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THE SNMMI and EANM PRACTICE GUIDELINE FOR GASTROINTESTINAL BLEEDING SCINTIGRAPHY 2.0

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PREAMBLE

These guidelines are an educational tool designed to assist practitioners in providing appropriate care for patients. They are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care. For these reasons and those set forth below, both the SNMMI and the EANM caution against the use of these guidelines in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the physician or medical physicist in light of all the circumstances presented. Thus, there is no implication that an approach differing from the guidelines, standing alone, is below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in the guidelines when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations of available resources, or advances in knowledge or technology subsequent to publication of the guidelines.
The practice of medicine includes both the art and the science of the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment. Therefore, it should be recognized that adherence to these guidelines will not ensure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of these guidelines is to assist practitioners in achieving this objective.

I. INTRODUCTION

Gastrointestinal bleeding scintigraphy (GIBS) is a noninvasive study that is performed in patients with suspected gastrointestinal (GI) bleeding to determine if the bleeding is active, to localize the bleeding site, and to approximate the bleeding volume for prognostic purposes. These characteristics can be challenging to identify but are important for initiation of prompt and effective therapy. The clinical signs and symptoms and laboratory indicators of GI hemorrhage are often unreliable and misleading regarding the presence of active bleeding. There is frequently a marked lag between the onset of bleeding and the clinical findings. Melena is a sequela of earlier bleeding that could have stopped and blood may remain in the bowel for hours before being evacuated. Orthostatic hypotension and tachycardia may be detected more acutely, but are insensitive and nonspecific. Decrease in hematocrit and elevation in serum blood urea nitrogen (BUN) generally lag behind a bleeding episode, which may have ended hours earlier.

GIBS enables continuous monitoring of the entire GI tract for up to approximately 24 hours (1). The ability to perform continuous imaging increases the likelihood of detection of intermittent bleeding over other techniques that are limited to only a single time point or periodic sampling (2-6). Furthermore, GIBS is a procedure that does not require any patient preparation, can be performed with standard nuclear medicine instrumentation, and is well tolerated even in patients who are acutely ill.

GI bleeding may be classified as upper GI bleeding (above the ampulla of Vater and within reach of esophagogastroduodenoscopy (EGD)), mid GI bleeding (small bowel from the ampulla of Vater to the terminal ileum and can be evaluated by capsule endoscopy or double-balloon enteroscopy), or lower GI bleeding located in the colon which can be evaluated by colonoscopy (7). Common causes of upper GI bleeding include esophageal varices, gastric and duodenal ulcers, gastritis, esophagitis, Mallory-Weiss tears, and neoplasms. The most common causes of mid GI bleeding are angiodysplasia, neoplasms, Crohn’s disease, diverticula, and Meckel’s diverticulum. Common causes of lower GI hemorrhage include angiodysplasia, diverticulosis, benign and malignant bowel neoplasms, adenomatous polyps, inflammatory bowel disease, and infectious bowel disease.

While this guideline is focused on the use of $^{99m}$Tc-labeled autologous red blood cells ($^{99m}$Tc-RBCs) for detection of sites of GI bleeding, the methods described in this guideline may be applicable to localizing occult bleeding elsewhere in the body.

II. GOALS
The purpose of this guideline is to assist nuclear medicine practitioners in recommending, performing, interpreting, and reporting the results of GIBS in adults and children. The goals of GIBS are to determine whether the patient is actively bleeding, to localize the bleeding bowel segment, and to estimate the rate of blood loss, which allows for treatment planning and risk stratification.

III. DEFINITIONS

GIBS is a diagnostic radionuclide imaging study performed with $^{99m}$Tc-RBCs that detects active bleeding into the GI lumen. GI bleeding can be classified as: 1) occult GI bleeding that is detected only on guaiac fecal occult blood testing and 2) overt GI bleeding with clinical signs and symptoms of GI bleeding such as melena or hematochezia. Obscure GI bleeding is defined as persistent or recurrent GI bleeding from an unknown source despite an exhaustive work-up including EGD, colonoscopy, and/or other initial studies and can be either overt or occult in nature (8).

IV. COMMON CLINICAL INDICATIONS

Common indications for gastrointestinal bleeding scintigraphy include but are not limited to:

A. Identification of an active GI bleeding site in patients with overt GI bleeding. GIBS should not be performed in patients with chronic occult GI bleeding because the guaiac fecal occult blood test may detect bleeding at rates well below those necessary to be identified on GIBS.

B. GIBS is indicated primarily for overt mid or lower GI bleeding, specifically for cases where an upper GI bleed has been excluded by nasogastric lavage (9). In this scenario, GIBS can be used as an early diagnostic study for GI bleeding especially for hospitalized patients or patients in the emergency department (9-11). GIBS can be beneficial when other studies require lengthy patient preparation or are contraindicated and particularly after hours when other studies may not be readily available. Although GIBS can also identify overt upper GI bleeding, nasogastric lavage is usually the first procedure performed to confirm upper GI bleeding followed by EGD to identify and treat suspected overt upper GI bleeding.

C. Help identify the source of obscure overt GI bleeding. Two guidelines have removed GIBS from the diagnostic algorithm for obscure overt GI bleeding (12-13). However, most studies have shown that GIBS is useful in assisting to localize the obscure overt bleeding site in these patients (14-21).

D. Risk-stratification of patients with GI bleeding. (22-28)

E. Directing timely diagnostic angiography and assisting in plans for surgical or other interventional procedures. (6,29-34)

V. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL (in the United States)

Refer to Section V of the SNMMI Procedure Guideline for General Imaging 6.0.
VI. PROCEDURE/SPECIFICATIONS OF THE EXAMINATION

A. Request

At the time of the request, it is important for the referring clinician to have a management plan in place prior to GIBS. By coordinating clinical services (such as interventional radiology, gastroenterology, and/or surgery) early, the patient can be directed promptly to the next diagnostic and/or therapeutic procedure if GIBS is positive (35). Any unnecessary delay increases the likelihood of negative angiography as bleeding often stops spontaneously (33).

All pertinent clinical information should be reviewed before the study is started.

Information specifically related to GIBS may include:

1. Clinical signs of GI bleeding:
   a. Frequency, volume, and character (hematochezia, melena, or hematemesis) of bleeding
   b. Current and recent hemoglobin, hematocrit, and BUN
   c. Number of recent transfusions
   d. Current blood pressure and heart rate
   e. Presence of orthostatic vital signs

2. History of prior abdominal or pelvic surgeries

3. Diagnostic studies:
   a. Nasogastric tube aspiration
   b. EGD
   c. Capsule endoscopy
   d. Double-balloon enteroscopy
   e. Sigmoidoscopy or colonoscopy
   f. Prior GIBS
   g. Angiography
   h. CT enterography/angiography

4. Therapeutic interventions:
   a. Endoscopic epinephrine injection, coagulation (by cautery, heater probe, laser, or argon plasma coagulator) or mechanical therapy (clips, bands, or detachable loops)
   b. Angiographic embolization
   c. Selective arterial infusion of vasoconstrictors such as vasopressin

5. Current medications

6. Factors that may decrease RBC radiolabeling efficiency (3,36-37)
   a. Drug interactions:
      i. Iodinated contrast
      ii. Chemotherapy
      iii. Digoxin
      iv. Calcium channel blockers
      v. Cyclosporin
      vi. Metronidazole
      vii. Ranitidine
      viii. Propanolol
      ix. Quinidine
x. Dipyridamole

xi. Heparin

b. Low hematocrit

c. Sickle-cell disease or thalassemia

d. Circulating antibodies from prior transfusion or transplantation

7. Oral contrast agents such as barium used for other GI imaging studies can cause photopenic artifacts (38). However the presence of these agents is not an absolute contraindication for GIBS (39).

B. Patient preparation and precautions

1. Patients with suspected GI bleeding who are considered hemodynamically unstable should be monitored by a physician or nurse while in the nuclear medicine department.

2. Reinjection of radiolabeled blood poses the risk of incorrect administration to the wrong patient. Written policies must be in place with special safeguards regarding the handling and administration of blood to eliminate any possibility of administration to the wrong patient particularly when two or more red cell labeling studies are performed simultaneously. Universal precautions must be followed to avoid staff exposure to blood products. Refer to Section III.G of the SNMNI Procedure Guideline for Use of Radiopharmaceuticals 4.0.

3. Fasting is not required for GIBS. However, fasting may be required for subsequent procedures such as angiography or surgery.

4. Patients should be instructed to void immediately prior to imaging so they are comfortable during a potentially long scan and to facilitate scan interpretation.

C. Radiopharmaceuticals

Historically, two radiopharmaceuticals have been used for GIBS: $^{99m}$Tc-RBCs and $^{99m}$Tc-sulfur colloid. $^{99m}$Tc-RBCs are the radiopharmaceutical of choice for performing GIBS due to an intravascular half-life that allows continuous imaging of the GI tract over many hours (40-43). In contrast, $^{99m}$Tc-sulfur colloid is rarely used because of its short residence time in the vascular compartment. $^{99m}$Tc-sulfur colloid is rapidly cleared from the blood by the reticuloendothelial system (liver, spleen, and bone marrow) restricting scan times to only 20-30 minutes (41,44). In addition, significant activity in the liver and spleen may mask the identification of a bleeding site adjacent to these organs. The superior clinical utility of $^{99m}$Tc-RBCs has been demonstrated in comparison studies (40-42).

$^{99m}$Tc-RBCs can detect GI bleeding at a rate as low as 0.04 mL/min in experimental animal models and 0.1 mL/min in clinical studies (28,45). High efficiency of RBC labeling with minimal unbound $^{99m}$Tc is critical to producing optimal, artifact-free images. Three techniques are available to label RBCs: in vitro, modified in vivo and in vivo methods. The in vitro method using a commercially available kit yields the highest labeling efficiency (≥95%) and is the method of choice (46-47). A further advantage of the in vitro method is that a sample can be evaluated for radiolabeling efficiency with a centrifuge method as described in the manufacturer’s package insert. Additionally, if radiolabeling is substandard due to a drug interaction, low hematocrit, or other factor (see Section VI.A.6 above), or to a
procedural deviation, a salvage technique may be attempted (48). This procedure involves transferring the in vitro $^{99m}$Tc-RBCs into a sterile 15 mL polypropylene centrifuge tube and centrifuging at 400 g for 5 minutes. The supernatant is then removed with a sterile pipette and the $^{99m}$Tc-RBCs are resuspended in 2 mL of 0.9% sodium chloride. If the radiochemical purity of the $^{99m}$Tc-RBCs is subsequently more than 95% and adequate radioactivity remains, the salvage is deemed successful. The modified in vivo label (90% labeling efficiency) can serve as an alternative when the in vitro method is not available (49-50). The in vivo method is not recommended due to suboptimal labeling and a higher likelihood of free $^{99m}$Tc-pertechnetate. However, the in vivo method may be needed for patients who, due to religious convictions or other reasons, will not accept injection of blood.

The recommended administered activity of $^{99m}$Tc-RBCs is 555-1110 MBq (15-30 mCi) in adults. In children under 18 years old, the recommended administered activity is based on the EANM Pediatric Dosage Card which uses a baseline activity of 56 MBq (1.51 mCi) multiplied by a weight-based multiple (51-52). The resulting minimum administered activity is 80 MBq (2.16 mCi) for a 3 kg patient and the maximum administered activity is 784 MBq (21.19 mCi) for a 68 kg patient.

D. Protocol/Image acquisition

1. Image acquisition

In the supine position, anterior images of the abdomen and pelvis are acquired using a large field-of-view gamma camera. A low-energy high-resolution collimator is preferred although a low-energy general-purpose collimator can be used. If the study must be performed at the bedside using a small field-of-view portable camera, a diverging collimator (if available) may be used to visualize the entire abdomen and pelvis, particularly in large patients. A minimum image matrix of 128 x 128 is recommended. Any items on the patient that may produce imaging artifacts should be removed or moved out of the field-of-view. Care should be taken to keep patients’ upper extremities from overlying the abdomen and pelvis during imaging as they can obscure findings and their movement can cause artifacts.

Following the injection of $^{99m}$Tc-RBCs, rapid image acquisition at a rate of 1 frame per 1-3 seconds for 60 seconds (nuclear angiography) can be performed to visualize the distribution of vascular structures and may help differentiate between blood pool activity and bleeding on later images. However, these angiographic images seldom add to the overall study result and are considered optional.

Immediately following the angiographic study, dynamic imaging should be performed. Serial intermittent static images are not recommended. The maximum recommended frame rate should not exceed 1 frame per 60 seconds. As the frame rate becomes longer, the temporal resolution of the scan decreases, possibly leading to inaccurate localization of the bleeding source.

Since intraluminal blood promotes rapid bowel peristalsis and movement of blood antegrade and/or retrograde away from the bleeding site, faster frame rates such as 1 frame per 10-20 seconds allow for higher temporal resolution to better localize the GI bleeding site (53). On the other hand, a small volume of
273 intraluminal blood and/or slow GI bleeding may be more difficult to detect when
274 utilizing fast frame rates due to lower count densities (53). This shortcoming can
275 be compensated by reformatting the acquired study into longer frames (53-54).
276 Therefore, reformatting is recommended when using fast frame rates. However,
277 the optimal dynamic frame rate for GIBS has not been established since there are
278 no published clinical studies that have compared these various acquisition
279 techniques.
280
281 Acquiring the dynamic images in 10-15 minute sequences may facilitate
282 review of these images by the physician as one series can be reviewed while
283 subsequent sequences are still being acquired.
284
285 Since GI bleeding occurs intermittently, the patient should be imaged
286 continuously for as long as practical to identify the bleeding source (10,34,55-57).
287 Initial imaging for a minimum of 60 minutes is recommended if no GI bleeding is
288 detected (14,19,42,54,58).
289
290 Urine activity in a full bladder may obscure sigmoid or rectal bleeding on
291 a standard anterior view. Lateral, posterior, and/or subpubic views may help in
292 identifying activity in the rectum that would otherwise not be detected due to
293 bladder activity or soft-tissue attenuation. The entire abdomen and pelvis must be
294 examined before concluding that no GI bleeding is detected. When a dual-headed
295 camera is used, simultaneous imaging in the anterior and posterior views may
296 improve the sensitivity for detecting rectal bleeding. Furthermore, lateral views
297 are helpful in differentiating anterior vascular penile activity (which can move or
298 change in intensity during imaging) from bleeding in the more posteriorly located
299 rectosigmoid colon (35).
300
301 If the patient has a bowel movement during the scan, the stool should be
302 imaged to assess for radioactivity. The presence of radioactivity in the stool
303 would only confirm active GI bleeding and does not necessarily localize the
304 origin of the bleeding. If gastric activity is visualized, an anterior image of the
305 head and neck should be obtained to evaluate for possible thyroid and salivary
306 gland activity. Activity at these sites suggests the presence of free $^{99m}$Tc-
307 pertechnetate as the cause of the gastric activity rather than gastric bleeding.
308
309 If no bleeding site is identified on the initial images, delayed images can
310 be acquired by re-scanning the patient for up to 24 hours, especially if there is
311 clinical evidence of recurrent GI bleeding (see section F.2 below). All delayed
312 images should be acquired using the same dynamic method as the initial images.
313
314 2. Processing
315
316 If motion correction software is available, it can minimize the effects of
317 patient movement.
318
319 Computer subtraction of background activity of early images from later
320 frames in the imaging sequence has the following limitations:
321 1) The patient must remain still during the examination or motion
322 correction software must be applied and
323 2) The biodistribution of the $^{99m}$Tc-RBCs should be similar between the
324 early frames and any image to be subtracted (53,59-63). Failure to
325 control these factors can cause false positive findings.
3. Interventions

Pharmacologic intervention is controversial and is not widely used. The use of anticoagulants and/or thrombolitics, such as heparin and urokinase, has been suggested as an adjunct to provoke bleeding (64-67). However, these interventions have a significant risk of severe bleeding and should only be considered for select patients with recurrent bleeding from an unknown site despite a comprehensive work-up and should be performed under direct physician supervision. Glucagon has also been suggested as an adjunct to GIBS because it decreases intestinal peristalsis and increases vasodilatation. Small studies have shown mixed results on its use (68-69).

E. Interpretation

Accurate interpretation of GIBS requires knowledge of normal and abnormal anatomic variations in the abdomen and pelvis. Comparison with anatomic imaging studies (CT, MRI, or radiographs) of the abdomen and pelvis is useful in establishing GI tract and vascular anatomy. Review of the dynamic images in cinematic display is essential to detect subtle GI bleeding and avoid inaccurate localization of the bleeding site (1-2,54,70-71). Proper adjustment of grayscale levels on the interpreting physician’s computer display also facilitates the detection of subtle abnormalities.

$^{99m}$Tc-RBCs are rapidly distributed within the vascular space including the heart, liver, spleen, and great vessels. Some excreted radioactivity may be seen in the urinary tract due to small amounts of free $^{99m}$Tc-pertechnetate and other $^{99m}$Tc moieties even when in vitro labeling is used (72). The initial angiographic phase images rarely reveal the site of rapid GI bleeding that may be difficult to localize on the subsequent dynamic images or a vascular blush in neoplasms, arteriovenous malformations, or angiodysplasia (54,73-74).

The key diagnostic criteria for scintigraphic GI bleeding are: 1) appearance of activity outside the expected anatomical blood pool structures, 2) changing intensity of the activity on consecutive images, and 3) movement of the activity in a pattern consistent with bowel. All three of the above criteria must be satisfied to diagnose a site of active GI bleeding.

Small bowel bleeding usually can be distinguished from large bowel bleeding by its rapid curvilinear movement and usual central location in the abdomen or pelvis. In comparison, large bowel bleeding has a more linear pattern and typically occurs in the periphery of the abdomen or pelvis. Large bowel bleeding can also be visualized as an S-shaped pattern in the central pelvis conforming to the distribution of the rectosigmoid colon. The origin of the site of GI bleed should be reported as the location of the initial site of detected activity rather than the most intense, largest, or most proximal site of activity.

GIBS may be used to estimate the severity of the bleeding. Factors associated with a low bleeding rate include: visualization of blood after 1 h, activity less intense than that in the liver, and shorter bleeding durations (28). Higher bleeding rates are associated with early appearance of blood in the bowel, intense activity equal to or greater than that in the liver and longer duration of bleeding (28).
F. Sources of error

1. Image acquisition should continue for sufficient time after abnormal focal red cell activity is initially detected to confidently identify the bleeding site. Accurate localization of the bleeding site is dependent upon identification of the initial location of extravasated blood and movement of blood from that site within the bowel lumen. Increased imaging time may be particularly needed to differentiate a small bowel bleed from a large bowel bleed. Single photon emission computed tomography/computed tomography (SPECT/CT) may be also helpful in this context (75).

2. Delayed imaging after a period of non-imaging can be problematic since bowel activity seen immediately on the first frame of delayed images merely indicates that bleeding originating elsewhere in the GI tract has occurred during the interim and should not be misinterpreted as the bleeding site. Therefore, the location of delayed bowel activity should only be reported as the bleeding site when an actual episode of RBC extravasation on dynamic imaging is observed. Digital subtraction may be helpful for identification of the actual site of active bleeding when delayed images have been obtained (see Section D2 above). The benefits of delayed imaging, including its effect on patient management such as transfusion requirements, referrals to angiography and/or surgery, and clinical outcomes, are controversial (76-77). Many investigators have shown that delayed images are not as accurate in localizing the site of GI bleeding compared to early imaging (30,34,58,76,78-79). Some authors advocate imaging patients for as long as possible during the initial phase rather than performing routine delayed imaging at arbitrary time intervals hours after injection (10,56). Other investigators have demonstrated usefulness of delayed imaging in detecting a site of intermittent GI bleeding not seen on the initial phase (1,40,55,57,62,80-82). Therefore, delayed imaging is considered optional.

3. Interpretative pitfalls include:
   a. Free $^{99m}$Tc-pertechnetate:
      i. Free $^{99m}$Tc-pertechnetate can be visualized in the upper GI tract secondary to swallowed salivary gland activity and/or excreted gastric mucosal activity. Since free $^{99m}$Tc-pertechnetate can move from the stomach into the small bowel over time, it can be mistaken for upper GI bleeding.
      ii. Urinary tract activity may be seen in the abdomen or pelvis.
      iii. Images of the neck to detect thyroid and salivary gland activity can confirm the presence of free $^{99m}$Tc-pertechnetate as a source of artifact.
   b. The following causes of increased RBC activity can confound interpretation:
      i. Reproductive system:
         1. Penile blood pool can be mistaken for rectal bleeding (83). Obtaining lateral images or changing position of the penis can distinguish penile activity from rectal bleeding (35).
2. Variable uterine activity during the ovulatory cycle causes fixed increased perfusion due to endometrial proliferation (84).

3. Uterine leiomyoma may show transient, fixed activity due to hypervascularity (85-86).

ii. Renal activity is usually fixed but can confuse interpretation when the activity arises from an unexpected location such as:
   1. Pelvic or ectopic kidney (87-88)
   2. Horseshoe kidney (89)
   3. Renal transplant

iii. Movement or pooling of urine activity can mimic GI bleeding located in the following areas:
   1. Ureter
   2. Bladder or bladder diverticulum (3)
   3. Urinary diversion surgery

iv. Vascular:
   1. Abdominal aortic or iliac aneurysms present as static activity. However, rupture can mimic GI bleeding (90-93).
   2. Aortoduodenal fistula rupture (94).
   3. Hemangiomas in the liver or small bowel (95-96).
   4. Abdominal varices usually present as fixed activity. However, they can rupture and cause bleeding (97-101).
   5. Ovarian vein may appear as static, linear activity (102).

v. Splenic variants and pathology can cause fixed activity in the form of accessory spleens and splenosis. They can mimic GI bleeding if they rupture (103-105).

vi. Activity in the gallbladder in patients with renal failure or prior transfusions from hepatobiliary excretion of radiolabeled heme. Less commonly, gallbladder activity can be seen with hemobilia (106-111).

vii. Bleeding from a pancreatic pseudocyst through the papilla of Vater and into the duodenum (112).

viii. A catheter site can cause static activity in the abdominal wall (113).

ix. Blush of activity in bowel due to hyperemia following surgical resection or in Crohn’s disease (91).

x. Non-enteric bleeding activity can move and accumulate and confuse interpretation including:
   1. Intrapertoneal hemorrhage (114-115)
   2. Mesenteric bleeding (116)
   3. Soft tissue hematoma/hemorrhage (117-122)

xi. Both benign and malignant neoplasms and metastatic disease can cause hyperemia and bleeding when ulcerated or necrotic (123-132).

xii. Retroperitoneal bleeding can show focal uptake that grows in intensity, but is not expected to move in a luminal pattern (133).
G. Issues requiring further clarification

SPECT: Using planar technique, GIBS may only be able to approximate the site of bleeding. The inherent 3D nature of SPECT with multi-plane reconstruction may yield more accurate localization of a GI bleeding site. Comparison of SPECT results to anatomic cross sectional imaging such as CT and MRI can also help to identify the source of bleeding.

SPECT/CT: Software fused SPECT and CT images can be beneficial but are limited due to potential interval change in bowel location between the two modalities. The use of dedicated SPECT/CT hybrid cameras can help overcome these shortcomings. Several early studies have suggested that SPECT/CT scanning is able to better pinpoint the site of bleeding not well localized or equivocal on planar images or to differentiate physiologic uptake from pathologic activity (135-137). In one study where abnormal activity on standard planar scans were evaluated by SPECT/CT, 37% of these patients required SPECT/CT to either precisely localize the site of GI bleeding or to exclude GI bleeding (136). While these authors used a 30 minute acquisition for the SPECT images, a shorter acquisition (approximately 15 minutes) may be adequate.

SPECT/CT can be particularly helpful in slow GI bleeding when one may have to wait a long time to see the bowel activity conform into a more specific pattern (75). SPECT/CT can also estimate the length of the GI tract leading to the bleeding site and therefore help decide which endoscopic approach to utilize for further evaluation (75). Furthermore, SPECT/CT helps clarify and avoid the pitfalls that can mimic GI bleeding (35). Larger studies are needed to validate these results. No data exists on the use of SPECT/CT when planar GIBS shows no evidence of GI bleeding.

VII. DOCUMENTATION/REPORTING
A. Goals of the report
Refer to Section VII.A of the SNMMI Procedure Guideline for General Imaging 6.0.

B. Direct communication
Refer to Section VII.B of the SNMMI Procedure Guideline for General Imaging 6.0.

C. Written Communication
Refer to Section VII.C of the SNMMI Procedure Guideline for General Imaging 6.0.

D. Contents of the report
1. Study identification
2. Patient demographics
3. Clinical information (indication for the study)
4. Comparison/correlative imaging data
5. Procedure description
   a. Radiopharmaceutical, dose, and route of administration
   b. Radiolabeling method for RBCs (in vitro, in vivo, or modified in vivo)
   c. Duration of the acquisition, frame rate, projections acquired, and whether delayed or special images were obtained
6. Study quality and limitations, if any
7. Description of findings
   a. Describe the presence of any baseline vascular, GI tract or solid organ
      variants
   b. Characteristics of any abnormal activity:
      i. Description of the time of onset in relation to injection
      ii. Shape
      iii. Intensity: activity in relationship to the background liver activity
      iv. Extent:
          1. Subjective volume: small, medium, or large amount of
             bleeding
          2. Focal or diffuse
      v. Presence or absence of movement:
          1. Stationary activity
          2. Movement of activity in the GI tract:
             a. Curvilinear (small bowel type) progression of
                activity versus more linear (large bowel type)
                movement
             b. Rapid versus slow movement
             c. Antegrade and/or retrograde movement
   c. Location
      i. Quadrant of the abdomen and pelvis
      ii. Gastric
      iii. Small bowel: duodenum, jejunum, or ileum. If SPECT/CT is used, an attempt
           should be made to approximate the distance from the
           ampulla of Vater to the bleeding site to help determine which
           endoscopic technique can be utilized should gastroenterology is
           consulted. The ampulla of Vater is located in the medial aspect of
           the 2\textsuperscript{nd} (descending) portion of the duodenum at the confluence
           of the common bile duct and pancreatic duct.
      iv. Large bowel: Cecum, ascending colon, hepatic flexure, transverse
           colon, splenic flexure, descending colon, sigmoid colon, or rectum.
      v. If the bleeding site cannot be definitively localized, then giving an
         approximate site based on the imaging characteristics is
         appropriate.

8. Impression
   a. State whether the study was positive or negative for active GI bleeding.
   b. For a positive scan, describe the originating site of GI bleeding whenever
      possible.

VIII. EQUIPMENT SPECIFICATION

A large field-of-view gamma camera equipped with a low-energy high-resolution
collimator is preferred although a low-energy general-purpose collimator may also be
used. When the study must be performed at the bedside, a diverging collimator is useful
to visualize the maximum abdominal and pelvic areas. A SPECT or SPECT/CT camera
can be used to assist further localization of the GI bleeding site. Refer to SNMMI
Guideline for SPECT/CT Imaging 1.0.
IX. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION CONCERNS

Refer to Section IX of the SNMM Procedure Guideline for General Imaging 6.0.

X. RADIATION SAFETY IN IMAGING

Refer to Section X of the SNMM Procedure Guideline for General Imaging 6.0.

Radiation dosimetry in adults, 5-yr old child and fetus are presented in Tables 1-3.

Administration of radiopharmaceuticals to pregnant, potentially pregnant, or lactating patients is addressed in the SNMM Procedure Guideline for General Imaging 6.0. ICRP publication 106, Appendix D, suggests that lactating patients who receive in vivo $^{99m}$Tc-RBCs require a 12 hour interruption of breast feeding. No cessation of breast feeding is required for patients receiving in vitro $^{99m}$Tc-RBCs. The physician must consider the indication for the test, the potential benefit the information may provide, and the potential radiation risk to the mother and fetus.

### TABLE 1
Radiation Dosimetry: Adults*

<table>
<thead>
<tr>
<th>Radiopharmaceutical</th>
<th>Administered activity</th>
<th>Organ receiving the largest radiation dose</th>
<th>Effective dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{99m}$Tc-RBCs</td>
<td>555–1,100 IV (15–30)</td>
<td>0.023 heart (0.085)</td>
<td>0.0070 (0.026)</td>
</tr>
</tbody>
</table>


### TABLE 2
Radiation Dosimetry: Children*

(5 Years Old)

<table>
<thead>
<tr>
<th>Radiopharmaceutical</th>
<th>Administered activity</th>
<th>Organ receiving the largest radiation dose</th>
<th>Effective dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{99m}$Tc-RBCs</td>
<td>11.39-26.67 IV (0.31-0.72)</td>
<td>0.066 heart (0.24)</td>
<td>0.021 (0.078)</td>
</tr>
</tbody>
</table>

Radiation Dosimetry: Dose Estimates to the Fetus

\(^{99m}\text{Tc-RBCs}\)

<table>
<thead>
<tr>
<th>Stage of Gestation</th>
<th>Fetal Dose mGy/MBq (rad/mCi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early</td>
<td>0.0068 (0.025)</td>
</tr>
<tr>
<td>3 months</td>
<td>0.0047 (0.017)</td>
</tr>
<tr>
<td>6 months</td>
<td>0.0034 (0.013)</td>
</tr>
<tr>
<td>9 months</td>
<td>0.0028 (0.010)</td>
</tr>
</tbody>
</table>


XI. ACKNOWLEDGEMENTS

The Committee on SNMMI Guidelines consists of the following individuals: Kevin J. Donohoe, MD (Chair) (Beth Israel Deaconess Medical Center, Boston, MA); Sue Abreu, MD (Sue Abreu Consulting, Nichols Hills, OK); Helena Balon, MD (Beaumont Health System, Royal Oak, MI); Twyla Bartel, DO (UAMS, Little Rock, AR); Paul E. Christian, CNMT, BS, PET (Huntsman Cancer Institute, University of Utah, Salt Lake City, UT); Dominique Delbeke, MD (Vanderbilt University Medical Center, Nashville, TN); Vasken Dilsizian, MD (University of Maryland Medical Center, Baltimore, MD); Kent Friedman, MD (NYU School of Medicine, New York, NY); James R. Galt, PhD (Emory University Hospital, Atlanta, GA); Jay A. Harolds, MD (OUHSC-Department of Radiological Science, Edmond, OK); Aaron Jessop, MD (UT MD Anderson Cancer Center, Houston, TX); David H. Lewis, MD (Harborview Medical Center, Seattle, WA); J. Anthony Parker, MD, PhD (Beth Israel Deaconess Medical Center, Boston, MA); James A. Ponto, RPh, BCNP (University of Iowa, Iowa City, IA); Lynne T. Roy, CNMT (Cedars-Sinai Medical Center, Los Angeles, CA); Heiko Schöder, MD (Memorial Sloan-Kettering Cancer Center, New York, NY); Barry L. Shulkin, MD, MBA (St. Jude Children’s Research Hospital, Memphis, TN); Michael G. Stabin, PhD (Vanderbilt University, Nashville, TN); Mark Tulchinsky, MD (Milton S. Hershey Med Center, Hershey, PA)

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XII. REFERENCES


37) Sampson CB. Complications and difficulties in radiolabelling blood cells: a


Anez LF, Gupta SM. Serendipitous detection of a horseshoe kidney during blood


XIII. APPROVAL

This practice guideline (Version 2.0) was approved by the Board of Directors of the SNMMI on Month, Day, 2014. Version 1.0 was approved on February 7, 1999.