

**Radiologic Management of Lower Gastrointestinal Tract Bleeding  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
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. <i>Digestion</i> . 2011;84(3):207-211.	Review/Other-Dx	26 patients	To present our experience with the detection of bleeding in the small intestine by means of scintigraphy with in vivo-labelled RBCs in the period of 1998-2009.	A total of 26 patients had a positive scintigraphy with in vivo-labelled RBCs and 14 patients had negative scintigraphy. The final diagnosis was confirmed in 20/26 patients with a positive scintigraphy by push enteroscopy (6/20), intraoperative enteroscopy (7/20), surgery (4/20), duodenoscopy (1/20), double-balloon enteroscopy (1/20) and X-ray angiography (1/20). The correct location of the bleeding site was identified by RBC scintigraphy in 15/20 (75%) patients with the confirmed source. The locations of the bleeding site identified by scintigraphy and enteroscopy (push, intraoperative) and surgical investigations were highly correlated in patients with a positive scintigraphy within the first 3 hours. 11/20 correctly localized studies and none of the incorrectly localized studies were positive in the dynamic phase of imaging. In 5 patients (all erroneously localized), scintigraphy was positive only at a period longer than 18 hours.	4
2. Tabibian JH, Wong Kee Song LM, Enders FB, Aguet JC, Tabibian N. Technetium-labeled erythrocyte scintigraphy in acute gastrointestinal bleeding. <i>Int J Colorectal Dis</i> . 2013;28(8):1099-1105.	Observational-Dx	100 consecutive TRBC scans	To evaluate the clinical outcomes of the technetium-labeled RBC scan in patients presenting with acute GI bleeding.	Of the 80 technetium-labeled RBC scans, 29 (36%) were positive and 51 (64%) were negative for bleeding. 8 (10%) were incorrect positive (leading to 5 incorrect operations), 12 (15%) true positive, 9 (11%) unconfirmed positive, 17 (21%) false negative, and 34 (43%) unconfirmed negative. The cause of bleeding was confirmed in 31 cases, of which the scan result was incorrect positive in 2 (7%), true positive in 12 (39%), and false negative in 17 (55%).	3
3. Kuhle WG, Sheiman RG. Detection of active colonic hemorrhage with use of helical CT: findings in a swine model. <i>Radiology</i> . 2003;228(3):743-752.	Review/Other-Dx	16 exams in 14 swine	To evaluate the feasibility of helical CT as an imaging modality for depicting active colonic hemorrhage in a swine model.	16 swine exams yielded 16 contrast material-enhanced blood dilution curves. An excellent fit of the model to each dilution curve was achieved (mean R2 value of 0.8402). Helical CT has the potential to depict active colonic hemorrhage at rates of 0.5 mL/min or less.	4

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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. <i>J Vasc Interv Radiol</i> . 2010;21(6):848-855.	Observational-Dx	74 patients; 86 CT angiograms	To retrospectively evaluate the ability of CT to detect and localize GI bleeding.	26% of CTs were positive for hemorrhage. Of the negative CTs, 92% required no further therapy. Sensitivity and specificity were 79% and 95%, respectively. CTA provides valuable information that can be used to determine the appropriateness of catheter angiography and guide mesenteric catheterization if a bleeding source is localized. The authors' experience with this study cohort supports its use before angiography in those patients with acute GI bleeding of an unknown source who are being considered for catheter-directed intervention.	3
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. <i>AJR Am J Roentgenol</i> . 2010;194(2):496-499.	Observational-Dx	27 patients	To prospectively evaluate the efficacy of CT for detecting occult LGIB in pediatric patients.	The sensitivity, specificity, and diagnostic accuracy of MDCT were 82%, 50%, and 74%. MDCT can be used to identify the location and source of LGIB in infants and children.	2
6. Yoon W, Jeong YY, Shin SS, et al. Acute massive gastrointestinal bleeding: detection and localization with arterial phase multi-detector row helical CT. <i>Radiology</i> . 2006;239(1):160-167.	Observational-Dx	26 consecutive patients	To prospectively evaluate accuracy of arterial phase MDCT for detection and localization of acute massive GI bleeding, with angiography as reference standard.	Overall location-based sensitivity, specificity, accuracy, PPV and NPV values of MDCT for detection of GI bleeding were 90.9% (20/22), 99% (107/108), 97.6% (127/130), 95% (20/21), and 98% (107/109), respectively. Overall patient-based accuracy of MDCT for detection of acute GI bleeding was 88.5% (23/26). Arterial phase MDCT is accurate for detection and localization of bleeding sites in patients with acute massive GI bleeding.	3
7. Marti M, Artigas JM, Garzon G, Alvarez-Sala R, Soto JA. Acute lower intestinal bleeding: feasibility and diagnostic performance of CT angiography. <i>Radiology</i> . 2012;262(1):109-116.	Observational-Dx	47 patients	To assess the diagnostic performance of CTA as the initial diagnostic examination for patients presenting to the emergency room with acute LGIB.	CTA demonstrated active bleeding in 14 patients and intraluminal hyper attenuating material in 6 patients. The sensitivity, specificity, PPV, and NPV of CTA in depicting active or recent bleeding were 100% (19/19), 96% (27/28), 95% (19/20), and 100% (27/27), respectively. Findings of CTA and the standard of reference were concordant for determining definite or potential cause of bleeding in 44/47 patients (93% accuracy).	2

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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. <i>J Clin Gastroenterol</i> . 2012;46(1):31-41.	Observational-Dx	113 consecutive patients	To prospectively assess the utility of MDCT angiography in the diagnosis of active GI bleeding.	Positive CT findings for active GI bleeding were identified in 80/113 patients (70.8%), all of which were confirmed by 1 or more reference standard. Negative MDCT angiography results were obtained in 33 patients (29.2%). Of these, 27 patients did not require any further intervention and were discharged without incident. The overall sensitivity, specificity, PPV and NPV, and accuracy of MDCT angiography was 86.0%, 100%, 100%, 60.6%, and 88.5%, respectively.	3
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. <i>Eur Radiol</i> . 2013;23(5):1181-1190.	Review/Other-Dx	22 studies; 672 patients	To assess the diagnostic accuracy of CTA in the evaluation of patients with an episode of acute GI hemorrhage.	22 studies were included and provided data on 672 patients (range of age 5–74) with a mean age of 65 years. The overall sensitivity of CTA for detecting active acute GI hemorrhage was 85.2% (95% CI, 75.5% to 91.5%). The overall specificity of CTA was 92.1% (95% CI, 76.7% to 97.7%). The likelihood ratios for positive and negative test results were 10.8 (95% CI, 3.4 to 34.4) and 0.16 (95% CI, 0.1 to 0.27) respectively, with an area under the curve of 0.935 (95% CI, 0.693 to 0.989). The sources of heterogeneity explored had no significant impact on diagnostic performance.	4
10. Chan V, Tse D, Dixon S, et al. Outcome Following a Negative CT Angiogram for Gastrointestinal Hemorrhage. <i>Cardiovasc Intervent Radiol</i> . 2014:[E-pub ahead of print].	Observational-Dx	180 patients	To evaluate the role of a negative CTA in patients who present with GI hemorrhage.	A total of 180 patients had 202 CTAs during the 8-year period: 87 CTAs were performed for upper GI hemorrhage (18 positive for active bleeding, 69 negative) and 115 for LGIB (37 positive for active bleeding, 78 negative); 58.7% (37/63) of patients with upper GI bleed and 77.4% (48/62) of patients with LGIB who had an initial negative CTA did not rebleed without the need for radiological or surgical intervention. This difference was statistically significant ( $P=0.04$ ). The relative risk of rebleeding, following a negative CTA, in LGIB vs upper GI bleeding patients is 0.55 (95% CI, 0.32–0.95).	3

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11. Foley PT, Ganeshan A, Anthony S, Uberoi R. Multi-detector CT angiography for lower gastrointestinal bleeding: Can it select patients for endovascular intervention? <i>J Med Imaging Radiat Oncol.</i> 2010;54(1):9-16.	Review/Other-Dx	20 patients	A retrospective review of the results of using MDCT angiography to localize LGIB.	Out of the 20 patients examined, 10 had positive CTAs demonstrating the bleeding site. 9 were hemodynamically unstable at the time of the study. 4 patients with positive CT angiograms were able to be treated directly with surgery and avoided invasive angiography. 10 patients had negative CTAs. 4 of these were hemodynamically unstable, 6 hemodynamically stable. Only 1 required intervention to secure hemostasis, the rest stopped spontaneously. No hemodynamically stable patient who had a negative CTA required intervention. CTA is a useful noninvasive technique for localizing the site of LGIB. In our patient population, in the absence of hemodynamic instability, the diagnostic yield of CTA was low and bleeding was likely to stop spontaneously. In hemodynamically unstable patients, a positive CTA allowed patients to be triaged to surgery or angiography, whereas there was a strong association between a negative CTA and spontaneous cessation of bleeding.	4

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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. <i>AJR Am J Roentgenol.</i> 2008;191(4):1107-1114.	Observational- Dx	41 patients	To compare CT and Tc-99m-labeled RBC scanning for the evaluation of active LGIB.	Findings were positive on contrast-enhanced MDCT and negative on Tc-99m-labeled RBC in 2 patients; findings were negative on contrast-enhanced MDCT and positive on Tc-99m-labeled RBC in 11 patients. Statistics showed significant disagreement, with simple agreement (68.3%, kappa = 0.341, and $P=0.014$ ). 16/60 (26.7%) contrast-enhanced MDCT scans were positive prospectively, with all accurately localizing the site of bleeding and identification of the underlying lesion in 8/16 (50%). 19/41 (46.3%) Tc-99m-labeled RBC scans were positive. 18/41 matched patients went on to angiography. In 4/18 (22.2%) patients, the site of bleeding was confirmed by angiography, but in 14/18 (77.8%), the findings were negative. Contrast-enhanced MDCT and Tc-99m-labeled RBC scanning show significant disagreement for evaluation of active LGIB. Contrast-enhanced MDCT appears effective for detection and localization in cases of active LGIB in which hemorrhage is active at the time of CT.	2
13. Green BT, Rockey DC, Portwood G, et al. Urgent colonoscopy for evaluation and management of acute lower gastrointestinal hemorrhage: a randomized controlled trial. <i>Am J Gastroenterol.</i> 2005;100(11):2395-2402.	Experimental- Tx	50 patients	Prospective randomized study to compare urgent colonoscopy to standard care.	A total of 50 patients were randomized to each group. A definite source of bleeding was found more often in urgent colonoscopy patients (diverticula, 13; angioectasia, 4; colitis, 4) than in the standard care group (diverticula, 8; colitis, 3) (the OR for the difference among the groups was 2.6; 95% CI, 1.1–6.2). In the urgent colonoscopy group, 17 patients received endoscopic therapy; in the standard care group, 10 patients had angiographic hemostasis. There was no difference in outcomes among the 2 groups-including: mortality 2% vs 4%, hospital stay 5.8 vs 6.6 days, ICU stay 1.8 vs 2.4 days, transfusion requirements 4.2 vs 5 units, early rebleeding 22% vs 30%, surgery 14% vs 12%, or late rebleeding 16% vs 14% (mean follow-up of 62 and 58 months).	1

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14. Lhewa DY, Strate LL. Pros and cons of colonoscopy in management of acute lower gastrointestinal bleeding. <i>World J Gastroenterol.</i> 2012;18(11):1185-1190.	Review/Other-Dx	N/A	To discuss the advantages and disadvantages of colonoscopy in the management of acute LGIB.	Colonoscopy has the ability to diagnose all sources of bleeding from the colon and, unlike the radiologic modalities, does not require active bleeding at the time of the examination. In addition, therapeutic interventions such as cautery and endoclips can be applied to achieve hemostasis and prevent recurrent bleeding. Studies suggest that colonoscopy, particularly when performed early in the hospitalization, can decrease hospital length of stay, rebleeding and the need for surgery. However, results from available small trials are conflicting and larger, multicenter studies are needed. Compared to other management options, colonoscopy is a safe procedure with complications reported in <2% of patients, including those undergoing urgent examinations. The requirement of bowel preparation (typically 4 or more liters of polyethylene glycol), the logistical complexity of coordinating after-hours colonoscopy, and the low prevalence of stigmata of hemorrhage complicate the use of colonoscopy for LGIB, particularly in urgent situations.	4
15. Laine L, Shah A. Randomized trial of urgent vs. elective colonoscopy in patients hospitalized with lower GI bleeding. <i>Am J Gastroenterol.</i> 2010;105(12):2636-2641; quiz 2642.	Experimental-Tx	85 patients had urgent upper endoscopy; 13 had upper source; 72 patients randomized to urgent (n=36) or elective (n=36) colonoscopy	Randomized study to determine, in patients with serious hematochezia, the proportion who have an upper GI source and whether urgent colonoscopy improves outcomes as compared with elective colonoscopy in those without an upper source.	Further bleeding occurred in 8 (22%) vs 5 (14%) of the urgent vs elective groups (difference=8%, 95% CI, -9% to 26%). Units of blood (1.5 vs 0.7), hospital days (5.2 vs 4.8), subsequent diagnostic or therapeutic interventions for bleeding (36% vs 33%), and hospital charges (\$27,590 vs \$26,633) also were not lower in the urgent group. A major limitation is that the study was terminated before reaching the pre-specified sample size. Patients with clinically serious hematochezia should have upper endoscopy initially to rule out an upper GI source. Use of urgent colonoscopy in a population hospitalized with serious LGIB showed no evidence of improving clinical outcomes or lowering costs as compared with routine elective colonoscopy.	2

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16. Yi WS, Garg G, Sava JA. Localization and definitive control of lower gastrointestinal bleeding with angiography and embolization. <i>Am Surg.</i> 2013;79(4):375-380.	Review/Other-Dx	152 patients	To evaluate the efficacy of angiography and embolization for localizing and treating LGIB as well as to evaluate the occurrence of bowel ischemia after embolization.	159 angiograms were performed on 152 patients. Mean age was 72 years. Angiographic localization was successful in 23.7% of patients. Although embolization after angiographic localization achieved definitive control of bleeding in 50% of patients, the success rate was only 8.6% of all patients who had angiography. 1 patient developed postembolization ischemia requiring laparotomy. Angiographic localization of LGIB is successful in only 23.7% of patients. Definitive hemostasis through embolization was successful in only 8.6% of patients who underwent angiography for LGIB.	4
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. <i>J Vasc Interv Radiol.</i> 2010;21(4):477-483.	Observational-Dx	34 patients	To retrospectively evaluate the safety and effectiveness of provocative angiography.	Tissue-type plasminogen activator infusion yielded extravasation of contrast in 31% of patients all of whom had negative prior studies. No bleeding complications occurred. In this series, provocative mesenteric angiography was safe and effective for eliciting the source of occult LGIB, leading to definitive therapy in about one third of patients.	4
18. Widlus DM, Salis AI. Reteplase provocative visceral arteriography. <i>J Clin Gastroenterol.</i> 2007;41(9):830-833.	Review/Other-Dx	9 patients	A retrospective study reporting the results of using reteplase for provocative angiography.	Colonic bleeding was stimulated in 8 patients (89%) allowing embolization or surgery to treat the bleeding in 7 patients. Reteplase may prove safe and effective as a provocative agent, stimulating bleeding to allow localization, in patients with occult, recurrent, massive LGIB.	4
19. Abbas SM, Bissett IP, Holden A, Woodfield JC, Parry BR, Duncan D. Clinical variables associated with positive angiographic localization of lower gastrointestinal bleeding. <i>ANZ J Surg.</i> 2005;75(11):953-957.	Observational-Dx	88 patients	To determine what clinical factors predict positive angiographic demonstration of bleeding site by auditing the Auckland Hospital experience of selective angiography, in localizing LGIB.	Bleeding site was localized in 50%. Indicators of a positive angiogram were hemodynamic instability, particularly those needing more than 5 units of blood to achieve hemodynamic stability. Catheter angiography for acute LGIB will successfully localize a point of bleeding in approximately 50% of patients. The most useful clinical indicator for positive angiography was hemodynamic instability particularly in those who require transfusion of $\geq 5$ units of blood to achieve hemodynamic stability.	4

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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. <i>Am J Gastroenterol.</i> 2005;100(11):2407-2418.	Review/Other-Dx	396 patients; 14 studies	To evaluate the yield of small bowel findings with CE compared to other modalities in patients with occult bleeding.	CE had a much higher diagnostic yield than other modalities. CE is superior to push enteroscopy and small bowel barium radiography for diagnosing clinically significant small bowel pathology in patients with OGIB. In study populations, the incremental yield of CE over push enteroscopy and small bowel barium radiography for clinically significant findings is $\geq 30\%$ with a number needed to test of 3, primarily due to visualization of additional vascular and inflammatory lesions by CE.	4
21. Laine L, Sahota A, Shah A. Does capsule endoscopy improve outcomes in obscure gastrointestinal bleeding? Randomized trial versus dedicated small bowel radiography. <i>Gastroenterology.</i> 2010;138(5):1673-1680 e1671; quiz e1611-1672.	Observational-Dx	136 patients	Randomized study to compare CE to barium small bowel radiography both in detection of lesions and in long term outcome.	Diagnostic yield with CE was higher (30% vs 7%) however the rate of subsequent bleeding was essentially equivalent.	4
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. <i>Abdom Imaging.</i> 2008;33(4):398-406.	Review/Other-Dx	N/A	To compare CE and CT in patients with OGIB.	The 2 modalities were fairly similar in accuracy but complimentary in that each missed different kinds of lesions.	4
23. Huprich JE, Fletcher JG, Fidler JL, et al. Prospective blinded comparison of wireless capsule endoscopy and multiphase CT enterography in obscure gastrointestinal bleeding. <i>Radiology.</i> 2011;260(3):744-751.	Observational-Dx	58 patients	To compare the performance of multiphase CT enterography with that of CE in a group of patients with OGIB.	58 adult patients, referred for the evaluation of OGIB (occult, 25 patients [43%]; overt, 33 patients [57%]), underwent both tests. A small bowel bleeding source was identified in 16/58 patients (28%). The sensitivity of CT enterography was significantly greater than that of CE (88% [14/16 patients] vs 38% [6/16 patients], respectively; $P=.008$ ), largely because it depicted more small bowel masses (100% [9/9 patients] vs 33% [3/9 patients], respectively; $P=.03$ ). No additional small bowel tumors were discovered during the follow-up period (range, 5.6–45.9 months; mean, 16.6 months).	2



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24. Wang Z, Chen JQ, Liu JL, Qin XG, Huang Y. CT enterography in obscure gastrointestinal bleeding: a systematic review and meta-analysis. <i>J Med Imaging Radiat Oncol.</i> 2013;57(3):263-273.	Review/Other-Dx	18 studies	To provide a comprehensive and update overview of clinical application of CT enterography in the evaluation of OGIB.	A total of 18 studies (n = 660) reported the yield of CT enterography in evaluating OGIB and the pooled yield was 40% (95% CI: 33%–49%). 7 studies (n = 279) compared the yield of CT enterography with CE. The yield for CT enterography and CE for all findings was 34% and 53%, respectively (IY = -19%, 95% CI = -34% to -4%). When considering the types of identified lesions, the yield was significantly different for vascular and inflammatory lesions but not significantly different for neoplastic or other lesions. 2 studies (n = 63) compared the yield of CT enterography with double-balloon enteroscopy. The yield for CT enterography and double-balloon enteroscopy was 38% and 78%, respectively (IY = -40%, 95% CI = -55% to -25%). 3 studies (n = 49) compared the yield of CT enterography with digital subtraction angiography. The yield for CT enterography and digital subtraction angiography was 64% and 60%, respectively (IY = 4%, 95% CI = -40% to 47%).	4
25. Heo HM, Park CH, Lim JS, et al. The role of capsule endoscopy after negative CT enterography in patients with obscure gastrointestinal bleeding. <i>Eur Radiol.</i> 2012;22(6):1159-1166.	Observational-Dx	30 patients	To evaluate the role of CE in patients with OGIB after negative CT enterography.	Based on CE results, a definitive diagnosis was made for 17 patients (57%): ulcer in 9 patients (30%), active bleeding with no identifiable cause in 5 (17%), angiodysplasia in 2 (7%) and Dieulafoy's lesion in 1 (3%). 2 patients with jejunal ulcers were diagnosed with Crohn's disease. 7 patients (41%) with positive CE received double balloon enteroscopy and 2 patients (12%) received steroid treatment for Crohn's disease. Patients with overt bleeding, a previous history of bleeding, or who received large amounts of blood transfusions were more likely to show positive CE.	3

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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. <i>Scand J Gastroenterol.</i> 2010;45(4):490-500.	Observational-Dx	46 patients	To compare the diagnostic utility and yield of video-capsule enteroscopy to that of MRI in patients with suspected or established Crohn's disease (Group I), OGIB (Group II), or suspected tumors (Group III).	In Group I, lesions were found by video-capsule enteroscopy in 9/21 patients and by MRI in 6. In 5 patients, both modalities showed pathology. In Group II, pathological changes were detected in 11/20 patients by video-capsule enteroscopy and in 8 patients by MRI. In 5 cases, pathology was found with both modalities. In Group III, neither modality showed small-bowel pathology. For the patient groups combined, diagnostic yield was 43% with video-capsule enteroscopy and 30% with MRI. The diagnostic yield of video-capsule enteroscopy was superior to that of MRI in the upper small bowel in both Groups I and II.	3
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. <i>Endoscopy.</i> 2012;44(7):668-673.	Observational-Dx	38 patients	To compare the diagnostic yield of MR enteroclysis and CE in patients with OGIB, using balloon-assisted enteroscopy as the reference standard.	Over a period of 26 months, 38 patients were included (20 female [53%]; mean age 58 years, range 28–75 years). 4 patients (11%) did not undergo CE due to high grade small-bowel stenosis at MR enteroclysis (n = 3; 8%) or timing issues (n = 1; 3%). CE was nondiagnostic in 1 patient. The reference standard identified abnormal findings in 20 patients (53%). MR enteroclysis had sensitivity, specificity, and positive and negative likelihood ratios of 21%, 100%, infinity, and 0.79, respectively. The corresponding values for CE were 61%, 85%, 4.1, and 0.46. The reference standard and CE did not differ in percent positive findings (P=0.34), but MRE differed significantly from the reference balloon-assisted enteroscopy (P<0.001). CE was superior to MR enteroclysis for detecting abnormalities (P=0.0015).	2

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28. Bandi R, Shetty PC, Sharma RP, Burke TH, Burke MW, Kastan D. Superselective arterial embolization for the treatment of lower gastrointestinal hemorrhage. <i>J Vasc Interv Radiol.</i> 2001;12(12):1399-1405.	Review/Other-Tx	48 patients; 2 mesenteric artery catheterization procedures	To evaluate technical success, efficacy and ischemic complications of embolization.	35/48 patients underwent technically successful embolization, and 33/35 achieved initial hemostasis. 12/33 had a recurrence of bleeding and most of these were then treated by surgery. Asymptomatic ischemia occurred in 24% of fully evaluated patients. Embolization provided definitive treatment in 21/48 (44%) patients. Superselective embolization is a feasible, safe, and effective technique for treating acute LGIB.	4
29. d'Othee BJ, Surapaneni P, Rabkin D, Nasser I, Clouse M. Microcoil embolization for acute lower gastrointestinal bleeding. <i>Cardiovasc Intervent Radiol.</i> 2006;29(1):49-58.	Review/Other-Tx	19 patients	To retrospectively assess outcomes after microcoil embolization for LGIB.	Technical success was 89% with clinical success in 84%. 11% rate of colonic ischemia. Microcoil embolization for active LGIB is safe and effective in most patients, with high technical and clinical success rates, no procedure-related mortality, and a low risk of bowel ischemia and late rebleeding.	4
30. Funaki B, Kostelic JK, Lorenz J, et al. Superselective microcoil embolization of colonic hemorrhage. <i>AJR Am J Roentgenol.</i> 2001;177(4):829-836.	Observational-Tx	27 patients	To evaluate efficacy of embolization for severe colonic hemorrhage.	Initial hemostasis achieved in 26/27 patients (96%). 3/26 rebled within 24 hours. One patient developed bowel infarction requiring left hemicolectomy. Prolonged clinical success was seen in 22/27 (81%). Therapeutic microcoil embolization for severe colonic hemorrhage is an effective and well-tolerated procedure.	2

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31. Khanna A, Ognibene SJ, Koniaris LG. Embolization as first-line therapy for diverticulosis-related massive lower gastrointestinal bleeding: evidence from a meta-analysis. <i>J Gastrointest Surg.</i> 2005;9(3):343-352.	Review/Other-Tx	25 publications; 12 consecutive patients	To determine which etiologies of LGIB are best treated with embolization.	Multiple regression analysis demonstrated no significant difference in pooled outcomes when varying the included study, age, or embolization method on the outcome of rebleeding. The pooled OR for arteriovenous dysplastic lesions and other diseases was 3.53 compared with rebleeding after localization and embolization for diverticular disease (95% CI, OR, 1.33, 9.41; $P < 0.01$ ). Embolization for diverticular bleeding was successful in 85% of patients. In contrast, rebleeding after embolization for nondiverticular bleeding occurred in >40% of patients and over a more protracted period. Embolization for LGIB is most effective for the treatment of diverticular bleeding. Caution should be used when applying embolization therapy for nondiverticular causes due to the considerably higher associated failure rate. An inpatient observation period of 2 days is suggested following embolization for diverticular bleeding.	4
32. Kickuth R, Rattunde H, Gschossman J, Inderbitzin D, Ludwig K, Triller J. Acute lower gastrointestinal hemorrhage: minimally invasive management with microcatheter embolization. <i>J Vasc Interv Radiol.</i> 2008;19(9):1289-1296 e1282.	Observational-Tx	20 patients	To assess the efficacy of superselective embolization for LGIB.	100% technical success and 90% clinical success. Had 1 case of colonic infarction. Clinical success attributed to transcatheter arterial embolization was documented in 18/20 patients (90%). Superselective embolization may be used for effective, minimally invasive control of acute LGIB.	2
33. Kuo WT, Lee DE, Saad WE, Patel N, Sahler LG, Waldman DL. Superselective microcoil embolization for the treatment of lower gastrointestinal hemorrhage. <i>J Vasc Interv Radiol.</i> 2003;14(12):1503-1509.	Review/Other-Tx	22 patients	To evaluate the safety and effectiveness of superselective microcoil embolization for LGIB.	Postembolization objective follow-up was performed in 64% of patients (14/22 patients). 10 patients underwent follow-up colonoscopy; 1 patient received a follow-up barium enema; and 3 patients underwent subsequent surgery. Initial success in 100%, but 3 (14%) rebled. There was no major ischemia and 1 case (4.5%) with minor ischemia. Superselective microcoil embolization is a safe and effective treatment for LGIB.	4

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
34. Lipof T, Sardella WV, Bartus CM, Johnson KH, Vignati PV, Cohen JL. The efficacy and durability of super-selective embolization in the treatment of lower gastrointestinal bleeding. <i>Dis Colon Rectum</i> . 2008;51(3):301-305.	Review/Other-Tx	71 patients	To evaluate the short and long term efficacy and safety of superselective embolization for LGIB.	90% were colon or rectal bleeds, only 10% small bowel. PVA exclusive agent in 67%. Immediate hemostasis was seen in 97%. Rebleeding occurred in 16% and 7% developed post embolization ischemia. This large series reaffirms the high success rate (97%) and relatively low acute ischemia risk (7%) of superselective embolization for LGIB. Furthermore, only 15% of patients ultimately required readmission for recurrent bleeding. It is recommended that superselective embolization be used as the primary therapeutic modality in the treatment of angiogram positive LGIB.	4
35. Neuman HB, Zarzaur BL, Meyer AA, Cairns BA, Rich PB. Superselective catheterization and embolization as first-line therapy for lower gastrointestinal bleeding. <i>Am Surg</i> . 2005;71(7):539-544; discussion 544-535.	Review/Other-Tx	23 patients	To study the efficacy of embolization for LGIB.	5 patients (22%) had recurrent bleeding. Symptomatic ischemia was uncommon. Long-term (mean 19 months) follow-up was available for 17 patients. In this series, superselective catheterization and embolization was an effective first-line therapy for LGIB.	4

**Radiologic Management of Lower Gastrointestinal Tract Bleeding  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
36. Tan KK, Wong D, Sim R. Superselective embolization for lower gastrointestinal hemorrhage: an institutional review over 7 years. <i>World J Surg.</i> 2008;32(12):2707-2715.	Observational-Tx	32 patients	To retrospectively assess the results of embolization for LGIB and analyze factors that correlate with treatment failure.	Technical and clinical success for embolization was 97% and 63%. Rebleeding was more likely to occur if the site of bleeding was located in the small bowel compared to the colon (OR: 8.33, 95% CI, 1.03–66.67). It was also more likely in patients with a hematocrit level $\leq 20.0\%$ (OR: 7.52, 95% CI: 1.14–50.00) and a platelets level $\leq 140 \times 10^9/l$ (OR: 9.35, 95% CI: 1.36–62.5) just before the procedure. Surgical resection was also more likely in patients with a hematocrit level $\leq 20.0\%$ just before embolization (OR: 12.66, 95% CI: 1.96–83.33), and it appeared to be more likely if the underlying cause was diverticular disease (OR 8.70, 95% CI: 0.93–83.33). The use of superselective mesenteric embolization for the treatment of LGIB is highly successful and relatively safe 97% technical success and 3% postembolization ischemia in our series. In 63% of cases it is definitive without any further intervention. Greater vigilance must be adopted in treating patients who have active hemorrhage from the small bowel and in those with a hematocrit $\leq 20.0\%$ .	2

**Radiologic Management of Lower Gastrointestinal Tract Bleeding  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
37. Gillespie CJ, Sutherland AD, Mossop PJ, Woods RJ, Keck JO, Heriot AG. Mesenteric embolization for lower gastrointestinal bleeding. <i>Dis Colon Rectum</i> . 2010;53(9):1258-1264.	Observational-Tx	78 patients	To determine the outcome of angiography and embolization and its influencing factors.	There were 107 angiograms performed during 83 episodes of LGIB in 78 patients. Active bleeding was identified in 40 episodes (48%), and embolizations were performed in 37 (45%). One patient without active bleeding on angiogram also underwent embolization, making a total of 38 embolizations. Overall mortality was 7% with 4 deaths due to rebleeding and 2 deaths due to a medical comorbidity (respiratory failure, pneumonia). Short-term complications of angiography were false aneurysm (1 patient) and Enterobacter sepsis (1 patient). Long-term complications were groin lymphocele (1 patient) and late rebleed from collateralization (1 patient). In 43 episodes, angiography did not demonstrate active bleeding. 12 (28%) of these patients continued to bleed, 9 of whom had successful surgery. Of the 38 patients who had embolizations, all had immediate cessation of bleeding. 9 patients (24%) later rebled; 5 of these patients required surgery and 3 had reembolizations. Of the 3 patients who underwent reembolization, 2 developed ischemic bowel and 1 stopped bleeding; surgery was required in 1 patient.	3
38. Huang CC, Lee CW, Hsiao JK, et al. N-butyl cyanoacrylate embolization as the primary treatment of acute hemodynamically unstable lower gastrointestinal hemorrhage. <i>J Vasc Interv Radiol</i> . 2011;22(11):1594-1599.	Review/Other-Tx	27 patients	To evaluate NBCA embolization as the primary treatment for patients with severe and acute hemodynamically unstable LGIB.	The procedure was technically successful in all patients. 26 patients were treated solely with NBCA, and 1 required microcoil embolization. Embolization was performed at the level of the arteria recta or as close as possible to the point of bleeding. Immediate hemostasis occurred in all cases. 4 patients experienced repeat hemorrhage, 1 of whom died. The other 3 were treated successfully with repeat NBCA embolization. None of the surviving patients had evidence of bowel ischemia. In addition, none of the patients with severe underlying disease died during the follow-up period (range, 3 months to 2 years).	4

**Radiologic Management of Lower Gastrointestinal Tract Bleeding  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
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. <i>J Vasc Interv Radiol.</i> 2014;25(1):10-19.	Observational-Tx	112 patients	To assess the safety and efficacy of transcatheter arterial embolization for LGIB and to determine the prognostic factors that affect clinical outcome.	A total of 112 patients were included (36 with small-bowel LGIB, 36 with colon LGIB, and 40 with rectal LGIB). NBCA was the embolic agent for 84 patients (75.0%), whereas gelatin sponge pledgets (n = 20), microcoils (n = 2), polyvinyl alcohol particles with adjunctive gelatin sponge pledgets (n = 1), and blood clots (n = 1) were used in the other patients. The technical success rate was 96.4%. For the entire group, the rates of early recurrent bleeding, major complications, clinical success, and in-hospital mortality were 17.4%, 4.6%, 74.5%, and 25.0%, respectively. These were 15.2%, 4.8%, 75.3%, and 26.2%, respectively, in the NBCA group. Hematologic malignancy, immobilization status, and coagulopathy were significant prognostic factors for clinical outcomes.	2
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. <i>Ann Coloproctol.</i> 2013;29(5):205-208.	Observational-Tx	27 patients	To highlight our experience after adopting mesenteric embolization in the management of acute LGIB.	27 patients with a median age of 73 years (range, 31 to 86 years) formed the study group. More than half (n = 16, 59.3%) of the patients were on either antiplatelet and/or anticoagulant therapy. The underlying etiology included diverticular disease (n = 9), neoplasms (n = 5) and postprocedural complications (n = 6). The colon was the most common bleeding site and was seen in 21 patients (left, 10; right, 11). The median hemoglobin prior to the embolization was 8.6 g/dL (6.1 to 12.6 g/dL). A 100% technical success rate with immediate cessation of hemorrhage at the end of the session was achieved. There were 3 clinical failures (11.1%) in our series. 2 patients re-bled, and both underwent a successful repeat embolization. The only patient who developed an infarcted bowel following embolization underwent an emergency operation and died 1-week later. There were no factors that predicted clinical failure.	3



**Radiologic Management of Lower Gastrointestinal Tract Bleeding  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
41. Peck DJ, McLoughlin RF, Hughson MN, Rankin RN. Percutaneous embolotherapy of lower gastrointestinal hemorrhage. <i>J Vasc Interv Radiol.</i> 1998;9(5):747-751.	Review/Other-Tx	21 patients	To retrospectively evaluate embolization for the treatment of LGIB.	Initial success was achieved in 15 patients (71%), but prolonged hemostasis was seen in only 10 (48%). All embolizations distal to the cecum resulted in prolonged hemostasis, but 3 of 4 jejunal and 3 of 4 cecal embolizations rebled. There were no ischemic complications. Based on these data, it would appear that the risk of bowel ischemia/infarction in the LGI tract may not be as high as has been suggested. 2 regions (cecum and proximal jejunum) were associated with poor results, suggesting these areas may not be as responsive to embolotherapy as other sites in the LGI tract.	4
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. <i>J Vasc Interv Radiol.</i> 2013;24(3):422-431.	Observational-Tx	37 patients	To assess the clinical utility and safety of transcatheter arterial embolization with NBCA for urgent control of acute arterial bleeding in the upper and LGI tract.	The technical success rate was 100%. Recurrent bleeding occurred in 2 patients. Complete hemostasis was achieved in all 11 patients with coagulopathy. Ulcers induced by transcatheter arterial embolization were noted in 6/20 patients who underwent endoscopic examination; the ulcers were successfully treated with conservative measures. Histologic examination revealed that despite inflammatory reactions in and around the vessels, no intestinal necrosis secondary to NBCA embolization was found. Hepatic abscess occurred in 2 cases, and ischemia of the lower limb occurred in 1 case; these complications were managed by percutaneous drainage and bypass surgery.	2
43. Feinman M, Haut ER. Lower gastrointestinal bleeding. <i>Surg Clin North Am.</i> 2014;94(1):55-63.	Review/Other-Dx	N/A	To examine causes of occult, moderate and severe LGIB.	No results stated in abstract.	4
44. Yi WS, Vegeler R, Hoang K, Rudnick N, Sava JA. Watch and wait: conservative management of lower gastrointestinal bleeding. <i>J Surg Res.</i> 2012;177(2):315-319.	Observational-Tx	194 patients	To assess outcomes of patients allowed to exceed traditional triggers for surgery because of LGIB.	194 LGIB patients had scintigraphy during the period of study with 180 meeting inclusion criteria. 56 (31%) patients had at least 1 operative indication, and 32 (60%) were managed nonoperatively without a mortality. There were 2 (8.3%) mortalities in those who had operative management, 1 of which was because of exsanguination. 18 (32%) patients who met operative criteria were unlocalized.	2

## Evidence Table Key

### Study Quality Category Definitions

- *Category 1* The study is well-designed and accounts for common biases.
- *Category 2* The study is moderately well-designed and accounts for most common biases.
- *Category 3* There are important study design limitations.
- *Category 4* The study is not useful as primary evidence. The article may not be a clinical study or the study design is invalid, or conclusions are based on expert consensus. For example:
  - a) the study does not meet the criteria for or is not a hypothesis-based clinical study (e.g., a book chapter or case report or case series description);
  - b) the study may synthesize and draw conclusions about several studies such as a literature review article or book chapter but is not primary evidence;
  - c) the study is an expert opinion or consensus document.

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Dx = Diagnostic

Tx = Treatment

## Abbreviations Key

CE = Capsule endoscopy

CI = Confidence interval

CT = Computed tomography

CTA = Computed tomography angiography

GI = Gastrointestinal

LGI = Lower gastrointestinal

LGIB = Lower gastrointestinal bleeding

MDCT = Multidetector computed tomography

MRI = Magnetic resonance imaging

NBCA = N-butyl cyanoacrylate

NPV = Negative predictive value

OGIB = Obscure gastrointestinal bleeding

OR = Odds ratio

PPV = Positive predictive value

RBC = Red blood cell