

# Cinematic Nuclear Scintigraphy Reliably Directs Surgical Intervention for Patients With Gastrointestinal Bleeding

Brian B. O'Neill, MD; Jessica E. Gosnell, MD; Robert J. Lull, MD; William P. Schecter, MD; Johannes Koch, MD; Robert A. Halvorsen, MD; Hobart W. Harris, MD, MPH

**Hypothesis:** Cinematic technetium Tc 99m red blood cell (<sup>99m</sup>Tc-RBC) scans, in which real-time scanning is performed and analyzed, can accurately localize gastrointestinal bleeding and thus direct selective surgical intervention.

**Design:** Retrospective medical record review with historical controls.

**Setting:** Large, university-affiliated public hospital in urban setting.

**Patients:** Twenty-six patients presenting with upper and lower gastrointestinal hemorrhage who underwent cinematic <sup>99m</sup>Tc-RBC scan examinations between 1990 and 1997 and required surgical intervention to control the bleeding.

**Interventions:** All patients with gastrointestinal bleeding underwent open surgical procedures to provide cessation of bleeding and resection of appropriate abnormalities.

**Main Outcome Measures:** Patient outcome was based on correlation between preoperative RBC scans and in-

traoperative findings, surgical pathology, and postoperative clinical course.

**Results:** Twenty-five (96%) of 26 scans were interpreted as positive for gastrointestinal bleeding. In 22 of these 25 scans, the site of bleeding was correctly identified for a sensitivity of 88%. One or more additional diagnostic tests were performed on 19 (73%) of 26 patients, and included angiography and flexible endoscopy. The most common operation performed to control bleeding was a hemicolectomy (14/26). Diverticulosis was the most prevalent diagnosis (46%). Two patients (8%) experienced rebleeding after operation. The overall mortality rate was 19% (5/26).

**Conclusions:** Cinematic <sup>99m</sup>Tc-RBC scintigraphy is a sensitive, noninvasive alternative to mesenteric angiography for accurately localizing the site of gastrointestinal hemorrhages. As such, this technique can be reliably used to direct selective surgical intervention.

*Arch Surg.* 2000;135:1076-1082

**G**ASTROINTESTINAL bleeding remains a frequently encountered clinical entity, the incidence of which has remained relatively constant at approximately 70 episodes per 100 000 population per year.<sup>1</sup> Although the treatment of gastrointestinal bleeding is often straightforward, the identification and localization of the source of bleeding is more challenging.

The inability to promptly identify and localize the source of gastrointestinal bleeding adversely affects patient outcome. Delay in localization leads to increased episodes of bleeding, greater transfusion requirements, and poorer prognosis.<sup>2</sup> Historically, clinicians have relied on one or more of the following tests to arrive at their diagnoses: barium enema, endoscopy, angiography, and nuclear

scintigraphy. Nevertheless, the localization of gastrointestinal bleeding can remain elusive in up to 25% of cases.<sup>1</sup>

The inability to identify or accurately localize the site of gastrointestinal bleeding can lead to the performance of improper segmental resections or blind subtotal abdominal colectomies. These untoward events underscore the importance of having a diagnostic examination that is both safe and noninvasive and that permits accurate, rapid localization of gastrointestinal bleeding sites.

The introduction of nuclear scintigraphy using technetium Tc 99m-labeled red blood cells (<sup>99m</sup>Tc-RBC) in the late 1970s added another diagnostic modality to the clinician's armamentarium. Scans have the advantage of being a safe, noninvasive examination with no associated morbidities. Technetium 99m has a half-

*From the Departments of Surgery (Drs O'Neill, Gosnell, Schecter, and Harris), Radiology (Drs Lull and Halvorsen), and Medicine (Dr Koch), San Francisco General Hospital, University of California, San Francisco.*

## PATIENTS AND METHODS

We performed a retrospective review of all patients who underwent  $^{99m}\text{Tc}$ -RBC scintigraphy for the evaluation of clinically significant gastrointestinal bleeding prior to undergoing surgical intervention. All patients were evaluated at San Francisco General Hospital (San Francisco, Calif), a large, university-affiliated public hospital, during the period from June 1990 to July 1997. The medical records of all patients were reviewed for comorbidities, medications, vital signs, hematocrits, transfusion requirements, length of hospitalization, additional diagnostic modalities employed to confirm the preoperative diagnoses, intraoperative findings, surgical pathologic findings, and postoperative clinical course. These data were compared with interpretations of the preoperative RBC scans to determine the accuracy of scintigraphy in identifying and localizing the sites of gastrointestinal bleeding. In all cases, scintigraphic reports were generated immediately after completion of the study and without knowledge of any angiographic or endoscopic findings.

The 26 patients involved in this study underwent 26 nuclear scintigraphy examinations in the Nuclear Medicine Department to identify and localize their source of hemorrhage. Studies were performed by attending nuclear medicine physicians and were available on a 24-hour basis. Our facility employs an *in vitro* method for RBC radiolabeling. During the study period, the Mallinckrodt "Ultratag" kit (Mallinckrodt, St Louis, Mo) was employed to radiolabel autologous RBCs. The RBCs were labeled as described previously by Lull and Morris<sup>6</sup> and this technique did not vary during the study period. Briefly, in this technique patients

are phlebotomized and their whole blood is added to the kit, incubated for 10 minutes, and reinjected. Quality control was always performed to determine percent cellular labeling. A minimum of 95% RBC labeling was acceptable for this study. Preparations with lower percent labeling were washed in isotonic sodium chloride solution to achieve acceptable percent labeling efficiency.

A large-field gamma camera (General Electric 4000C; General Electric Inc, Milwaukee, Wis) was positioned over the anterior abdomen, and serial images at 60 seconds per frame were obtained for the first 90 minutes following injection of the labeled RBCs. After 1996, temporal resolution of 10 seconds per frame was used for acquisition and the study was reformatted into 60-second images for dynamic display. Additional dynamic imaging for 60 minutes was obtained when deemed necessary by the nuclear medicine physician until gastrointestinal bleeding was observed. Accurate localization of gastrointestinal bleeding within bowel was secured by following the path of intraluminal tracer activity. Continuous dynamic imaging using sequential computer acquisition enabled cinematic playback. The  $^{99m}\text{Tc}$ -RBC scans were considered positive when the interpreting radiologist unequivocally identified a specific site of bleeding.  $^{99m}\text{Tc}$ -RBC scans were considered negative when the interpreting radiologist failed to identify a specific site of bleeding or deemed the examination to be suboptimal.

Occasionally during the  $^{99m}\text{Tc}$ -RBC examinations, special techniques were employed by the attending nuclear medicine physician to increase the sensitivity of the study. Such techniques included imaging of gloves after digital rectal examination, postdefecation bedpan imaging, and heparin challenge.

life of 6 hours, which allows for prolonged imaging and reimaging for up to 24 hours after its initial injection. The ability to reimage patients over an extended period is helpful in identifying intermittent bleeding sites. These bleeding sites might otherwise be missed when using diagnostic techniques that can only identify lesions that are actively bleeding at the time of the initial examination, such as endoscopy or angiography. And perhaps most important,  $^{99m}\text{Tc}$ -RBC scintigraphy has been reported to detect bleeding rates as slow as 0.12 to 0.50 mL/min, providing greater sensitivity for detection of slow or chronic gastrointestinal bleeding.<sup>3</sup>

Since  $^{99m}\text{Tc}$ -RBC scintigraphy can provide sufficient sensitivity in identifying and localizing gastrointestinal bleeding, delays in diagnosis can be minimized, unnecessary invasive diagnostic testing can be avoided, and proper segmental resections can be performed, thus minimizing the incidence of rebleeding and subtotal abdominal colectomies. However, the question of whether  $^{99m}\text{Tc}$ -RBC scintigraphy alone is accurate enough to be used to direct appropriate surgical intervention remains controversial. Review of the recent literature has yielded varied conclusions regarding the ability of this technique to accurately localize the site of gastrointestinal hemorrhage. Whereas Voeller et al<sup>4</sup> reported that none of the  $^{99m}\text{Tc}$ -RBC scans performed preoperatively correctly pre-

dicted surgical intervention, Suzman et al<sup>5</sup> reported a 96% accuracy rate.

In this study, we hypothesized that nuclear scintigraphy is accurate enough to identify and localize gastrointestinal bleeding, obviating the need for angiography and thus independently directing surgical intervention. To test this hypothesis, we reviewed the results of  $^{99m}\text{Tc}$ -RBC scans performed at our institution in patients with gastrointestinal bleeding who required an intestinal resection.

## RESULTS

There were 26 patients (18 male), with a male-female ratio of approximately 2:1 and ages ranging from 28 to 83 years (mean  $\pm$  SD, 55  $\pm$  15 years). Among the 26 scans performed to localize gastrointestinal bleeding in patients who ultimately required surgery, 25 scans (96%) were read as positive. One study was interpreted as borderline and was considered negative for the purposes of this study. Of the 25 positive examinations, the majority were localized to the lower gastrointestinal tract (n=23), with the remaining 2 studies identifying bleeding sites in the stomach and duodenum, respectively. The lower gastrointestinal sites of bleeding were located in

the small bowel (n=5), ascending colon (n=12), descending colon (n=3), and rectosigmoid colon (n=4).

Among the 25 patients with positive RBC scans preoperatively, the correct site of bleeding was confirmed in 22 cases (88%). Surgical procedures performed included hemicolectomies (n=14), small-bowel resections (n=6), duodenotomies (n=2), subtotal colectomy (n=1), sigmoid colectomy (n=1), rectal fulguration (n=1), and resection of a sigmoid abscess with colostomy and segmental small-bowel resection (**Table 1**).

Cinematic <sup>99m</sup>Tc-RBC scintigraphy failed to correctly localize the site of bleeding in 3 patients (12%). One scan identified the site of bleeding as the cecum, when in actuality the patient was found to have a jejunal source of bleeding and underwent a segmental small-bowel resection. Pathologic findings in this case revealed cytomegalovirus and cryptosporidial enteritis. The second patient's scan identified a right upper quadrant/hepatic flexure site of bleeding, yet this patient was subsequently found to have an ileal leiomyoma that was resected. The third patient's scan preoperatively diagnosed a gastric source of bleeding. However, a duodenal ulcer was identified that was oversewn along with performance of a vagotomy (**Table 2**).

Nineteen (73%) of the patients in this study underwent 1 or more additional diagnostic tests during the evaluation of their gastrointestinal bleeding. Angiography was used in 11 patients (42%) in whom 4 examinations were negative. Three of the negative angiograms occurred in patients with a documented positive <sup>99m</sup>Tc-RBC scan, with the fourth patient's scan interpreted as borderline. In addition, 17 patients underwent one or more endoscopic examinations to confirm the nuclear

scintigraphy findings. These procedures included colonoscopy (n=10), esophagogastroduodenoscopy (n=8), flexible sigmoidoscopy (n=4), enteroscopy (n=3), and anoscopy (n=1). The endoscopic examinations identified a discrete site of gastrointestinal bleeding in only 5 (29%) of 17 patients.

Diverticulosis was the most frequently encountered diagnosis (46%) in our study group. Other diagnoses included arteriovenous malformations (15%), neoplasm (15%), angiodysplasia (8%), diverticulitis (4%), colitis (4%), sigmoid perforation (4%), and duodenal ulceration (4%) (**Table 3**).

Twenty patients (77%) were discharged from the hospital without any further episodes of bleeding. Two patients (8%) suffered recurrences. One recurrence was secondary to gastric telangiectasias and the other was secondary to an arteriovenous malformation. Additionally, there were 5 deaths in the postoperative period, for a 30-day mortality rate of 19%. Only 1 of the 5 deaths was secondary to gastrointestinal bleeding.

## COMMENT

Localization of gastrointestinal hemorrhage often presents a diagnostic dilemma. Similarly, disagreement amongst clinicians persists regarding which diagnostic test most definitively identifies the source of bleeding and the appropriate use of <sup>99m</sup>Tc-RBC scintigraphy in the diagnostic algorithm. Radiography, endoscopy, angiography, and nuclear scintigraphy have distinct advantages and disadvantages for the diagnosis of bleeding from the gastrointestinal tract.

A barium enema is a quick, noninvasive examination that is readily available to the patient with gastrointestinal hemorrhage. However, barium enemas can fail to identify the source of hemorrhage in up to 30% of cases.<sup>4</sup> Additionally, barium, in the setting of colonic blood, does not coat the colon well, may obscure further investigation, and, when pathologic lesions are identified, there is no assurance that the finding is responsible for the bleeding.

Endoscopy has the potential benefit of being both diagnostic and therapeutic. However, bleeding sites can be difficult to visualize during severe hemorrhage even by the most skilled endoscopist. Intermittent gastrointestinal bleeding can also lead to nondiagnostic studies. Additionally, colonoscopy is relatively invasive, with risks including bowel perforation, exacerbation of bleeding, and septicemia. A recent report summarizing the previ-

**Table 1. Operative Procedures Performed for Gastrointestinal Bleeding**

Operation	No. of Patients
Segmental resection	21
Right hemicolectomy	10
Left hemicolectomy	4
Sigmoid colectomy	1
Small-bowel resection	6
Duodenotomy/vagotomy	2
Rectal fulguration	1
Resection of abscess, small-bowel resection, colostomy	1
Subtotal colectomy	1
Total procedures	26

**Table 2. Incorrectly Localized Gastrointestinal Hemorrhages\***

Patient No.	<sup>99m</sup> Tc-RBC Scan	Angiography	Colonoscopy	Operative Findings	Procedure	Pathological Findings
1	Cecal source	Ileal artery, embolization	Macerated lesion at cecal valve	Jejunal bleeding	SB resection	CMV, cryptosporidial enteritis
2	RUQ, hepatic flexure	Left colon	Abrasions of proximal left colon	Bleeding not observed	Resection of ileal mass	Ileal leiomyoma
3	Gastric source	Negative	Negative	Duodenal hemorrhage	Duodenotomy and vagotomy	Duodenal ulcer

\*<sup>99m</sup>Tc-RBC indicates technetium Tc 99m red blood cell; SB, small bowel; CMV, cytomegalovirus; and RUQ, right upper quadrant.

ous results of colonoscopy performed for gastrointestinal bleeding noted an average complication rate of 1.3%.<sup>7</sup>

Angiography is widely accepted as the most accurate means of diagnosing the presence and site of active gastrointestinal bleeding. Angiography also offers the therapeutic options of arterial embolization or selective vasopressin infusion. However, the ability of selective arteriography to detect a bleeding site is limited when the rate of bleeding is less than 0.5 to 1.0 mL/min.<sup>8</sup> And as with colonoscopy, angiographic examinations can be nondiagnostic due to intermittent or quiescent gastrointestinal bleeding. Last, angiography is an invasive procedure with a 2% complication rate, including contrast-induced renal failure, arterial injury and/or thrombosis, and mesenteric ischemia.<sup>1</sup>

Our study indicates that <sup>99m</sup>Tc-RBC scintigraphy can accurately identify gastrointestinal bleeding sites and thus correctly guide subsequent surgical intervention. In our study group, <sup>99m</sup>Tc-RBC scintigraphy was able to accurately direct surgical intervention in approximately 90% of patients. This is among the highest rates of success reported.<sup>5</sup> Similarly, the ability of nuclear scintigraphy to effectively confirm the diagnosis of active gastrointestinal bleeding was excellent. Ninety-six percent of examinations performed in our study group were interpreted as positive, which is also among the highest sensitivities noted in the literature<sup>9</sup> (**Table 4**).

Owing to the success of <sup>99m</sup>Tc-RBC scintigraphy in identifying and localizing gastrointestinal bleeding, this technique should be the first diagnostic modality employed

when evaluating patients with gastrointestinal bleeding (**Figure**). After initial resuscitation, complete history and physical examinations, appropriate laboratory tests, and nasogastric lavage are routinely performed. The results of nasogastric lavage allow for the source of bleeding to be stratified as either an upper or lower gastrointestinal location. If an upper gastrointestinal source is suspected, esophagogastroduodenoscopy should be performed, and therapeutic interventions implemented as needed. If a lower gastrointestinal source of bleeding is suspected, or if an upper gastrointestinal source has been excluded, <sup>99m</sup>Tc-RBC scintigraphy should be performed. Additional diagnostic examinations, such as colonoscopy and angiography, can be utilized after negative <sup>99m</sup>Tc-RBC examination results, as illustrated in the Figure.

Dividing the gastrointestinal tract into upper and lower segments at the ligament of Treitz, one can further stratify the accuracy of <sup>99m</sup>Tc-RBC scintigraphy. Of the 23 scans that predicted a lower gastrointestinal source of bleeding, only 2 examinations falsely localized the site. However, of the 2 scans that predicted an upper gastrointestinal source of bleeding, 1 falsely localized the site. Thus, our data suggest that <sup>99m</sup>Tc-RBC scans may more accurately localize lower gastrointestinal rather than upper gastrointestinal sources of bleeding (91% vs 50%). Other investigators have also made this observation.<sup>4,5,19</sup> Recognizing this relative inaccuracy of scintigraphy for the diagnosis of upper gastrointestinal bleeding, it should be noted that the vast majority of upper gastrointestinal hemorrhages can be ruled out with gastric lavage and esophagogastroduodenoscopy. Also, an anorectal source of bleeding can be ruled out with anoscopy and proctoscopy. Once these 2 sources have been excluded, the increased sensitivity of nuclear scintigraphy to identify lower gastrointestinal sources of hemorrhage may provide the surgeon with increased confidence for the performance of a segmental colonic resection.

The present success of <sup>99m</sup>Tc-RBC scintigraphy in accurately localizing gastrointestinal bleeding has resulted from strict adherence to techniques and principles of continuous dynamic imaging at a rate of 1 frame per minute. As a result of such adherence, real-time cinematic images are obtained that are more accurate than conventional, static imaging. Gastrointestinal bleeding can be identified immediately and followed with subsequent images, which

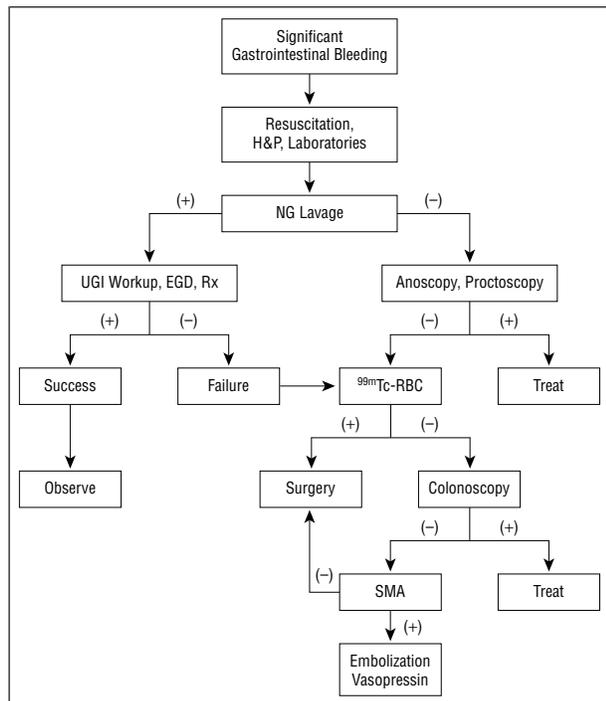
**Table 3. Verified Causes of Gastrointestinal Bleeding**

Pathologic Findings	No. of Patients
Diverticulosis	12
Arteriovenous malformation	4
Neoplasm	4
Angiodysplasia	2
Diverticulitis	1
Duodenal ulcer	1
Sigmoid perforation	1
Colitis	1
<b>Total</b>	<b>26</b>

**Table 4. Correct Localization of Gastrointestinal Bleeding Identified by <sup>99m</sup>Tc-RBC Scintigraphy in Previous Studies\***

Reference	Year Reported	No. of Scans	Positive Scans, %	Correct Localization, %
Suzman et al <sup>5</sup>	1997	224	51	96
Orechhia et al <sup>9</sup>	1988	76	34	94
Emslie et al <sup>10</sup>	1996	75	28	88
Leitman et al <sup>11</sup>	1988	28	43	86
Bearn et al <sup>8</sup>	1992	23	78	82
Dusold et al <sup>12</sup>	1994	74	59	75
Rantis et al <sup>13</sup>	1995	80	47	73
Van Geelen et al <sup>14</sup>	1994	42	57	69
Nicholson et al <sup>15</sup>	1989	43	72	67
Hunter and Pezim <sup>16</sup>	1990	203	26	58
Bentley and Richardson <sup>17</sup>	1991	182	60	52
Garofalo and Abdu <sup>18</sup>	1997	161	49	19
Voeller et al <sup>4</sup>	1991	111	22	0

\*<sup>99m</sup>Tc-RBC indicates technetium Tc 99m red blood cell. Positive Scans indicates percentage of total scans; Correct Localization, percentage of positive scans.



Algorithm for diagnosis and treatment of gastrointestinal bleeding. NG indicates nasogastric tube; H&P, history and physical; UGI, upper gastrointestinal; EGD esophagogastroduodenoscopy; Rx, treatment; <sup>99m</sup>Tc-RBC, technetium Tc 99m red blood cell scan; and SMA, selective mesenteric angiography.

can localize the source to the correct anatomic location. The acquisition of real-time images is in stark contrast to interval imaging that may miss the first evidence of bleeding and thus inaccurately localize the source because of rapid intraluminal transit times or retrograde peristalsis.

The wide variation in previously reported localization results (Table 4) is secondary to the different techniques used in the performance of the <sup>99m</sup>Tc-RBC examinations. The authors who strictly adhered to the principle of frequent interval image acquisition and utilized cinematic playback reported superior results, whereas those who obtained images at less frequent intervals reported poor localization rates. In addition to infrequent imaging, the reliance on delayed static imaging to localize the source of gastrointestinal bleeding can lead to further errors in localization. These errors can occur with delayed imaging because the first appearance of radiotracer is often diffuse. This impairs the identification of initial radiotracer accumulation, which can be followed to further elucidate bowel anatomy and permit accurate localization.

Right hemicolectomy was the most frequently performed surgical procedure (38% of patients) in our study. This finding is in keeping with other reports,<sup>5,11</sup> but more importantly, underscores the importance of preoperative localization of the bleed site to maximize segmental resections. Massive lower gastrointestinal bleeding, when not localized, has been treated by performing blind-limited colon resections. This type of resection is associated with increased rebleeding rates and often necessitates repeated operations. Similarly, while conceptually sound, subtotal abdominal colectomy has an increased mortality rate (approximately 10%) and alters postop-

erative bowel function.<sup>5,11</sup> Thus, with accurate preoperative localization, surgeons can avoid performing either a blind-limited or a subtotal abdominal colectomy.

Additional diagnostic examinations were performed in 19 of 26 patients during the evaluation of their gastrointestinal hemorrhage. These tests were ordered mainly by surgeons uncomfortable with proceeding to the operating room armed solely with <sup>99m</sup>Tc-RBC scan results. However, in retrospect, positive angiographic and colonoscopic findings only served to confirm the nuclear scintigraphy data. In the 3 cases where <sup>99m</sup>Tc-RBC scans failed to precisely guide surgical intervention (1 duodenal, 2 small bowel), angiographic and colonoscopic examinations also failed to accurately localize the source of bleeding. In all 3 cases, laparotomy revealed the source of bleeding to reside within the same quadrant of the abdomen as predicted by <sup>99m</sup>Tc-RBC examination. Other authors have also reported that errors in localizing the site of intestinal bleeding most commonly occur when the source is in the duodenum and small bowel.<sup>10</sup> These errors in localization are thought to result from the rapid transit time seen with intraluminal blood and with prolonged intervals between the acquisition of static images.

The overall mortality rate of 19% is significant, but comparable with other recent reports.<sup>11,19</sup> The high mortality rate in these patients reflects the confounding comorbidities often present, including hypertension, diabetes, alcohol abuse, and chronic renal and liver disease. Importantly, it is this critically ill patient population that can most clearly benefit from a safe, noninvasive diagnostic test such as <sup>99m</sup>Tc-RBC scintigraphy. Only 1 of 5 deaths was directly attributable to gastrointestinal bleeding, with the other 4 deaths related to preexisting morbidities. Two patients (8%) suffered further episodes of bleeding after surgery, which compares favorably with other reports.<sup>11</sup>

In conclusion, cinematic <sup>99m</sup>Tc-RBC scintigraphy is a sensitive, noninvasive alternative to mesenteric angiography for accurately localizing the site of gastrointestinal hemorrhages. With continuous dynamic imaging, use of special techniques, and avoidance of static delayed imaging for estimating bleeding sites, cinematic <sup>99m</sup>Tc-RBC scintigraphy's ability to localize gastrointestinal bleeding sites is greatly improved. This in turn enables the surgeon to confidently provide accurate and appropriate surgical intervention for patients with gastrointestinal bleeding.

Presented at the 71st Annual Session of the Pacific Coast Surgical Association, San Francisco, Calif, February 22, 2000.

Reprints: Hobart W. Harris, MD, MPH, Department of Surgery, San Francisco General Hospital, Ward 3A, 1001 Potrero Ave, San Francisco, CA 94110-3518 (e-mail: hharris@sfghsurg.ucsf.edu).

## REFERENCES

- Peter D, Dougherty J. Evaluation of the patient with gastrointestinal bleeding: an evidence based approach. *Emerg Med Clin North Am.* 1999;17:239-261.
- Jacobson A, Cerqueira M. Prognostic significance of late imaging results in technetium-99m-labeled red blood cell gastrointestinal bleeding studies with early negative images. *J Nucl Med.* 1992;33:202-207.

3. Orecchia P, Hensley M, McDonald P, Lull R. Localization of lower gastrointestinal hemorrhage. *Arch Surg*. 1985;120:621-624.
4. Voeller G, Bunch G, Britt L. Use of technetium-labeled red blood cell scintigraphy in the detection and management of gastrointestinal hemorrhage. *Surgery*. 1991;110:799-804.
5. Suzman M, Talmor M, Jennis R, Binkert B, Barie P. Accurate localization and surgical management of active lower gastrointestinal hemorrhage with technetium-labeled erythrocyte scintigraphy. *Ann Surg*. 1996;224:29-36.
6. Lull R, Morris G. Scintigraphic detection of gastrointestinal hemorrhage: current status. *J Nucl Med Technol*. 1986;12:79-86.
7. Zuckerman GR, Prakash C. Acute lower intestinal bleeding, part I: clinical presentation and diagnosis. *Gastrointest Endosc*. 1998;48:606-617.
8. Bearn P, Persad R, Wilson N, Flanagan J, Williams T. <sup>99m</sup>Tc-technetium-labeled red blood cell scintigraphy as an alternative to angiography in the investigation of gastrointestinal bleeding: clinical experience in a district general hospital. *Ann R Coll Surg Engl*. 1992;74:192-199.
9. Vernava A, Moore B, Longo W, Johnson F. Lower gastrointestinal bleeding. *Dis Colon Rectum*. 1997;40:846-858.
10. Emslie J, Zarnegar K, Siegel M, Beart RJ. Technetium-99m-labeled red blood cell scans in the investigation of gastrointestinal bleeding. *Dis Colon Rectum*. 1996;39:750-754.
11. Leitman MI, Paull DE, Shires GT. Evaluation and management of massive lower gastrointestinal hemorrhage. *Ann Surg*. 1989;209:175-180.
12. Dusold R, Burke K, Carpentier W, Dyck W. The accuracy of technetium-99m-labeled red blood cell scintigraphy in localizing gastrointestinal bleeding. *Am J Gastroenterol*. 1994;89:345-348.
13. Rantis PJ, Harford FJ, Wagner RH, Henkin RE. Technetium-labeled red blood cell scintigraphy: is it useful in acute lower gastrointestinal bleeding? *Int J Colorectal Dis*. 1995;10:210-215.
14. Van Geelen J, De Graaf E, Bronsveld W, Boer R. Clinical value of labeled red blood cell scintigraphy in patients with difficult to diagnose gastrointestinal bleeding. *Clin Nucl Med*. 1994;19:949-952.
15. Nicholson M, Neoptolemos J, Sharp J, Watkin E, Fossard D. Localization of lower gastrointestinal bleeding using in vivo technetium-99m-labeled red blood cell scintigraphy. *Br J Surg*. 1989;76:358-361.
16. Hunter J, Pezim M. Limited value of technetium 99m-labeled red blood cell scintigraphy in localization of lower gastrointestinal bleeding. *Am J Surg*. 1990;159:504-506.
17. Bentley D, Richardson J. The role of tagged red blood cell imaging in the localization of gastrointestinal bleeding. *Arch Surg*. 1991;126:821-824.
18. Garofalo T, Abdu R. Accuracy and efficacy of nuclear scintigraphy for the detection of gastrointestinal bleeding. *Arch Surg*. 1997;132:196-199.
19. Kouraklis G, Misiakos E, Karatzas G, Gogas J, Skalkeas G. Diagnostic approach and management of active lower gastrointestinal hemorrhage. *Int Surg*. 1995;80:138-140.

## DISCUSSION

**Karen Deveney, MD, Portland, Ore:** Localization of the bleeding site in patients with gastrointestinal hemorrhage is obviously the critical element in planning appropriate therapy. Although technetium-labeled RBC scans have been available for over 20 years, the literature is mixed on its accuracy and most of us have personal or institutional experiences vivid in our memories in which the red cell scan was unclear at best or misleading at worst. Multiple trips to the nuclear medicine department and the use of delayed static images contribute to its inaccuracy. And one of the most appealing aspects of the current study is that their nuclear medicine department has created a real-time dynamic study with images that are produced every minute for up to 60 minutes, so that the precise site and direction of the bleeding are more likely to be identified. This dynamic technique was utilized only in the last 2 years of this study, however, and the manuscript does not state how many of the 26 scans were performed by the newer technique. I wonder, therefore, how much this technique actually added in the patients described in this study and would ask the authors to comment on that. Although the authors report that the RBC scan correctly localized the site of bleeding in 88% of the 25 patients with positive scans who subsequently went to surgery, and this percentage favorably compares with the results

of other studies, the number of patients in this study is very small, suggesting a very limited use of RBC scans in their institution. I suspect that there are quite a few patients at an institution as large as San Francisco General Hospital who had other localizing tests. In reviewing this paper and reflecting on my own time as a student and resident at San Francisco General Hospital, I recalled that patients with gastrointestinal bleeding are admitted to the medicine service with surgery consulting. Bill Schecter confirmed that such is still the case. The surgical consultant is likely not to be in complete control of the test selected, the adequacy and speed of the patient's evaluation, and may even be consulted late in the game. I suspect that there was no consistent algorithm in the decision of what tests to order. Am I correct in that assumption? Were there other patients during this time who went directly to surgery after angiography or colonoscopy in whom we don't know whether the RBC scan would have been positive or accurate?

I am also surprised that an RBC scan was needed to identify sites of bleeding in the stomach or duodenum and wonder why endoscopy did not identify those sites, especially the one whose scan was positive for gastric hemorrhage and had a bleeding duodenal ulcer found at operation. Was endoscopy not done?

I am curious as to how the RBC scan really helped in the patient who underwent subtotal colectomy and the 2 with duodenotomies who should have had their site identified if esophagogastroduodenoscopy had been performed. As the authors point out, RBC scans are most successful in identifying colonic sources of bleeding. The never-never land is the small bowel. I am curious as to how the scans were able to guide surgical therapy in the patients with small-bowel sites. How many times were adjunctive intraoperative measures such as enteroscopy needed to identify the precise site of bleeding in the small bowel? What specifically were the small-bowel lesions, and how did the scans help?

I am intrigued by the promise shown by this newer dynamic cinematic testing, and I look forward to hearing more about this technique as further experience is gained in its use.

**John T. Vetto, MD, Portland:** My nuclear medicine colleagues tell me that there are 2 ways to do these scans: (1) red-cell scans where the cells are taken out and labeled—this is time-inefficient, expensive, and is really best for intermittent chronic bleeding; and (2) blood-pool scans where the technetium is injected intravenously. The latter technique is better for rapid bleeding. So I have 2 questions for the authors. First, were some of your more active bleeders actually undergoing blood-pool scans? Secondly, if they all underwent red-cell scans as I surmise from the presentation, does that mean that this study is actually a subset of patients with chronic intermittent bleeding?

**S. Eric Wilson, MD, Orange, Calif:** It was of interest to me that the majority of your patients had segmental right colon resection. Also, the majority of them had bleeding diverticula. Now, right colon diverticula are usually associated with pancolonic diverticula. Does this mean that you would do a regional resection, ie, a right colon resection, if you have isolated bleeding on the right side in a patient with pancolonic diverticula?

**John Owings, MD, Sacramento, Calif:** I noticed in one of the slides that you said that these were all read by attending nuclear medicine physicians. My questions then are as follows: (1) is it particularly technician-dependent, and (2) if that is the case, what was the spread of the hour of the day during which these studies were performed?

**Chris D. Virgilio, MD, Torrance, Calif:** My comments echo those of Dr Deveney. You had only 26 patients who entered the study. Can you give us a better guideline as far as your algorithm for how you approach a patient with a gastrointestinal bleed?

**Dr Schecter:** Regarding Dr Deveney's questions, all of our scans were performed with at least 1-minute intervals since the beginning of the study. However, in the past 2 years, we have

increased the interval frequency to every 10 seconds; only several of the studies were performed with 10-second intervals.

You are correct, Dr Deveney, that this is a retrospective study and we did not use a specific protocolized algorithm. All of the patients were actually admitted to the medical service before being referred to us. You are also correct that there were patients with rapid bleeding who either had angiography or upper gastrointestinal hemorrhage with the source localized by endoscopy who went to the operating room without the need for scintigraphy.

We did have 2 patients who were bleeding from the upper gastrointestinal tract who had nonbleeding ulcers identified by endoscopy at the initial study and then bled again. Scintigraphy identified the ulcers as the source of hemorrhage. That relates to the question concerning our approach to gastrointestinal hemorrhage. Our approach is probably similar to everybody's in the room. Somebody comes in, we resuscitate the patient, we drop an nasogastric tube and try to answer the question of whether the patient is bleeding from above or below the ligament of Treitz. We endoscope almost all patients to confirm that the duodenum is clear of blood or lesions, and that brings us to the problem of bleeding below the ligament of Treitz. The greatest value of this study is sorting out those patients who are bleeding from below the ligament of Treitz. There are other ways of assessing colonic bleeding that are not completely accurate, but we are still left with the area between the cecum and the ligament of Treitz, which is a never-never land. These rapid-sequence radionuclide scintigraphic studies really address this problem and help us much more.

How many intraoperative enteroscopies did we use? We had 2 of the patients who had hemorrhages identified from the

small bowel and who required intraoperative enteroscopy but, as you all know, intraoperative enteroscopy is a major hassle and psychologically it is a lot nicer to go into the operating room being set up and prepared for it. The other patients who had bleeding from the small bowel were bleeding from tumors that we were able to identify by running the bowel and therefore we didn't need to do enteroscopy in those cases.

This is a retrospective study. I suppose in that sense it is a subset of patients, but all of the patients who were in the study spanned the spectrum from intermittent chronic bleeding to acute hemorrhage. In fact, one of the patients actually evacuated on the table and there is a nice radionuclide study of the evacuated blood and stool on the table that we didn't show in this presentation.

There were no gated pool studies. All of these studies were radionuclide red-cell scans. Dr Wilson asked an excellent question. Would we do a segmental right hemicolectomy if we localized the bleeding site from the right colon if the patient had pancolonic diverticuli? The answer to that question is yes. Many of these patients are unstable. If we really are confident that we know the site of bleeding, we would do an operation that addressed that problem. It would be only in the case where we were unsure that we would do a subtotal colectomy.

This study is technician-independent. All of the studies were done in the presence of attending nuclear medicine physicians. Most of these studies were done during the daytime, but some of them were done in the middle of the night. It depended on the degree of hemorrhage, but in an unstable patient, when we choose a radionuclide study, we have very aggressive nuclear medicine physicians who do come in the middle of the night.

#### IN OTHER AMA JOURNALS

##### ARCHIVES OF INTERNAL MEDICINE

##### Systematic Review of the Epidemiological Evidence on *Helicobacter pylori* Infection and Nonulcer or Uninvestigated Dyspepsia

John Danesh, MBChB, MSc, DPhil; Martin Lawrence, MD†; Mike Murphy, MD; Sarah Roberts, RN; Rory Collins, MBBS, MSc

**Background:** Previous studies have yielded conflicting results and substantial uncertainty about any independent association of *Helicobacter pylori* infection with dyspepsia, and about any benefits of antibiotic treatments for nonulcer or uninvestigated dyspepsia.

**Objectives:** To perform a systematic review of the literature to determine whether chronic infection with *H pylori* is relevant to nonulcer or uninvestigated dyspepsia.

**Methods:** Observational studies of associations between *H pylori* and dyspepsia published before April 1999 and randomized trials of the effects of *H pylori* eradication on dyspepsia published before January 2000 were identified by computer-assisted literature searches of relevant journals, reference lists, and discussions with authors. Relevant data were abstracted from the published reports by 2 investigators according to a fixed protocol.

**Results:** Thirty relevant observational studies were identified involving approximately 3392 patients with nonulcer dyspepsia, and 11 separate observational studies were identified, involving 6426 patients with uninvestigated dyspepsia. Reports of strong associations in small observational studies without appropriate adjustment for potential confounding factors were not generally confirmed by larger and better-designed studies. No studies have been reported, however, that can reliably confirm or exclude the existence of any weak associations. Twenty-two randomized trials of treatments against *H pylori* were found involving a total of 2340 patients with nonulcer dyspepsia, almost all with positive *H pylori* test results. Only a few of these trials involved effective antibacterial regimens with prolonged follow-up, and even these studies were too small to assess the possibility of moderate benefits.

**Conclusion:** The available evidence indicates that there is no strong association between *H pylori* and dyspepsia, but there is insufficient evidence to confirm or refute the existence of a modest association. (2000;160:1192-1198)

Reprints: John Danesh, MBChB, MSc, DPhil, Clinical Trial Service Unit, Radcliffe Infirmary, Oxford OX2 6HE, England.