setting of suspected GIB. However, no data exist on the use of SPECT/CT when planar (standard 2-D) GIB scintigraphy shows no evidence of GIB [22].

US Abdomen. Sonographic evaluation of the abdomen can be useful in certain patients presenting with GIB, particularly those with suspected intussusception [23]. Although US is not intended to replace endoscopy in the

diagnostic workup of intestinal polyps in young patients, it can play an important role in the detection of intestinal polyps, and a specific diagnosis is possible in many cases, as most polyps have a characteristic appearance [24]. Sonographic findings for a variety of diseases that can present with GIB in children have been described, but US is rarely considered the first-line diagnostic imaging modality in the setting of GIB unless intussusception is suspected. There is also emerging evidence to support abdominal US in the evaluation of suspected malrotation and volvulus, which can present with GIB [25]. It is also important to include color and spectral Doppler evaluation of the portal circulation to evaluate for signs of portal hypertension if variceal bleed is suspected.

Arteriography Visceral. Angiographic diagnosis and therapy for GIB has been reviewed extensively in adults, but there is a paucity of data on pediatric experience in this setting. The benefit of angiography for GIB is that it can be both diagnostic and therapeutic in the form of embolotherapy [34]. Although angiography is often not considered a first-line test with regard to diagnosis in the setting of UGIB or LGIB in pediatric patients, it is being considered earlier in the course of disease as a therapeutic option when bleeding is identified on other imaging studies. Angiography alone as a method of diagnosis and localization of GIB is typically not indicated as there are other noninvasive imaging studies that are more sensitive. Angiography can reportedly detect GIB at rates as low as 0.5 mL/min with proper technique. However, a pediatric study from the 1980s suggested that the bleeding rate required for detection on angiography rate might be higher in children, and in their study, bleeding was rarely identified unless there was difficulty keeping up with the patient's blood loss [35]. A major challenge for pediatric angiography is patient and vessel size, with risk of vascular access site and other vascular complications increasing in smaller patients. Technological advances in the field of interventional radiology have helped mitigate some of these risks. When bleeding is identified angiographically, several methods for transarterial embolization can be employed for treatment, although further discussion of embolotherapy is beyond the scope of this document. Visceral angiography can be diagnostic and potentially therapeutic, and was rated as may be appropriate, but with disagreement among panel members due to a relative paucity of pediatric evidence.

MR Enterography. There is limited literature supporting the use of MR enterography in the setting of obscure GIB in children (defined as patients not found to have a source of bleeding after performing upper and lower endoscopy, small bowel evaluation with video capsule endoscopy or enteroscopy and radiographic evaluation), without additional

suspicion of Crohn disease (see the ACR Appropriateness Criteria[®] topic on “Crohn Disease-Child” [36] for further guidance). One study by Casciani et al [32] reported that MR enterography is safe and accurate in the evaluation of pediatric occult GIB with diagnostic capability comparable to capsule endoscopy in this patient group.

MRA Abdomen and Pelvis Without and With IV Contrast. MRA is an emerging imaging option in pediatrics. Advances in MR imaging equipment and techniques have made MRA a viable alternative to CT for cross-sectional evaluation, but there are currently very little data on its use in pediatric GIB. One study in pediatric patients concluded that MRA is a safe and accurate imaging modality in the evaluation of pediatric LGIB, and its diagnostic capability is comparable to current evidence for capsule endoscopy in this patient group [32]. For chronic or obscure GIB, bleeding due to portal hypertension, or suspected vascular malformation, MRA has been used for evaluation with varying levels of evidence to support its use [18,33]. However, with only a small adult case series and single pediatric case report on the use of MRA with blood pool contrast agent in the setting of acute GIB [17], there is no strong evidence to support the use of MRA in the setting of acute GIB given its lower spatial resolution compared with CTA, artifact from bowel peristalsis, and long acquisition time [18].

CT Enterography. Although CTE has been studied for evaluation of GIB in adults, typically as a second-line modality, there is a paucity of pediatric literature supporting the use of CTE in the absence of additional suspicion for inflammatory bowel disease. One study of CTE in six pediatric patients was too small to calculate sensitivity, specificity, and positive predictive value, but CTE was able to identify pathology despite negative US in all six patients and negative pertechnetate (Meckel) scans in five of six patients [37].

CTA Abdomen and Pelvis With IV Contrast. A meta-analysis of data from 672 adults with acute GIB revealed an overall sensitivity of 83% and a specificity of 92% for detecting the bleeding site. The detection rates with CTA increase when patients have evidence of severe bleeding or hemodynamic instability [8,10,29]. CTA is more sensitive than fluoroscopic angiography for detection of active extravasation but less sensitive than RBC scanning, being able to depict bleeding at a rate of 0.3 to 0.5 mL/min [10]. If no active extravasation is observed, CTA can be performed to detect bowel wall disease such as intraabdominal hematoma, mass, or vascular malformations [30]. However, compared with multiphase CTE, it is relatively limited in the assessment of the bowel wall and intraluminal contents [10]. There is a paucity of pediatric literature supporting the use of CTA

abdomen and pelvis with IV contrast aside from case reports and small case series [16]. The usefulness of CTA for evaluation of GIB in adults is well established with clear guidance on indications and technique based on multiple society consensus guidelines and strong evidence, almost all of which recommend CTA without and with IV contrast [31]. Unfortunately, pediatric-specific literature regarding the use of CTA abdomen and pelvis with IV contrast as a second-line imaging study when initial imaging was negative is less robust and pediatric clinical practice is based on extrapolation of the adult literature supplemented by pediatric case reports and small case series [16].

CTA Abdomen and Pelvis Without and With IV Contrast. A meta-analysis of data from 672 adults with acute GIB revealed an overall sensitivity of 83% and a specificity of 92% for detecting the bleeding site. The detection rates with CTA increase when patients have evidence of severe bleeding or hemodynamic instability [8,10,29]. CTA is more sensitive than fluoroscopic angiography for detection of active extravasation but less sensitive than RBC scanning, being able to depict bleeding at a rate of 0.3 to 0.5 mL/min [10]. If no active extravasation is observed, CTA can be performed to detect bowel wall disease such as intraabdominal hematoma, mass, or vascular malformations [30]. However, compared with multiphase CTE, it is relatively limited in the assessment of the bowel wall and intraluminal contents [10]. There is a paucity of pediatric literature supporting the use of CTA abdomen and pelvis without and with IV contrast aside from case reports and small case series [16]. The usefulness of CTA for evaluation of GIB in adults is well established with clear guidance on indications and technique based on multiple society consensus guidelines and strong evidence, almost all of which recommend CTA without and with IV contrast [31]. Unfortunately, pediatric-specific literature regarding the use of CTA abdomen and pelvis without and with IV contrast as a second-line imaging study when initial imaging was negative is less robust and pediatric clinical practice is based on extrapolation of the adult literature supplemented by pediatric case reports and small case series [16]. Final disagreement rating primarily centered upon discussion of single arterial versus two phase CTA (including noncontrast) in absence of unequivocal pediatric focused literature.

Arteriography Abdomen and Pelvis. There is no relevant pediatric literature supporting the use of arteriography abdomen and pelvis in children in the setting of acute GIB in stable patients.

Arteriography Chest Abdomen Pelvis. There is no relevant pediatric literature supporting the use of arteriography

chest, abdomen, and pelvis in children in the setting of acute GIB in stable patients.

CT Abdomen and Pelvis With IV Contrast. There is no relevant pediatric literature supporting the use of CT abdomen and pelvis with IV contrast as the next imaging study in children in the setting of acute GIB in stable patients when initial imaging was negative.

CT Abdomen and Pelvis Without IV Contrast. There is no relevant pediatric literature supporting the use of CT abdomen and pelvis without IV contrast as the next imaging study in children in the setting of acute GIB in stable patients when initial imaging was negative.

CT Abdomen and Pelvis Without and With IV Contrast. There is no relevant pediatric literature supporting the use of CT abdomen and pelvis without and with IV contrast as the next imaging study in children in the setting of acute GIB in stable patients when initial imaging was negative.

Variant 4: Child. Suspected GI bleed. Melena, or bright red blood per rectum, or positive fecal occult blood test. Unstable patient. Initial imaging

The goal of imaging is to diagnose and localize the site of hemorrhage in children with suspected GIB who are clinically unstable (tachycardia, hypotension). This imaging information improves patient outcomes by allowing timely, targeted treatment of bleeding. Imaging information benefits the patient by reducing delay in treatment and hastening recovery.

LGIB can be acute or chronic. In patients presenting with melena, the origin of bleeding may be anywhere from the UGI or LGI tract. For patients presenting with BRBPR, bleeding is usually from an LGI source but can be a result of a brisk UGIB [5]. Endoscopy EGD and colonoscopy are currently considered the first-line diagnostic procedures of choice for UGIB and LGIB, respectively. The site and the cause of bleeding can be identified in 85% to 90% of the patients [1].

Further discussion of endoscopy is beyond the scope of this document. In certain clinical scenarios, particularly in the setting of an unstable patient, urgent surgical intervention may be warranted without antecedent imaging to guide the surgical approach. When feasible, urgent/emergent diagnostic imaging studies may be performed to help establish a diagnosis and guide treatment. Any imaging studies requested should focus on the most likely etiology of bleeding for a given patient (please refer to the Introduction/Background section for a list of the most common etiologies based on age and clinical severity).

This variant is applicable to a clinical scenario in which a patient presents with melena, BRBPR, or positive FOBT and is too unstable to proceed to endoscopy. Depending on the degree of clinical instability and the response to resuscitation, the patient may proceed directly to surgery without antecedent imaging.

CTA Abdomen and Pelvis Without and With IV Contrast. CTA can detect bleeding at a rate as slow as 0.3 mL/min. CTA can also detect vascular malformations and masses, with limitations in assessing the bowel wall and intraluminal contents compared with CTE [29]. A meta-analysis of data from 672 adults with acute GIB revealed an overall sensitivity of 83% and a specificity of 92% for detecting the bleeding site. The detection rates with CTA increase when patients have evidence of severe bleeding or hemodynamic instability [8,10,29]. The usefulness of CTA for evaluation of GIB in adults is well established with clear guidance on indications and technique based on multiple society consensus guidelines and strong evidence, almost all of which recommend CTA without and with IV contrast [31]. Unfortunately, pediatric-specific literature regarding the use of CTA abdomen and pelvis without and with IV contrast as a first-line imaging study in unstable patients is less robust and pediatric clinical practice is based extrapolation of the adult literature supplemented by pediatric case reports and small case series [16]. CTA may be considered as an initial imaging study in an unstable patient to help guide therapy (either emergent surgery or angiography/embolization) depending on the patient's response to initial resuscitation, but in general, endoscopy, angiography, or surgery should not be delayed to obtain imaging in unstable patients.

Radiography Abdomen. Although there is no relevant pediatric literature to support the use of abdominal radiography for patients presenting with GIB, it is often one of the first imaging studies ordered for patients presenting to the emergency department. Most causes of GIB cannot be sufficiently imaged with abdominal radiographs alone, although there are some radiographic signs that can point to possible diagnoses. An abdominal radiograph may be useful if there is clinical suspicion for ingested foreign body causing melena, BRBPR, or positive FOBT, especially if there is associated dysphagia [3]. Abdominal radiography is also indicated for infants with acute hematochezia to evaluate for intestinal obstruction and pneumatosis intestinalis related to necrotizing enterocolitis, and for older children with inflammatory bowel disease to evaluate for toxic megacolon.

Arteriography Visceral. Angiographic diagnosis and therapy for GIB has been reviewed extensively in adults, but there is a paucity of data on pediatric experience in this setting.

Angiography can reportedly detect GIB at rates as low as 0.5 mL/min with proper technique. The benefit of angiography for GIB is that it can be both diagnostic and therapeutic in the form of embolotherapy [34]. Although angiography is often not considered a first-line test with regard to diagnosis in the setting of UGIB or LGIB in pediatric patients, it may be considered earlier in the course of disease as a potentially therapeutic option when patients are too unstable to undergo noninvasive imaging and surgical or endoscopic procedures. Angiography can reportedly detect GIB at rates as low as 0.5 mL/min with proper technique. However, a pediatric study from the 1980s suggested that the bleeding rate required for detection on angiography rate might be higher in children, and in their study, bleeding was rarely identified unless there was difficulty keeping up with the patient's blood loss [35]. A major challenge for pediatric angiography is patient and vessel size, with risk of vascular access site and other vascular complications increasing in smaller patients. Technological advances in the field of interventional radiology have helped mitigate some of these risks. When bleeding is identified angiographically, several methods for transarterial embolization can be employed for treatment, although further discussion of embolotherapy is beyond the scope of this document. Visceral angiography can be diagnostic and potentially therapeutic, and was rated as may be appropriate, but with disagreement among panel members due to a robust paucity of pediatric evidence.

CTA Abdomen and Pelvis With IV Contrast. CTA can detect bleeding at a rate as slow as 0.3 mL/min. CTA can also detect vascular malformations and masses, with limitations in assessing the bowel wall and intraluminal contents compared with CTE [29]. A meta-analysis of data from 672 adults with acute GIB revealed an overall sensitivity of 83% and a specificity of 92% for detecting the bleeding site. The detection rates with CTA increase when patients have evidence of severe bleeding or hemodynamic instability [8,10,29]. The usefulness of CTA for evaluation of GIB in adults is well established with clear guidance on indications and technique based on multiple society consensus guidelines and strong evidence, almost all of which recommend CTA without and with IV contrast [31]. Unfortunately, pediatric-specific literature regarding the use of CTA abdomen and pelvis with IV contrast as a first-line imaging study in unstable patients is less robust and pediatric clinical practice is based extrapolation of the adult literature supplemented by pediatric case reports and small case series [16]. CTA may be considered as an initial imaging study in an unstable patient to help guide therapy (either emergent surgery or angiography/embolization) depending on the patient's response to initial resuscitation, but in general, endoscopy, angiography, or surgery should not be delayed to obtain imaging in unstable patients.

Arteriography Abdomen and Pelvis. There is no relevant pediatric literature supporting the use of arteriography abdomen and pelvis in children in the setting of acute GIB in unstable patients.

Arteriography Chest Abdomen Pelvis. There is no relevant pediatric literature supporting the use of arteriography chest, abdomen, and pelvis in children in the setting of acute GIB in unstable patients.

MRA Abdomen and Pelvis Without and With IV Contrast. There is no relevant pediatric literature supporting the use of MRA abdomen and pelvis without and with IV contrast as an initial imaging study for detection of GIB in hemodynamically unstable children.

CT Abdomen and Pelvis With IV Contrast. There is no relevant pediatric literature supporting the use of CT abdomen and pelvis with IV contrast as an initial imaging study for detection of GIB in hemodynamically unstable children.

CT Abdomen and Pelvis Without IV Contrast. There is no relevant pediatric literature supporting the use of CT abdomen and pelvis without IV contrast as an initial imaging study for detection of GIB in hemodynamically unstable children.

Pertechnetate Scan Abdomen and Pelvis. Tc-99m pertechnetate (Meckel) scan abdomen and pelvis is not useful as an initial imaging study for detection of GIB in hemodynamically unstable children.

Pertechnetate Scan With SPECT or SPECT/CT Abdomen and Pelvis. Tc-99m pertechnetate (Meckel) scan with SPECT or SPECT/CT is not useful as an initial imaging study for detection of GIB in hemodynamically unstable children.

RBC Scan Abdomen and Pelvis. The Tc-99m RBC scan abdomen and pelvis is not useful as an initial imaging study for detection of GIB in hemodynamically unstable children.

RBC Scan With SPECT or SPECT/CT Abdomen and Pelvis. The Tc-99m RBC scan with SPECT or SPECT/CT abdomen and pelvis is not useful as an initial imaging study for detection of GIB in hemodynamically unstable children.

CT Abdomen and Pelvis Without and With IV Contrast. There is no relevant pediatric literature supporting the use of CT abdomen and pelvis without and with IV contrast as an initial imaging study for detection of GIB in hemodynamically unstable children.

SUMMARY OF HIGHLIGHTS

This is a summary of the key recommendations from the variant tables. Refer to the complete narrative document for more information.

- **Variant 1:** For children presenting with hematemesis, no imaging study was rated usually appropriate based on a paucity of evidence regarding imaging in this clinical setting. Though outside the scope of this document, EGD is often considered the first-line diagnostic procedure of choice for patients presenting with UGIB. Radiography of the chest and radiography of the abdomen may be appropriate, particularly in the setting of suspected ingested foreign body. CTA of the abdomen without and with IV contrast may also be appropriate, particularly if EGD was not performed or negative.
- **Variant 2:** For children presenting with suspected GIB indicated by melena, BRBPR, or positive FOBT, only abdominal radiography is considered usually appropriate for initial imaging by the panel, typically in the setting of suspected foreign body ingestion or infants to evaluate for necrotizing enterocolitis. Abdominal US may be appropriate in the setting of suspected intussusception or malrotation/volvulus, and to evaluate for signs of portal hypertension. An RBC scan with or without SPECT may be appropriate as a first-line imaging study to localize bleeding. Tc-99m pertechnetate (Meckel) scan with or without SPECT was rated as may be appropriate, and Tc-99m pertechnetate scan should be considered early in the workup in a child with high clinical suspicion for Meckel diverticulum. CTA of the abdomen and pelvis with IV contrast as well as with and without IV contrast was also rated as may be appropriate.
- **Variant 3:** For children presenting with suspected GIB indicated by melena, BRBPR, or positive FOBT who have negative initial imaging and/or other diagnostic studies, nuclear medicine imaging evaluations including Tc-99m pertechnetate (Meckel) scans and tagged RBC studies without or with the addition of SPECT are usually appropriate as second-line imaging studies. Abdominal US may be appropriate in the setting of suspected intussusception or malrotation/volvulus, and to evaluate for signs of portal hypertension. Cross-sectional imaging including MR enterography, MRA of the abdomen and pelvis, CTE, and CTA of the abdomen and pelvis with IV contrast may be appropriate depending on exact clinical scenario. CTA of the abdomen and pelvis without and with IV contrast was also rated as may be appropriate. Visceral

angiography can be diagnostic and potentially therapeutic, and was rated as may be appropriate, though panel members noted a paucity of pediatric evidence.

- **Variant 4:** For clinically unstable children presenting with suspected GIB indicated by melena, BRBPR, or positive FOBT, from an imaging standpoint, CTA abdomen and pelvis without and with IV contrast is usually appropriate, and CTA abdomen and pelvis with IV contrast may be appropriate, but it is important to remember that imaging should not delay endoscopy or surgery in unstable patients. Visceral angiography may provide a means for diagnosis and treatment of GIB in unstable patients and was rated as 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, please go to the ACR website at <https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Appropriateness-Criteria>.

GENDER EQUALITY AND INCLUSIVITY CLAUSE

The ACR acknowledges the limitations in applying inclusive language when citing research studies that predates the use of the current understanding of language inclusive of diversity in sex, intersex, gender, and gender-diverse people. The data variables regarding sex and gender used in the cited literature will not be changed. However, this guideline will use the terminology and definitions as proposed by the National Institutes of Health [38].

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 [39].

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