10.1148/radiol.232298

Appendix S1

Process for Panel Selection, Document Preparation, and Consensus

In January of 2022 the Executive Committees of SAR and ACG signed a Memorandum of Understanding to collaborate on this project. We elected to limit the collaboration to these two societies given the breadth of expertise in the SAR GI Bleeding DFP and the role of the ACG in the development of the clinical guidelines for gastroenterologists.

The panel members consisted of 18 radiologists from the SAR GI Bleeding Disease-focused Panel (DFP). ACG members included three gastroenterologists who are consultants to the SAR GI Bleeding DFP (N.S., D.M.K., D.H.B.) and 2 ad hoc ACG members (J.A.L., M.L.). The SAR GI Bleeding DFP is a panel of radiologists with expertise and interest in the imaging of GI bleeding. The panel consists of 17 diagnostic radiologists and one interventional radiologist. Consultants to the DFP who are not SAR members consist of one nuclear medicine physician and the above mentioned three gastroenterologists. The ACG Executive Committee nominated the 2 ad hoc ACG members who were subsequently approved by the ACG Board of Trustees.

A virtual kickoff meeting was performed to discuss the goals of the project, to discuss and approve specific topics for inclusion and assignment of tasks. Each member of the panel was assigned to a specific section based on the clinical and academic expertise. One member was designated as the leader for each section. Each section performed a literature review of their topic and prepared a document describing technique, performance, advantages, and limitations. Following review of this document, consensus statements and recommendations were submitted by individual panel members. Initially 44 statements were submitted by members. The panel discussed each submitted recommendation followed by a round of voting using a 4-point scale of agreement (Fig 2) to determine level of consensus. The voting was done electronically and tabulated by the lead who was the only person to see individual responses (J.L.F.). Consensus was considered to be present if there was no or only one block (consensus-minus-one). If a statement received two or more stand-aside votes, further discussion on this statement was performed between the lead and individual(s) to determine the cause for dissent and if revisions could be made which might improve support. If the statement was revised a second round of voting was performed. The absence of a vote was considered acceptance. At the completion of the consensus voting 41 statements were included, with no blocks. There were some stand aside votes as certain members did not feel knowledgeable on certain technique recommendations.

Appendix S2

Overview of GI Bleeding

GI bleeding is the most common GI diagnosis leading to hospitalization within the United States (1). Data compiled from the 2014 National Inpatient Sample showed that a principal discharge diagnosis associated with GI bleeding was associated with over 500,000 hospitalizations, 2.2 million hospital days and $5 billion in direct costs (1). Prompt diagnosis and treatment of GI

bleeding is critical to improving patient outcomes and reducing high health care utilization and costs.

GI bleeding can be characterized by the presumed location of origin. Upper GI bleeding (UGIB) is defined as bleeding that originates from the esophagus, stomach, or duodenum. This accounts for approximately 80% of bleeding events (2). Lower GI bleeding (LGIB) has previously been defined as bleeding that originates distal to the ligament of Treitz but more recently is defined as bleeding distal to the ileocecal valve and throughout the colon. LGIB, depending on its anatomic landmarks, accounts for approximately 15%–30% of all GI bleeding events (3,4). Finally, small bowel, or midgut GI bleeding is defined as bleeding that occurs between the ligament of Treitz to the ileocecal valve and accounts for approximately 5%–10% of GI bleeding events (3,5). Bleeding from the small bowel is often considered the most difficult to diagnose and treat due to its length and accessibility. Small bowel bleeding often occurs in areas that are out of reach from standard endoscopy and colonoscopy, and only potentially accessible by capsule endoscopy and deep enteroscopy (6).

Understanding whether bleeding is overt or occult can help to triage the urgency of diagnostic and potentially therapeutic evaluation. The most common manifestations of overt bleeding are hematemesis, melena, and hematochezia. Hematemesis and melena typically indicate an upper GI source of bleeding whereas hematochezia most often represents a lower GI source. Occult GI bleeding tends to present more slowly over time and often with symptoms of iron deficiency anemia without visualized blood loss in stool. As a result, occult GI bleeding often requires a comprehensive, bidirectional luminal evaluation.

The most common etiology of overt UGIB is peptic ulcer disease (2). LGIB is most often caused by diverticular bleeding, which can be challenging to capture in the acute setting at the time of colonoscopy (4). Small bowel bleeding, both overt and occult, is often caused by angioectasias in older patients but may be related to inflammatory bowel disease in younger patients (3,5). In all cases of overt and occult GI bleeding it is important to exclude a GI malignancy. A recent publication provides a more in-depth review of the imaging findings for many of the GI bleeding etiologies, which is beyond the scope of this document (7).

The treatment of GI bleeding includes close monitoring of hemodynamics, resuscitation with intravenous fluids and blood products as needed, and endoscopic therapy tailored to the presumed etiology of bleeding. Endoscopy is the most effective diagnostic and therapeutic modality for GI bleeding including capsule endoscopy for suspected small bowel bleeding. However, radiologic techniques are frequently used, including CT angiography (CTA), catheter angiography (CA), CT enterography (CTE), magnetic resonance enterography (MRE), nuclear medicine red blood cell scan, and technetium-99 m pertechnetate scintigraphy (Meckel scan) (3,5,6). The decision to perform one test over another depends on the history, physical examination, hemodynamics, clinical manifestation of bleeding and available local expertise.

Appendix S3

Terminology of Cross-sectional Imaging Techniques Used in Imaging GI Bleeding

CTA

CTA is a type of CT where images are acquired while the IV contrast is within the arteries (arterial phase) and postprocessed images are generated to better demonstrate the arterial anatomy. In most cases, images are also acquired during an additional phase such as the portal venous or delayed phase (multiphase).

CTE

CTE is a type of CT where a large volume (1350–1500 mL) of oral contrast is administered to optimize evaluation of the small bowel (8,9). The increased small bowel distension improves visualization of abnormalities. The oral contrast agent has attenuation near water density which improves conspicuity of hyperenhancing lesions which cause GI bleeding. The majority of CTE examinations performed for inflammatory conditions are performed during a single phase.

When evaluating for suspected occult small bowel bleeding, many institutions perform a variation of the routine CTE examination and acquire images during multiple phases (multiphase) (10). The term for this specialized CTE varies by institution and includes multiphase CTE (mpCTE), CT Angiogram Enterography, CT for occult GI bleeding, CT for Obscure GI Bleeding, and Suspected Small-Bowel Bleeding CTE Protocol (7). To reduce confusion and develop consistency in reporting, this panel recommends using the term multiphase CTE (mpCTE).

Tables 1 and 2 show more information on CT technique, scan timing and utility of the individual phases for evaluating GI bleeding.

MR Angiography (MRA)

MRA is a type of MR where images are acquired while the IV contrast is within the arteries, similar to CTA. An advantage of MR is the lack of ionizing radiation and therefore multiple phases can be acquired. Because CTA has higher spatial and temporal resolution, MRA is generally not used in the setting of overt bleeding, and only performed in certain scenarios which will be discussed in subsequent sections.

MRE

MRE is a type of MR where a large volume (1350–1500 mL) of oral contrast is administered to optimize evaluation of the small bowel, similar to CTE. Most institutions administer the same oral contrast and drinking algorithm for both MRE and CTE. Because of the lack of ionizing radiation, multiple phases are routinely acquired after the administration of IV contrast compared with the single-phase examination performed for routine CTE. Additional pulse sequences are also routinely performed which aid in characterizing abnormalities. MRE has similar performance to CTE for inflammatory conditions (11,12) however, because of the inferior temporal and spatial resolution and artifacts which commonly occur on MR, CT techniques are

recommended for evaluating the majority of the other noninflammatory causes (vascular lesions, masses) of small bowel bleeding.

Individual techniques will be described in greater detail in the pertinent sections of the manuscript.

Appendix S4

Nuclear Medicine Labeling Methods

In vitro and modified in vivo labeling methods are recommended for LGIB studies.

The in vitro method has the highest labeling efficiency of 97% or higher and is the preferred method. The entire labeling process occurs outside of the patient in the vitro method with a commercial kit. The modified in vivo method has the second highest labeling efficiency of approximately 85%–90% and can serve as an appropriate alternative when the in vitro method is not available. The modified in vivo method consists of labeling the RBCs both inside and outside the patient.

The in vivo method has the lowest labeling efficiency of approximately 75%–80% which is lower than desirable and generally is not recommended for evaluation of gastrointestinal bleeding. However, for patients who will not accept injection of blood for religious or other reasons, the in vivo method may be the only viable option (13).

Appendix S5

Gastroenterology Perspective

Comparison of Advantages and Limitations Relative to Endoscopic Examinations

Overt lower GI bleeding.—

Role of colonoscopy:

Colonoscopy has long been considered the diagnostic test of choice in patients presenting with suspected colonic bleeding, due to the ability to determine the etiology of bleeding, allow for mucosal biopsy, and potentially provide a therapeutic intervention. In large international cohorts, colonoscopy has been shown to have a diagnostic yield of nearly 80%, with rates of therapeutic intervention as high as 21% in patients undergoing colonoscopy within 24 hours of presentation (14). Despite the high diagnostic yield of colonoscopy, rates of endoscopic intervention seem to be significantly lower in American cohorts where colonoscopy is not performed emergently, ranging from 3%–6% (15–17). Moreover, colonoscopy is an invasive procedure carrying risks of sedation in patients with significant cardiopulmonary comorbidities, and requires a bowel preparation to adequately locate and treat stigmata of hemorrhage. Colonoscopy should be performed only after the patient is hemodynamically stable and after adequate colon cleansing. Studies suggest that urgent colonoscopy within 24 hours does not improve outcomes (18).

Role of CTA versus colonoscopy:

Advantages of CTA over colonoscopy include the ability to rapidly obtain images without the need for sedation or a bowel preparation. Patients presenting with severe hematochezia despite

resuscitation may be unlikely to tolerate bowel preparation, and thus may benefit from performance of an initial CTA to localize the site of bleeding. Conversely, patients with stable hematochezia or severe hematochezia which resolved with resuscitation are unlikely to have extravasation seen on a CTA, and thus may benefit from a nonurgent colonoscopy to determine the etiology of bleeding. Patient level variables which have been shown to be predictive of a positive CTA include recent bowel resection, transfusion of greater than 3 units of packed red blood cells per day, use of antiplatelet medications, tachycardia, hypotension, and performance of CTA within 4 hours of hematochezia (19,20). Mortality rate data were unavailable in these two studies.

Use of $^{99\,m}$Technetium-labeled RBC scintigraphy has fallen out of favor compared with CTA, due to relatively long duration of the study as well as the inability to precisely localize the site of bleeding. In retrospective studies of patients with LGIB receiving CTA as compared with RBC scintigraphy, CTA was more accurate in detecting and localizing the source of lower gastrointestinal bleeding (21,22). Mortality rates were not significantly different in patients getting CTA or scintigraphy (22).

Colonoscopy versus CTA for initial testing:

There is limited available data comparing outcomes for patients undergoing colonoscopy versus CTA as their initial diagnostic testing. Small observational studies have shown that CTA was noninferior to colonoscopy in terms of bleeding site detection, and CTA may lead to a reduction in time to first examination and a higher frequency of detecting active bleeding as compared with colonoscopy (23,24). In a recent single center comparison of CTA to colonoscopy, colonoscopy was associated with a higher probability of source identification, however in the subgroup of patients with diverticular bleeding, CTA led to higher rates of therapeutic intervention (25).

Management of a patient with a positive CTA

Hemodynamically unstable patients with extravasation demonstrated on CTA should proceed with timely catheter angiographic embolization if extravasation is confirmed on catheter angiography. Depending on the clinical scenario and institutional preferences, either colonoscopy or CA can be performed for hemodynamically stable patients with active extravasation on CTA. Due to the intermittent nature of diverticular bleeding, timing of angiography after a positive CTA is critical; in single center reports, performance of angiography within 90 minutes of a positive CTA was 9 times more likely to detect extravasation (26). Colonoscopy also may be an option in patients who have a positive CTA. In Japanese retrospective cohort studies, the bleeding source was more frequently detected on colonoscopy when extravasation had been previously identified on CTA (27,28). There are limited data comparing outcomes of patients who undergo CTA and subsequent mesenteric embolization versus patients who undergo colonoscopy and are treated endoscopically. In a recent small retrospective cohort of patients undergoing colonoscopy (n = 27) or catheter angiography (n = 44) for LGIB, catheter angiography had a higher yield of detecting active bleeding, but similar rates of therapeutic intervention compared with colonoscopy (29).

Suspected small bowel bleeding.—

Capsule endoscopy in suspected small bowel bleeding

Identifying the source of suspected small bowel (SB) bleeding can be quite elusive because of the length and tortuosity of the small bowel. Capsule endoscopy (CE) has had a significant impact on diagnostic yield because it is able to examine most if not all of the small bowel mucosa (30). In addition, it is relatively noninvasive. Studies have shown that the diagnostic yield of CE in suspected small bowel bleeding ranges from 38%–83% (31). The yield tends to be higher for overt bleeding as opposed to occult bleeding or iron deficiency anemia. Timing of CE is also important, and the highest yield occurs when performed within two weeks of bleeding (32,33). A negative study is also helpful and is associated with a low risk of rebleeding of 19% (34). There is also evidence to suggest that repeating CE after a nondiagnostic initial study is associated with an improved diagnostic yield (35,36). CE is considered the test of choice after upper endoscopy and colonoscopy is negative in patients presenting with gastrointestinal bleeding (3,37). Cross-sectional imaging is considered complementary to CE in the assessment of suspected SB bleeding. CTE had a pooled yield of 40% compared with 53% for CE (38). CE appears to be superior for diagnosing angioectasia while cross-sectional imaging is better for tumors, masses, and inflammatory wall changes (39–42).

In addition to identifying the source of suspected SB bleeding, CE can help guide the initial direction of deep enteroscopy. If the lesion is identified in the first 60% of the SB based on transit time, then antegrade deep enteroscopy is recommended (43,44). Otherwise, the retrograde route is recommended. Capsule endoscopy may miss single mass lesions (45) and that is why cross sectional imaging with CTE is considered complimentary (42,46). The most significant complication associated with CE is capsule retention and for this reason, risk factors, such as known small bowel strictures, small bowel Crohn's disease or obstructive symptoms should be excluded prior to capsule ingestion (47,48).

Role of balloon assisted endoscopy in small bowel bleeding

Balloon assisted endoscopy (BAE) has revolutionized small bowel interrogations and endoscopic therapeutic options for small bowel bleeding. Both single and double balloon endoscopy (DBE) are now available, with DBE often utilized when a greater length of small bowel assessment is required. An antegrade (oral) or retrograde (rectal) approach is determined by the lesion location (antegrade: jejunum and proximal ileum; retrograde: mid and distal ileum). Given its invasive nature, BAE is often performed as a therapeutic modality once a suspected bleeding lesion or site is identified on CE or CT imaging. A large retrospective multicenter cohort exploring BAE noted a mean patient age of 66 years, 53% women, and 85% were antegrade approaches (49).

Multiple studies have now assessed the performance of BAE in cases of known or suspected small bowel bleeding. The overall diagnostic yield (DY) has been reported as approximately 70%, but up to 93% if performed after a positive finding on CE (50). The therapeutic yield (TY) of BAE might be as high at 67% in some populations (51). A recent systematic review and meta-analysis were performed involving twenty-two studies of overt small bowel bleeding (52). The pooled DY and TY of BAE was 74% and 34%, respectively. Modeling has suggested the ideal timing of BAE is within 2 days of overt small bowel bleeding (52).

Cross-sectional imaging in suspected small bowel bleeding

Cross-sectional imaging is complementary to CE and BAE in the evaluation of suspected small bowel bleeding. While CE is considered a first line diagnostic test in hemodynamically stable patients with occult bleeding, CT enterography (CTE) should be performed when CE is negative or contraindicated, or a mass lesion is suspected. CTA should be considered if there is brisk overt bleeding with hemodynamic instability. Cross-sectional imaging also can screen for contraindications to CE, including strictures (41).

Multiphase CTE, is best for older patients with occult bleeding and/or iron deficiency anemia where vascular etiologies are common (7). Single-phase CTE should be considered in younger patients, in an effort to reduce radiation exposure, or in individuals with suspected inflammatory conditions such as Crohn's disease, associated obstructive symptoms which can be seen with NSAID enteropathy, or prior radiation therapy. In patients with overt bleeding where CT scanning may be contraindicated, a radioisotope bleeding scan can be considered.

Nonvariceal upper GI bleeding.—

Unless contraindicated, the evaluation of UGI bleeding begins with upper endoscopy (2). The ideal timing of endoscopy appears to be within 24 hours of presentation, with higher mortality seen when performed early (less than 6–12 hours) or late (greater than 24–36 hours) (53,54). A prokinetic medication, erythromycin if available, should be administered prior to endoscopy and is superior to gastric lavage for reducing the need for second look endoscopy and hospital length of stay (2,55). Depending on the clinical situation and comorbidities, intubation for airway protection may need to be considered prior to endoscopy.

There is limited role for CTA as EGD is typically able to localize the site of bleeding. If, however, endoscopic treatment fails to achieve hemostasis, conventional angiography is recommended. In cases where patients cannot be stabilized for EGD, CTA can be performed and if positive subsequent catheter angiography.

Appendix S6

Additional Cross-sectional Imaging Techniques and Potential Future Advances

Dual Energy CT

Dual-energy CT (DECT), although theoretically possible since the conception of CT in the early 1970s, has only recently become technically feasible due to hardware advancements in CT technology. DECT has several major advantages over conventional single-energy CT, including significantly increased conspicuity of bleeding sites with low keV virtual monoenergetic images, ability to create virtual noncontrast images from a contrast enhanced acquisition thereby drastically reducing patient radiation exposure, and the capability of quantifying iodine in potential sites of GI bleeding. In a phantom model, Liu et al reported increased sensitivity, contrast-to-noise ratio (CNR), and GI bleeding detection rates using DECT compared with conventional CT (56). Sun and colleagues showed a decrease in overall radiation exposure in a DECT GI bleeding protocol due to replacement of the true noncontrast images with virtual noncontrast reconstructions (57). Further advancements in multienergy and spectral imaging,

including photon counting technology, are likely to further improve image quality and diagnostic accuracy of CT (58).

MR

MR enterography with its intrinsic high soft tissue contrast can help identify small bowel pathologies such as inflammatory bowel diseases and tumors, which can be the causes of bleeding. In a prospective comparative study by Schmidt et al, which included patients with GI bleeding of unknown cause, CTE provided better sensitivity in detecting small bowel lesions than MR enterography, with higher interobserver agreement (59). MR (MR enterography or MR angiography) can be used as an alternative when CTA or CTE may not be feasible due to radiation concerns or contrast media allergies. However, given the inferior spatial resolution compared with CT, MRI is likely not as sensitive at detecting subtle bleeds and vascular lesions (41,60). Intravascular MR contrast agents which lead to prolong intravascular enhancement may provide improved visualization of vascular lesions and bleeding however there currently is no data available in humans. An additional limitation is that MRI examinations may be degraded by motion artifact, particularly in patients who are acutely ill or elderly, who may not be able to comply with breath-hold instructions. A proposed MR enterography is shown below.

Pulse Sequence	Plane	Slice Thickness/ Gap (mm)	Technical Notes	Comments/Utility
ssT2	Coronal	5/0		Overview of bowel and other intrabdominal structures
FS-ssT2	Coronal	5/0		Detection of bowel wall edema/inflammation
ssT2	Axial	5–6/0		
bSSFP	Axial or Coronal	5/0 5–6/0	With or without FS	Intraluminal fluid more homogenous which may improve visualization of intraluminal masses.
DWI	Axial or Coronal	5–6/0	Coronal -More distortion -Faster Include high b value (800–1000)	Detection of bowel wall edema/inflammation
FS-3D T1	Coronal	4/0	precontrast	Detection of high T1 material mimicking enhancement
FS-3D T1	Coronal	4/0	Dynamic 3 phase 20 second delay Subtraction (optional)	Enhancing masses, inflammation, active bleeding Subtraction may help improve detection of enhancing lesions
FS-3D T1	Axial	5–6/0		

Note.—ss = single-shot, FS = fat-suppression, bSSFP = balanced steady-state free precession, DWI = diffusion-weighted images.

Notes:

1. Oral contrast is recommended to distend the bowel.
2. Antiperistaltic agents are recommended before the motion-sensitive sequences (3D T1).
3. Protocol can be performed with limited oral contrast or without in patients who or more acutely ill or cannot drink contrast.
4. Breathholding is recommended to reduce respiratory motion artifacts.

Appendix S7

Special Considerations

Pregnancy

When a pregnant patient presents with GI bleeding there can be confusion on which test to utilize because of the concern for harm to the fetus from ionizing radiation and IV contrast material.

The survival of the mother is paramount-the fetus will rarely survive if the mother dies during pregnancy. As such, the decision to perform a CT (and the protocol) should be driven by the acuity of the bleeding, with radiation dose a secondary concern. The American College of Radiology (ACR) has developed a document providing patient information on the use of CT for imaging pregnant patients (https://www.radiologyinfo.org/en/info/safety-ct-pregnancy) (61) and practice guidelines (62).

In summary, alternatives that do not use ionizing radiation should be considered. If these techniques do not provide the needed information CT may be utilized after discussion of the risks and benefits with the patient.

The amount of radiation used in normal CT imaging has never been shown to cause harm to an unborn child. However, if the CT scan examines the abdomen or pelvis area, then there may be a very slight risk to the baby. An unborn baby exposed to CT during pregnancy may have about a one in 1,000 greater chance of developing a cancer as a child. The level of risk is not proven though and may be nonexistent. The CT examination techniques should be optimized to lower the radiation dose to the patient.

If a CT is necessary for diagnosing a serious condition it should be performed to improve the outcome of mother and fetus (62).

IV contrast material used for CT and MR does cross the placenta. CT contrast agents have been used in pregnancy for decades without harm. However, the administration of gadolinium agents used for MR is not recommended due to potential harm to the fetus and should only be reserved for situations where there is potential for significant clinical benefit or pregnancy is not desired (63–65). A noncontrast MRE will not be able to assess for active GI bleeding but may show other conditions such as masses or inflammatory bowel disease.

Given the above, the approach to imaging of the pregnant patient depends on the suspected etiology and type of bleeding. If the patient has ongoing hemodynamically significant bleeding despite resuscitation, and endoscopy is either not possible or not recommended, CTA could be considered. If CTA is performed, the protocol should be optimized to reduce radiation dose with a limited number of phases performed. Unenhanced images may be helpful if there is ingested high attenuation material and could be obtained using an ultra-low dose technique or substituted with a virtual unenhanced phase if dual energy technique is available. A late portal venous phase may be the most helpful phase and can identify brisk arterial or slower venous bleeds as well as inflammation and masses. In hemodynamically stable patients with nonbrisk bleeding, after a negative EGD and/or colonoscopy, evaluation could begin with MR enterography performed without IV contrast to evaluate for inflammation or mass however this technique would not demonstrate active bleeding. If MR enterography is negative, CTE with IV contrast or a tagged-RBC scan could be performed. According to the United States FDA, pregnancy is a relative contraindication for capsule endoscopy and therefore cannot be utilized. A recent review discusses procedure-related consideration for endoscopy during pregnancy (66).

Consensus recommendations for imaging the pregnant patient.—

Techniques

1. If CTA is performed the technique should be adjusted to perform as low radiation dose as possible while maintaining adequate image quality.
2. If unenhanced images are obtained, they should be performed at an ultra-low dose or virtual non-contrast images could be substituted using dual energy CT.

3. A single phase is recommended, and the portal venous phase would likely be the most useful.
4. If MR is performed this should be done without IV contrast using enterography technique.

Role/Indications

1. If the patient has ongoing hemodynamically significant bleeding despite resuscitation, and endoscopy is either not possible or not recommended, CTA could be considered.
2. For hemodynamically stable patients, MR enterography without IV contrast could be considered to screen for inflammation or mass after negative EGD and/or colonoscopy.
3. If there is evidence of ongoing bleeding despite negative endoscopic evaluation and MR enterography, CTE or tagged-RBC scan could be considered.

Renal Impairment (eGFR Less than 30 mL/min/1.73 m2 and are not Undergoing Maintenance Dialysis.)

Iodinated CT contrast.—

A recent consensus statement from the ACR and National Kidney Foundation states the risk of contrast-induced acute kidney injury (CI-AKI) from intravenous iodinated contrast media is lower than previously thought. Necessary contrast-enhanced CT without a suitable alternative should not be avoided solely on the basis of CI-AKI risk (67). The ACR manual on contrast media (64) states the concern for the development of CI-AKI is a relative but not absolute contraindication to the administration of intravascular iodinated contrast medium in at-risk patients that have AKI or an eGFR less than 30 mL/min/1.73 m2 and are not undergoing maintenance dialysis. In these scenarios, the information that may be obtained by using no contrast medium (eg, noncontrast CT) and/or other modalities (eg, noncontrast magnetic resonance imaging [MRI]) may be sufficiently useful that contrast medium administration can be avoided. In some clinical situations, the use of intravascular iodinated contrast medium may be necessary regardless of CI-AKI risk. In centers with dual-energy CT, reduced contrast dose may be feasible in patients with impaired renal function using low-keV postprocessing.

Gadolinium-based MR contrast agents (GBCAs).—

GBCAs do not cause contrast induced nephropathy or worsen renal function when administered at the recommended dose. The concern for administering GBCAs in stage 4 or 5 chronic kidney disease is the development of nephrogenic systemic fibrosis (NSF). NSF is a rare disorder which leads to fibrosis in the skin, subcutaneous tissues, and sometimes skeletal muscles, mainly in the arms and legs. As a result, the ACR has divided GBCAs into three groups based on the risk for developing NSF. Group II GBCAs are the most stable and pose little or no risk for causing NSF (< 0.07%) (68). Therefore group II GBCAs may be safely administered in patients with renal failure (64).

For hemodynamically unstable patients presenting with brisk overt bleeding, this panel feels that CTA is appropriate and should be the first-line study. In hemodynamically stable patients with nonbrisk bleeding, after negative endoscopic evaluation and capsule endoscopy for suspected small bowel bleeding, radiologic evaluation could begin with a tagged-RBC scan. MR enterography without or with (group II gadolinium agent) IV contrast or a CT without IV contrast but with positive oral contrast could be performed to evaluate for a potential etiology after positive tagged-RBC scan or to detect etiologies, including extraluminal causes, not detected on previous imaging. If these tests are negative contrast enhanced CTE could be performed.

Consensus Recommendations for Imaging the Patient with Renal Impairment (eGFR Less than 30 mL/min/1.73 m2 and are not Undergoing Maintenance Dialysis.)

1. CTA is recommended as the first-line study for hemodynamically unstable patients.
2. In hemodynamically stable patients with ongoing non-brisk bleeding and negative initial endoscopic evaluation (endoscopy, colonoscopy, and/or capsule endoscopy), tagged-RBC scan can be considered as the first-line imaging study if there is concern for performing CTA with IV contrast.
3. MR enterography without or with (group II gadolinium agent) IV contrast or CT without IV contrast but with positive oral contrast could be performed to better characterize the cause of bleeding detected on other tests and detect etiologies not seen on prior evaluation.

Appendix S8

Comparison of Recommendations to the American College of Radiology (ACR) Appropriateness Criteria (AC)

The ACR has developed AC for the diagnosis and management of nonvariceal upper gastrointestinal tract bleeding (69) and lower gastrointestinal tract bleeding (70). The ACR AC classify all potential diagnostics tests into 3 categories: usually not appropriate, may be appropriate, or usually appropriate. Our panel acknowledges that there can be several appropriate options for diagnosing GI bleeding however decided to make recommendations on what was felt to be the most appropriate test if adequate technology and expertise was available.

The ACR AC include 4 variants for nonvariceal upper GI bleeding and 5 variants for lower GI tract bleeding. Our recommendations are in agreement with options listed as usually appropriate in the ACR AC.

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