

## American College of Radiology ACR Appropriateness Criteria®

**Clinical Condition:** Radiologic Management of Lower Gastrointestinal Tract Bleeding

**Variant 1:** Lower GI tract bleeding. Active bleeding with hematochezia or melena in a hemodynamically stable patient. Next procedure/intervention.

Treatment/Procedure	Rating	Comments
Transcatheter arteriography/intervention (TAI)	5	In the hemodynamically stable patient, colonoscopy is usually preferred as the first step; if there is active bleeding, TAI would be more likely to be beneficial.
Diagnostic/therapeutic colonoscopy	8	Upper endoscopy should also be considered in patients with brisk bleeding.
Surgery	3	
Tc-99m RBC scan abdomen and pelvis	7	
CTA abdomen and pelvis with contrast	7	
MRI abdomen and pelvis without and with contrast	2	
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate		

**Variant 2:** Lower GI tract bleeding. Active bleeding in a hemodynamically unstable patient or a patient who has required more than 5 units of blood. Next procedure/intervention.

Treatment/Procedure	Rating	Comments
Transcatheter arteriography/intervention (TAI)	8	
Diagnostic/therapeutic colonoscopy	4	This procedure is challenging in an unstable patient.
Surgery	5	This procedure is particularly appropriate if pathology is known. It is likely the best alternative if interventional radiology is not an option.
Tc-99m RBC scan abdomen and pelvis	1	
CTA abdomen and pelvis with contrast	5	This procedure is most appropriate if pathology is unknown. It may be used to define the pathology causing the bleeding.
MRI abdomen and pelvis without and with contrast	1	
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate		

**Clinical Condition:** Radiologic Management of Lower Gastrointestinal Tract Bleeding

**Variant 3:** Lower GI tract bleeding. Colonoscopy localized the bleeding site and treatment was attempted. Ongoing or recurrent bleeding. Next procedure/intervention.

Treatment/Procedure	Rating	Comments
Transcatheter arteriography/intervention (TAI)	8	Use of this procedure depends on the type of lesion.
Diagnostic/therapeutic colonoscopy	4	Use of this procedure depends on the type of lesion, but if therapy has failed, repeat colonoscopy may not be beneficial.
Surgery	7	Use of this procedure depends on the type of lesion.
Tc-99m RBC scan abdomen and pelvis	2	
CTA abdomen and pelvis with contrast	3	This procedure may be helpful for further anatomic delineation.
MRI abdomen and pelvis without and with contrast	2	
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate		

**Variant 4:** Lower GI tract bleeding. Intermittent or obscure nonlocalized recurrent bleeding. Next procedure/intervention (assumes prior negative endoscopy).

Treatment/Procedure	Rating	Comments
Transcatheter arteriography/intervention (TAI)	4	There is limited evidence for this procedure for provocative angiography. It should only be done by an expert team with experience in the technique.
Diagnostic/therapeutic colonoscopy	5	The utility of repeat colonoscopy depends largely on the character of bleeding and on the quality of the initial colonoscopy.
Surgery	3	
Tc-99m RBC scan abdomen and pelvis	7	
CTA abdomen and pelvis with contrast	8	
MRI abdomen and pelvis without and with contrast	2	
Capsule endoscopy	8	
Contrast small bowel radiography	2	Small-bowel follow-through is rarely helpful; enteroclysis requires an experienced provider.
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate		

# RADIOLOGIC MANAGEMENT OF LOWER GASTROINTESTINAL TRACT BLEEDING

Expert Panel on Interventional Radiology: Michael D. Darcy, MD<sup>1</sup>; Brooks D. Cash, MD<sup>2</sup>; Barry W. Feig, MD<sup>3</sup>; Nicholas Fidelman, MD<sup>4</sup>; Amy K. Hara, MD<sup>5</sup>; Baljendra S. Kapoor, MB, BS<sup>6</sup>; M-Grace Knuttinen, MD, PhD<sup>7</sup>; Drew L. Lambert, MD<sup>8</sup>; Jeet Minocha MD<sup>9</sup>; Paul J. Rochon, MD<sup>10</sup>; Colette M. Shaw, MB<sup>11</sup>; Charles E. Ray Jr, MD, PhD<sup>12</sup>; Jonathan M. Lorenz, MD.<sup>13</sup>

## **Summary of Literature Review**

### **Introduction/Background**

Acute gastrointestinal (GI) tract bleeding remains a major cause of morbidity and mortality despite advances in management. The mortality rate is around 10% but increases to 40% in cases of massive bleeding associated with hemodynamic instability or the requirement for transfusion of more than 4 units of blood.

Acute lower gastrointestinal (LGI) tract bleeding is defined as bleeding into the small bowel distal to the ligament of Treitz, or bleeding into the large bowel. It may present as either melena or hematochezia, depending on the site. Causes of LGI bleeding include inflammatory bowel disease, neoplasms, stress ulcers, surgical anastomoses, vascular lesions such as angiodysplasia, and diverticulitis.

Diagnostic and therapeutic options for LGI bleeding are discussed in detail under the discussions by variants. Diagnostic options include colonoscopy, Tc-99m red blood cell (RBC) scan, contrast-enhanced computed tomography (CT), magnetic resonance imaging (MRI), and transcatheter arteriography. Therapeutic options can be facilitated by transcatheter arteriography, colonoscopy, and surgery.

### **Discussion by Variant**

*Variant 1: Lower GI tract bleeding. Active bleeding with hematochezia or melena in a hemodynamically stable patient. Next procedure/intervention.*

Radiological tests commonly used include radionuclide scans, CT, and transcatheter arteriography. Radionuclide scans have traditionally been the initial diagnostic test since they are more sensitive than arteriography for detecting slower rates of bleeding (approximately 0.05 to 0.1 mL/min, compared to 0.5 to 1.0 mL/min for angiography). However, radionuclide scans frequently provide inaccurate localization of the site of bleeding. Several recent studies reported incorrect localization in 10%–25% of cases, some of which led to wrong site surgery [1,2]. Despite the sensitivity of radionuclide scans one of these studies [2] also showed a 55% rate of false-negative studies when the diagnosis was confirmed by other means.

CT scanning has been shown to have the ability to detect bleeding as low as 0.3 mL/min [3] and in many centers is replacing nuclear medicine scans for localization of bleeding. Although theoretically CT is less sensitive to bleeding than nuclear medicine scans, studies have shown the sensitivity of CT to range from 79% to 100% [4-8]. These studies also demonstrated that with CT the specificity and diagnostic accuracy are also quite good (50%–100% and 74%–98%, respectively). A meta-analysis that included 22 studies and 672 patients showed that sensitivity and specificity for CT were 85% and 92%, respectively [9]. Importantly, a negative CT angiography (CTA) is a good indicator that nothing else may need to be done. A review of 62 patients with negative CTA showed that 77.4% did not rebleed nor require further interventions [10]. In another study, no intervention was needed in any patient who was hemodynamically stable at the time of their negative CTA [11].

In addition to being more readily available and quicker to perform than radionuclide scans, CT has a number of other advantages as an initial test to localize LGI bleeding. It can often yield a diagnosis of the pathologic cause of the bleeding sometimes even if the patient is no longer actively bleeding. In one study [12], CT identified the pathology preoperatively in 50% of cases. Defining the cause of bleeding can help determine prognosis as well as

---

<sup>1</sup>Principal Author, Mallinckrodt Institute of Radiology, Saint Louis, Missouri. <sup>2</sup>University of South Alabama, Mobile, Alabama, American Gastroenterological Association. <sup>3</sup>University of Texas MD Anderson Cancer Center, Houston, Texas, American College of Surgeons. <sup>4</sup>University of California San Francisco, San Francisco, California. <sup>5</sup>Mayo Clinic, Scottsdale, Arizona. <sup>6</sup>Cleveland Clinic Foundation, Cleveland, Ohio. <sup>7</sup>University of Illinois at Chicago, Chicago, Illinois. <sup>8</sup>University of Virginia Health System, Charlottesville, Virginia. <sup>9</sup>University of California San Diego, San Diego, California. <sup>10</sup>University of Colorado Denver, Anschutz Medical Campus, Aurora, Colorado. <sup>11</sup>Thomas Jefferson University Hospital, Philadelphia, Pennsylvania. <sup>12</sup>Specialty Chair, University of Illinois Hospital and Health Science System, Chicago, Illinois. <sup>13</sup>Panel Chair, University of Chicago Hospital, Chicago, Illinois.

The American College of Radiology seeks and encourages collaboration with other organizations on the development of the ACR Appropriateness Criteria through society representation on expert panels. Participation by representatives from collaborating societies on the expert panel does not necessarily imply individual or society endorsement of the final document.

Reprint requests to: [publications@acr.org](mailto:publications@acr.org).

the best options for treatment. This allows patients who have lesions that are unfavorable for embolization to be triaged directly to surgery. In one series, as many as 40% of the cases could be triaged directly to surgery as a result of the CTA [11]. CT can also provide information about the arterial anatomy. It can identify variant anatomy or vessel occlusions that would influence subsequent transcatheter arteriography/intervention (TAI).

Urgent colonoscopy can be used for both the diagnosis and treatment of LGI bleeding. A randomized, controlled trial of urgent colonoscopy compared to standard care (scintigraphy and angiography followed by colonoscopy when the other tests were negative) was performed in 100 patients with acute LGI bleeding. Although the bleeding source was definitively diagnosed in 42% in the colonoscopy arm versus only 22% in the standard care group, there was no difference in outcomes, including rebleeding and hospital stay [13]. Although the diagnostic yield for colonoscopy has been reported to range from 74% to 100% [14], colonoscopy can be very challenging in the face of major active bleeding, which can obscure the endoscopist's view. Whether to use colonoscopy or radiologic testing for initial diagnosis will depend on local expertise and availability. A recent randomized trial [15] of patients with hematochezia and a negative upper endoscopy revealed that patients undergoing urgent lower endoscopy had essentially the same clinical outcome as those who had elective colonoscopy.

A negative arteriogram after a positive nuclear or CT study is not uncommon. In one recent study angiography revealed active extravasation in only 24% of patients with positive tagged RBC scans [16]. This may result just from the lower sensitivity of arteriography compared to scintigraphy or CT. However, LGI bleeding is frequently intermittent, and thus in many cases the bleeding has simply stopped by the time the arteriogram was done. If the patient has had multiple bleeding episodes without a diagnosis being made, provocative angiography can be used to uncover the location of the bleeding. With this technique, anticoagulants, vasodilators, or thrombolytic drugs can be infused to provoke and identify the source of bleeding. The yield of provocative angiography ranges widely from 31% to 89% [17,18], probably due in part to lack of standardized technique. Despite the fact that this technique precipitates active bleeding, identification of the bleeding source allows treatment, and there are no published reports of a patient has suffering uncontrollable hemorrhage with this technique.

*Variants 2 and 3: Lower GI tract bleeding. Active bleeding in a hemodynamically unstable patient or a patient who has required more than 5 units of blood. Colonoscopy localized the bleeding site and treatment was attempted. Ongoing or recurrent bleeding. Next procedure/intervention.*

Transcatheter arteriography is rarely used as the first diagnostic test except when the patients is massively bleeding and needs urgent therapy. Arteriography is more likely to identify the source of LGI bleeding in patients who have massive bleeding resulting in either hemodynamic instability or a requirement for transfusion of >5 units of blood [19]. Demonstration of the site of bleeding at arteriography enables the possibility of catheter-directed treatment.

In some cases, endoscopic treatment may fail despite demonstration of the site and etiology of bleeding. Depending on the etiology, operator preference, and clinical presentation, angiographic and surgical options are considered.

*Variant 4: Lower GI tract bleeding. Intermittent or obscure nonlocalized recurrent bleeding. Next procedure/intervention (assumes prior negative endoscopy).*

GI bleeding that persists or recurs despite negative upper and lower endoscopic evaluation is commonly referred to as obscure GI bleeding. Often, obscure bleeding originates from the small bowel, but no clear consensus exists on the optimal study to interrogate the small bowel. A meta-analysis of 17 studies compared capsule endoscopy (CE) to push enteroscopy and small-bowel barium radiography. The diagnostic yield was 63%–67% for CE, 28% for push enteroscopy, and 8% for small-bowel barium studies [20]. In a more recent study, patients with obscure bleeding were randomized to CE or small-bowel barium radiography [21]. The diagnostic yield with CE was higher (30% versus 7%); however, the rate of subsequent bleeding was essentially equivalent, thus the improvement in diagnosis did not translate into any outcome improvement. CT, in particular CT enterography, has been used recently in the setting of obscure bleeding. Although there is often concordance, CT occasionally detects lesions not seen on CE and vice versa [22,23]. Huprich et al [23] found that CT enterography had much better sensitivity for detecting small-bowel bleeding sources compared to CE (88% versus 38%) primarily due to detection of small-bowel masses. However, a systematic review of 18 studies revealed CT enterography to have lower sensitivity (34% and 53%, respectively) than CE [24]. Another study also showed that CE made a diagnosis in 57% of patients who had negative CT enterography [25]. Recently, several studies have also compared CE to

MR or MR enterography and shown better diagnostic yields for CE [26,27]. There is not enough evidence to make a clear recommendation between these modalities, and choice will depend in part on local expertise.

### **Angiographic Treatment**

Microcatheter technology has allowed super-selective embolization (SSE) to become the most commonly used angiographic intervention, virtually replacing vasopressin infusion as the treatment of choice. The primary situation in which vasopressin infusion is still indicated is when a diffuse source of bleeding is identified and embolization would necessitate occlusion of too much vascular territory.

Technical success rates of SSE for LGI bleeding range from 73% to 100% [28-40]. In this context technical success indicates successful deposition of emboli and elimination of contrast extravasation. When technical failure does occur, it is usually the result of vessel tortuosity or spasm.

Clinical success rates for SSE are usually lower than the technical success rates due to continued bleeding or early rebleeding despite angiographic evidence of a successful embolization. Clinical success in recent series has ranged from 63% to 96% [28-36] with rebleeding rates ranging from 11.1% to 50% [16,37-40]. However, in some series TAI has provided definitive treatment for 81%–86% of patients [30,33]. The efficacy of TAI varies depending on the location of the bleeding, small-bowel versus colon. Rebleeding is more common after small-bowel embolization than when treating colonic lesions, likely because of the more robust vascular supply and greater number of potential collateral pathways in the small bowel [41]. The pathology causing the bleeding also affects success. A meta-analysis of 25 studies revealed that recurrent bleeding occurred in only 15% of cases of SSE for colonic diverticular bleeding but occurred in 45% of cases when the pathologic lesion (such as angiodysplasia or inflammatory bowel) had a more diffuse arterial blood supply [31]. Coagulopathy is also a well-known risk factor for recurrent bleeding. In the face of coagulopathy, use of an agent that provides mechanical occlusion without requiring stable clot formation may be beneficial. N-butyl cyanoacrylate glue is such an agent and has been shown to provide effective hemostasis even in coagulopathic patients [42], although it does require a fair amount of expertise to use safely.

Signs of minor ischemic injury to the bowel (such as self-limited abdominal pain or asymptomatic serum lactic acid elevation) are not uncommon sequela of LGI embolization. However, major ischemic complications (those requiring treatment) are uncommon. Major ischemic complications have been reported to be as high as 11%, but on average most series report a rate of 3% or less [28-40].

No large prospective, randomized trials have been conducted to compare TAI with surgery for LGI bleeding. However, TAI can be performed at the time of diagnostic arteriography and can be used in patients who may be too ill to tolerate surgery. Even though 7% to 25% of LGI bleeding patients will ultimately require surgery to stop bleeding or deal with the underlying pathology [43,44], stopping hemorrhage through the use of TAI can allow time to stabilize the patient and prep the bowel, both of which will contribute to a better surgical outcome. Consequently, use of TAI in patients with acute LGI bleeding, where active contrast extravasation is seen during diagnostic arteriography, is a safe and relatively effective treatment that should be considered, depending on local experience and expertise.

### **Summary of Recommendations**

- In the patient in whom lower GI bleeding has stopped, colonoscopy is usually the preferred initial examination.
- For diagnosing the cause of colonic bleeding, urgent colonoscopy is an effective technique but can be challenging in the face of ongoing bleeding.
- Nuclear scintigraphy is still the most sensitive radiologic test for determining if the patient is actively bleeding. However, CT scanning is almost as sensitive, provides better localization, and may define the pathologic cause of the bleeding.
- Arteriography is most likely to demonstrate the site of bleeding (and guide therapeutic embolization) in patients with evidence of ongoing bleeding (hemodynamically unstable patients, or those who have required transfusion of >5 units of blood).
- For obscure bleeding, there is not a clear consensus whether CE or CT is more effective and they may be complementary.

- The effectiveness of TAI varies depending on the pathology causing the bleeding. Diverticular bleeding with a focal arterial supply is more effectively treated than conditions with more diffuse blood supply such as angiodysplasias, tumors, and inflammatory conditions.
- TAI is more effective for colonic lesions than for lesions involving the small bowel.
- Recurrence of bleeding following technically successful TAI may occur in 14%–65% of patients.
- Symptomatic bowel ischemia following TAI is uncommon.
- Many of the diagnostic, surgical, and interventional procedures described here are highly specialized. Their availability and utility vary by institutional and operator experience.

### Summary of Evidence

Of the 44 references cited in the *ACR Appropriateness Criteria® Radiologic Management of Lower Gastrointestinal Tract Bleeding* document, 18 are categorized as therapeutic references including 1 well-designed study, 7 good quality studies, and 2 quality studies that may have design limitations. Additionally, 26 references are categorized as diagnostic references including 5 good quality studies and 7 quality studies that may have design limitations. There are 22 references that may not be useful as primary evidence.

The 44 references cited in the *ACR Appropriateness Criteria® Radiologic Management of Lower Gastrointestinal Tract Bleeding* document were published between 1998–2014.

While there are references that report on studies with design limitations, 13 well-designed or good quality studies provide good evidence.

### Supporting Documents

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

### References

1. Dolezal J, Vizda J, Kopacova M. Single-photon emission computed tomography enhanced Tc-99m-pertechnetate disodium-labelled red blood cell scintigraphy in the localization of small intestine bleeding: a single-centre twelve-year study. *Digestion*. 2011;84(3):207-211.
2. Tabibian JH, Wong Kee Song LM, Enders FB, Aguet JC, Tabibian N. Technetium-labeled erythrocyte scintigraphy in acute gastrointestinal bleeding. *Int J Colorectal Dis*. 2013;28(8):1099-1105.
3. Kuhle WG, Sheiman RG. Detection of active colonic hemorrhage with use of helical CT: findings in a swine model. *Radiology*. 2003;228(3):743-752.
4. Kennedy DW, Laing CJ, Tseng LH, Rosenblum DI, Tamarkin SW. Detection of active gastrointestinal hemorrhage with CT angiography: a 4(1/2)-year retrospective review. *J Vasc Interv Radiol*. 2010;21(6):848-855.
5. Shih SL, Liu YP, Tsai YS, Yang FS, Lee HC, Chen YF. Evaluation of arterial phase MDCT for the characterization of lower gastrointestinal bleeding in infants and children: Preliminary results. *AJR Am J Roentgenol*. 2010;194(2):496-499.
6. Yoon W, Jeong YY, Shin SS, et al. Acute massive gastrointestinal bleeding: detection and localization with arterial phase multi-detector row helical CT. *Radiology*. 2006;239(1):160-167.
7. Marti M, Artigas JM, Garzon G, Alvarez-Sala R, Soto JA. Acute lower intestinal bleeding: feasibility and diagnostic performance of CT angiography. *Radiology*. 2012;262(1):109-116.
8. Sun H, Jin Z, Li X, et al. Detection and localization of active gastrointestinal bleeding with multidetector row computed tomography angiography: a 5-year prospective study in one medical center. *J Clin Gastroenterol*. 2012;46(1):31-41.
9. Garcia-Blazquez V, Vicente-Bartulos A, Olavarria-Delgado A, Plana MN, van der Winden D, Zamora J. Accuracy of CT angiography in the diagnosis of acute gastrointestinal bleeding: systematic review and meta-analysis. *Eur Radiol*. 2013;23(5):1181-1190.
10. Chan V, Tse D, Dixon S, et al. Outcome Following a Negative CT Angiogram for Gastrointestinal Hemorrhage. *Cardiovasc Intervent Radiol*. 2014:[E-pub ahead of print].
11. Foley PT, Ganeshan A, Anthony S, Uberoi R. Multi-detector CT angiography for lower gastrointestinal bleeding: Can it select patients for endovascular intervention? *J Med Imaging Radiat Oncol*. 2010;54(1):9-16.

12. Zink SI, Ohki SK, Stein B, et al. Noninvasive evaluation of active lower gastrointestinal bleeding: comparison between contrast-enhanced MDCT and 99mTc-labeled RBC scintigraphy. *AJR Am J Roentgenol*. 2008;191(4):1107-1114.
13. Green BT, Rockey DC, Portwood G, et al. Urgent colonoscopy for evaluation and management of acute lower gastrointestinal hemorrhage: a randomized controlled trial. *Am J Gastroenterol*. 2005;100(11):2395-2402.
14. Lhewa DY, Strate LL. Pros and cons of colonoscopy in management of acute lower gastrointestinal bleeding. *World J Gastroenterol*. 2012;18(11):1185-1190.
15. Laine L, Shah A. Randomized trial of urgent vs. elective colonoscopy in patients hospitalized with lower GI bleeding. *Am J Gastroenterol*. 2010;105(12):2636-2641; quiz 2642.
16. Yi WS, Garg G, Sava JA. Localization and definitive control of lower gastrointestinal bleeding with angiography and embolization. *Am Surg*. 2013;79(4):375-380.
17. Kim CY, Suhocki PV, Miller MJ, Jr., Khan M, Janus G, Smith TP. Provocative mesenteric angiography for lower gastrointestinal hemorrhage: results from a single-institution study. *J Vasc Interv Radiol*. 2010;21(4):477-483.
18. Widlus DM, Salis AI. Reteplase provocative visceral arteriography. *J Clin Gastroenterol*. 2007;41(9):830-833.
19. Abbas SM, Bissett IP, Holden A, Woodfield JC, Parry BR, Duncan D. Clinical variables associated with positive angiographic localization of lower gastrointestinal bleeding. *ANZ J Surg*. 2005;75(11):953-957.
20. Triester SL, Leighton JA, Leontiadis GI, et al. A meta-analysis of the yield of capsule endoscopy compared to other diagnostic modalities in patients with obscure gastrointestinal bleeding. *Am J Gastroenterol*. 2005;100(11):2407-2418.
21. Laine L, Sahota A, Shah A. Does capsule endoscopy improve outcomes in obscure gastrointestinal bleeding? Randomized trial versus dedicated small bowel radiography. *Gastroenterology*. 2010;138(5):1673-1680 e1671; quiz e1611-1672.
22. Filippone A, Cianci R, Milano A, Valeriano S, Di Mizio V, Storto ML. Obscure gastrointestinal bleeding and small bowel pathology: comparison between wireless capsule endoscopy and multidetector-row CT enteroclysis. *Abdom Imaging*. 2008;33(4):398-406.
23. Huprich JE, Fletcher JG, Fidler JL, et al. Prospective blinded comparison of wireless capsule endoscopy and multiphase CT enterography in obscure gastrointestinal bleeding. *Radiology*. 2011;260(3):744-751.
24. Wang Z, Chen JQ, Liu JL, Qin XG, Huang Y. CT enterography in obscure gastrointestinal bleeding: a systematic review and meta-analysis. *J Med Imaging Radiat Oncol*. 2013;57(3):263-273.
25. Heo HM, Park CH, Lim JS, et al. The role of capsule endoscopy after negative CT enterography in patients with obscure gastrointestinal bleeding. *Eur Radiol*. 2012;22(6):1159-1166.
26. Bocker U, Dinter D, Litterer C, et al. Comparison of magnetic resonance imaging and video capsule enteroscopy in diagnosing small-bowel pathology: localization-dependent diagnostic yield. *Scand J Gastroenterol*. 2010;45(4):490-500.
27. Wiarda BM, Heine DG, Mensink P, et al. Comparison of magnetic resonance enteroclysis and capsule endoscopy with balloon-assisted enteroscopy in patients with obscure gastrointestinal bleeding. *Endoscopy*. 2012;44(7):668-673.
28. Bandi R, Shetty PC, Sharma RP, Burke TH, Burke MW, Kastan D. Superselective arterial embolization for the treatment of lower gastrointestinal hemorrhage. *J Vasc Interv Radiol*. 2001;12(12):1399-1405.
29. d'Othee BJ, Surapaneni P, Rabkin D, Nasser I, Clouse M. Microcoil embolization for acute lower gastrointestinal bleeding. *Cardiovasc Intervent Radiol*. 2006;29(1):49-58.
30. Funaki B, Kostelic JK, Lorenz J, et al. Superselective microcoil embolization of colonic hemorrhage. *AJR Am J Roentgenol*. 2001;177(4):829-836.
31. Khanna A, Ognibene SJ, Koniaris LG. Embolization as first-line therapy for diverticulosis-related massive lower gastrointestinal bleeding: evidence from a meta-analysis. *J Gastrointest Surg*. 2005;9(3):343-352.
32. Kickuth R, Rattunde H, Gschossmann J, Inderbitzin D, Ludwig K, Triller J. Acute lower gastrointestinal hemorrhage: minimally invasive management with microcatheter embolization. *J Vasc Interv Radiol*. 2008;19(9):1289-1296 e1282.
33. Kuo WT, Lee DE, Saad WE, Patel N, Sahler LG, Waldman DL. Superselective microcoil embolization for the treatment of lower gastrointestinal hemorrhage. *J Vasc Interv Radiol*. 2003;14(12):1503-1509.
34. Lipof T, Sardella WV, Bartus CM, Johnson KH, Vignati PV, Cohen JL. The efficacy and durability of superselective embolization in the treatment of lower gastrointestinal bleeding. *Dis Colon Rectum*. 2008;51(3):301-305.

35. Neuman HB, Zarzaur BL, Meyer AA, Cairns BA, Rich PB. Superselective catheterization and embolization as first-line therapy for lower gastrointestinal bleeding. *Am Surg*. 2005;71(7):539-544; discussion 544-535.
36. Tan KK, Wong D, Sim R. Superselective embolization for lower gastrointestinal hemorrhage: an institutional review over 7 years. *World J Surg*. 2008;32(12):2707-2715.
37. Gillespie CJ, Sutherland AD, Mossop PJ, Woods RJ, Keck JO, Heriot AG. Mesenteric embolization for lower gastrointestinal bleeding. *Dis Colon Rectum*. 2010;53(9):1258-1264.
38. Huang CC, Lee CW, Hsiao JK, et al. N-butyl cyanoacrylate embolization as the primary treatment of acute hemodynamically unstable lower gastrointestinal hemorrhage. *J Vasc Interv Radiol*. 2011;22(11):1594-1599.
39. Hur S, Jae HJ, Lee M, Kim HC, Chung JW. Safety and efficacy of transcatheter arterial embolization for lower gastrointestinal bleeding: a single-center experience with 112 patients. *J Vasc Interv Radiol*. 2014;25(1):10-19.
40. Tan KK, Strong DH, Shore T, Ahmad MR, Waugh R, Young CJ. The safety and efficacy of mesenteric embolization in the management of acute lower gastrointestinal hemorrhage. *Ann Coloproctol*. 2013;29(5):205-208.
41. Peck DJ, McLoughlin RF, Hughson MN, Rankin RN. Percutaneous embolotherapy of lower gastrointestinal hemorrhage. *J Vasc Interv Radiol*. 1998;9(5):747-751.
42. Yata S, Ihaya T, Kaminou T, et al. Transcatheter arterial embolization of acute arterial bleeding in the upper and lower gastrointestinal tract with N-butyl-2-cyanoacrylate. *J Vasc Interv Radiol*. 2013;24(3):422-431.
43. Feinman M, Haut ER. Lower gastrointestinal bleeding. *Surg Clin North Am*. 2014;94(1):55-63.
44. Yi WS, Vegeler R, Hoang K, Rudnick N, Sava JA. Watch and wait: conservative management of lower gastrointestinal bleeding. *J Surg Res*. 2012;177(2):315-319.

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.