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ACR PRACTICE GUIDELINE FOR THE PERFORMANCE OF GASTROINTESTINAL SCINTIGRAPHY

PREAMBLE

These guidelines are an educational tool designed to assist practitioners in providing appropriate radiologic 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, the American College of Radiology cautions 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, an approach that differs from the guidelines, standing alone, does not necessarily imply that the approach was 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 on available resources, or advances in knowledge or technology subsequent to publication of the guidelines. However, a practitioner who employs an approach substantially different from these guidelines is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with 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 assure 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

This guideline has been developed by the American College of Radiology (ACR) to guide interpreting physicians performing gastrointestinal scintigraphy in adult and pediatric patients. Properly performed imaging with radiopharmaceuticals that localize in or are introduced into the gastrointestinal tract or peritoneum is a sensitive means for detection, evaluation, and quantification of numerous conditions affecting the alimentary tract. As with all scintigraphic studies, correlation of findings with the results of other imaging and nonimaging procedures, as well as clinical information, is necessary to achieve maximum diagnostic yield.

Application of this guideline should be in accordance with the ACR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals.

(For pediatric considerations see Section VI.)

II. DEFINITION

Gastrointestinal scintigraphy involves the intravenous, oral, transcatheter (to include enteric tubes), or intraperitoneal administration of a radiopharmaceutical which transits or localizes in the salivary glands, gastrointestinal tract, or peritoneal cavity, followed by gamma camera imaging, with or without computer acquisition. (For scintigraphy of the hepatobiliary tract or liver and spleen, see the ACR Practice Guideline for the Performance of Adult and Pediatric Hepatobiliary Scintigraphy and the ACR Practice Guideline for the Performance of Liver/Spleen Scintigraphy.)

III. GOAL

The goal of gastrointestinal scintigraphy is to enable the interpreting physician to detect and/or quantify anatomic or physiologic abnormalities of the salivary glands, gastrointestinal tract, or peritoneum by producing and using images of diagnostic quality and appropriate computer-based calculations.

IV. INDICATIONS

Clinical indications are very broad and depend on specific techniques. They include, but are not limited to, demonstration of salivary gland function and tumors, detection of heterotopic functioning gastric mucosa, demonstration of the presence and site of acute gastrointestinal bleeding, verification of aspiration, evaluation and quantification of transit through and reflux into the esophagus, quantification of the rate of emptying of liquid and/or solid meals from the stomach, transit through the small and large intestine, assessment of peritoneovenous shunt patency, detection of congenital or acquired perforation of the pleuroperitoneal diaphragm, and demonstration of the presence or absence of peritoneal loculations prior to intraperitoneal chemotherapy or radiopharmaceutical therapy.

V. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the ACR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals.

VI. RADIOPHARMACEUTICALS

Several radiopharmaceuticals are currently available. The radiopharmaceutical utilized should be chosen based on the clinical indications and circumstances.

A. Technetium-99m Sodium Pertechnetate

During the first 1 or 2 minutes after intravenous administration, this radiopharmaceutical may be used as a blood flow and “blood pool” marker. Within minutes after injection, technetium-99m pertechnetate begins to concentrate in gastric mucosa and salivary glands, making it a suitable radiopharmaceutical for detection of heterotopic gastric mucosa and evaluation of the salivary glands. Normal renal excretion results in visualization of the kidneys and bladder. Rapid absorption by the stomach and peritoneum makes technetium-99m pertechnetate unsuitable for oral or intraperitoneal administration. The usual adult administered activity is 10-25 millicuries (370-925 MBq) intravenously. Lower administered activity (3-5 millicuries [111-185 MBq]) may be used if a flow study is not performed. Administered activity for children should be reduced, based on weight or body surface area, and should be as low as practically achievable for appropriate image quality.

B. Technetium-99m Sulfur Colloid

After intravenous injection, technetium-99m sulfur colloid may be used to detect active gastrointestinal bleeding. It rapidly accumulates in the reticuloendothelial system; thus its presence in the vascular system is brief. When placed directly into the pharynx, esophagus, or stomach, it is not absorbed and is an excellent marker for evaluation and quantification of numerous parameters of swallowing and gastrointestinal motility and transit. It may also be used as a marker for liquid and solid meals. Its affinity for the protein matrix of egg white makes it easy to use to label egg as a solid-phase radiopharmaceutical. Administered intraperitoneally, it is not absorbed and becomes a qualitative marker of movement of ascitic fluid through congenital or traumatic diaphragmatic fenestrations and peritoneovenous shunts. The usual adult intravenous administered activity for gastrointestinal blood loss detection is 10 millicuries (370 MBq), but it should be reduced for children based on weight or body surface area, and should be as low as practically achievable for appropriate image quality. Administered activity for oral and intraperitoneal administration is 0.5-5.0 millicuries (18.5-185.0 MBq) and should be reduced for children as described above.

C. Technetium-99m Autologous Red Blood Cells (RBCs)

Technetium-99m RBCs are an intravascular marker and are commonly used for detection and localization of active gastrointestinal bleeding. There are three methods of labeling RBCs: in vivo, combined in vivo-in vitro, and in vitro (see the ACR Practice Guideline for the Performance of Cardiac Scintigraphy). The highest yield of labeling is with the in vitro method, which is preferred. The usual adult administered activity is 15-25 millicuries (555-925 MBq) intravenously. Administered activity for children should be reduced, based on weight or body

surface area, and should be as low as practically achievable for appropriate image quality.

D. Technetium-99m (Stannous) Diethylenetriamine-Pentaacetic Acid (DTPA)

Given orally, technetium-99m (Sn) DTPA may be used as a liquid-phase marker of gastric emptying or of small bowel transit. It is given in an administered activity of 0.5-1.0 millicurie (18.5-37.0 MBq) for adults. Administered activity for children should be reduced, based on weight or body surface area, and should be as low as practically achievable for appropriate image quality.

It cannot be used simultaneously for combined liquid-phase-solid-phase gastric emptying when any technetium-99m solid-phase radiopharmaceutical is employed.

E. Technetium-99m Macroaggregated Albumin (MAA)

Given intraperitoneally, technetium-99m MAA is not absorbed and becomes a qualitative marker of the movement of ascitic fluid through peritoneovenous shunt devices or congenital/traumatic diaphragmatic fenestrations. The usual adult administered activity is 0.5-5.0 millicuries (18.5-185.0 MBq). Administered activity for children should be reduced, based on weight or body surface area, and should be as low as practically achievable for appropriate image quality.

F. Indium-111 DTPA

Given orally, indium-111 DTPA may be used as a liquid-phase marker of gastric emptying. It is given in an administered activity of 0.1-0.5 millicurie (3.7-18.5 MBq) for adults. Administered activity for children should be reduced, based on weight or body surface area, and should be as low as practically achievable for appropriate image quality. Its use is usually restricted to cases in which combined liquid- and solid-phase data are being collected simultaneously.

VII. SPECIFICATIONS OF THE EXAMINATION

The written or electronic request for GI scintigraphy should provide sufficient information to demonstrate the medical necessity of the examination and allow for the proper performance and interpretation of the examination.

Documentation that satisfies medical necessity includes 1) signs and symptoms and/or 2) relevant history (including known diagnoses). The provision of additional information regarding the specific reason for the examination or a provisional diagnosis would be helpful and may at times be needed to allow for the proper performance and interpretation of the examination.

The request for the examination must be originated by a physician or other appropriately licensed health care provider. The accompanying clinical information should be provided by a physician or other appropriately licensed health care provider familiar with the patient's clinical problem or question and consistent with the state scope of practice requirements. 2006 (Res. 35)

A. Heterotopic Gastric Mucosa

The radiopharmaceutical technetium-99m pertechnetate is given intravenously. A rapid sequence of images (blood flow study) taken at 1-2 seconds per frame, over 1 minute, may be obtained in the anterior projection to evaluate the presence of hypervascular abdominal lesions that could be mistaken for heterotopic gastric mucosa. Serial static images then may be acquired over a period of 30 minutes for 300,000-500,000 counts each, or continuously on computer for 15-60 seconds per image. The study may be supplemented with oblique, lateral, postvoid, or delayed views, if necessary. Pharmacologic enhancement may be employed: H2-blocker (cimetidine, famotidine, or ranitidine) to enhance retention, and/or glucagon to decrease gastrointestinal peristalsis.

B. Gastrointestinal Blood Loss

All methods require that the patient be actively bleeding during the time when the radiopharmaceutical is present in the blood pool. Two approaches, using two different radiopharmaceuticals, have been described.

1. Technetium-99m Sulfur Colloid

   The radiopharmaceutical is injected intravenously. Blood flow and dynamic or continuous static images of the abdomen are initially collected over a period of 10 minutes, the approximate time during which the radiopharmaceutical is in the vascular space. Additional imaging for another 15-20 minutes may be needed to ensure that a hemorrhage in the region of the stomach, duodenum, or transverse colon has not been obscured by activity in the liver or spleen.

2. Technetium-99m RBCs

   The radiopharmaceutical is injected intravenously. Blood flow and dynamic or continuous static images of the abdomen are obtained continuously for 60-90 minutes. Oblique, lateral, postvoid, or delayed images may be obtained to supplement the basic examination. If the study is negative after 60-90 minutes, continued imaging may be appropriate. Computer acquisition and cinematic display, while not required, are highly recommended.

They may enhance detection of subtle bleeding and help to provide more accurate localization.

C. Salivary Gland Imaging

The patient is positioned in front of a gamma camera with the face in the Water's (nose-chin) position. Technetium-99m pertechnetate is given intravenously. Serial images of the face are obtained over a period of 30 minutes. If needed, these views may be supplemented by oblique or lateral images of the face. Computer acquisition using 30 seconds per frame and a 64 x 64 matrix may be helpful as well. If the gamma camera head is greater than 300 mm, a 128 x 128 or finer matrix may provide a more acceptable pixel size.

The collimator face should be protected using a plastic-backed pad or other similar material, especially if an external salivary fistula is suspected. A sialogogue, such as lemon juice, may be used to stimulate salivary gland emptying in cases of salivary duct obstruction, sialadenitis, or suspected Warthin's tumor. The position of palpable nodules should be confirmed using a radioactive source marker.

D. Esophageal Transit

Scintigraphy of esophageal transit may yield unique and useful physiologic information about esophageal motility in patients with conditions (e.g., scleroderma, stricture, achalasia) that cause impaired transit of esophageal contents from the pharynx to the stomach or following therapy for these conditions. The patient should have nothing by mouth or by tube feeding prior to the examination. The length of time that the patient should refrain from intake depends on the patient's age and the clinical circumstances, but in most cases 4 hours would be sufficient.

Data are usually collected in the posterior projection with the patient either supine or upright. Many techniques have been described. These may involve the patient swallowing 0.2-1.0 millicurie (7.4-37.0 MBq) of technetium-99m sulfur colloid in 10-15 ml of water, pudding, etc., as a bolus. Data acquisition at one to five frames per second for 5 minutes is recommended. The patient may be asked to dry swallow or take additional unlabeled water.

The normal value for esophageal transit is ≥ 90% in 15 seconds, although each facility should validate its own normal range for its specific technique or should closely follow a validated technique and normal range from the literature.

Additionally, time-activity curves may be generated for the proximal middle, and distal portions of the esophagus. Esophageal transit may be calculated for each frame as follows:

$$E_t = \frac{(C\ max - C_t) \times 100}{C\ max}$$

E_t = percentage of esophageal transit at time (t)
C max = maximum counts in esophagus
C_t = counts in esophagus at time (t)

E. Gastroesophageal Reflux

Scintigraphy for gastroesophageal reflux may give unique and useful physiologic information in patients whose symptoms suggest possible incompetence of the gastroesophageal sphincter associated with acute or chronic reflux of gastric contents into the esophagus.

Several techniques have been described. The patient should have nothing by mouth or by tube feeding prior to the examination. The length of time that the patient should refrain from intake depends on the patient's age and the clinical circumstances, but in most cases 4 hours would be sufficient. A liquid meal consisting of formula, milk, or 150 ml of orange juice containing 0.2-1.0 millicurie (7.4-37.0 MBq) of technetium-99m sulfur colloid is administered orally, by nasogastric tube, or by gastrostomy tube. The patient is then positioned supine beneath the gamma camera head, and serial 10 to 30-second images of the esophagus and stomach are obtained. In adults, a Valsalva maneuver or an abdominal binder may be of benefit.

The percentage of reflux is calculated as follows:

$$R = \frac{(E_t - E_b) \times 100}{G_0}$$

R = percentage of reflux
E_t = esophageal counts at time (t)
E_b = thoracic background
G_0 = gastric counts at time 0

The normal percentage of reflux is ≤ 4%, although each facility should validate its own normal range for its specific technique or should closely follow a validated technique and normal range from the literature.

The number of reflux events detected during the recording session, the duration, and the proximal extent of reflux may also be reported. The examination may be repeated using medications to assess the effectiveness of pharmacologic intervention.

The technique is adaptable to infants and small children.

F. Gastric Emptying

The patient should have nothing by mouth or by tube feeding prior to the examination. The length of time that the patient should refrain from intake depends on the patient's age and the clinical circumstances, but in most cases 4 hours would be sufficient. Three approaches are used: liquid phase, solid phase, and combined liquid-solid phase. In general, the liquid phase is preferred in infants and the neurologically impaired, whereas the solid phase is employed when the patient is capable of ingesting solid food. In both cases, the "meal" needs to be introduced into the stomach fairly quickly (i.e., within 10 minutes). It is a good general practice to cover the camera heads with protective wrap to prevent contamination. Computer acquisition is required to determine the half-time of emptying and/or percent of emptying and to generate gastric emptying time-activity curves. Several techniques have been proposed. The normal effective half-time of clearance should be validated for the specific technique used by the laboratory. Examples include the following:

1. Liquid phase

   Technetium-99m sulfur colloid or technetium-99m (Sn) DTPA is mixed with an appropriate volume (30-240 cc) of liquid carrier (e.g., orange juice, formula, milk) and is introduced into the stomach by swallowing, nasogastric tube, or gastric tube depending on the clinical situation in consultation with the referring clinician. The patient is positioned standing or supine with the camera anteriorly or left anterior oblique (LAO) over the abdomen. If a single-head camera is used, a posterior image can be obtained immediately after the anterior image. If a dual-head camera is available, these images can be obtained simultaneously. Posterior imaging may be used in children. Sequential imaging and computer data acquisition are performed over the course of 30-60 minutes (or longer, if indicated). A region of interest (ROI) is drawn over the stomach, and a decay-corrected time-activity curve is generated. In normal patients, the radiopharmaceutical exits from the stomach in an approximately exponential fashion for liquid meals. In children, imaging is usually performed during the first hour, and the percent of emptying is obtained at 60 minutes and later, if indicated.

2. Solid phase

   Technetium-99m sulfur colloid labeled to egg or other suitable food is incorporated into a meal (e.g., egg sandwich) taken with a small amount (100-200 ml) of liquid. The patient ingests this meal. The patient is positioned standing or supine with the camera anteriorly or LAO over the abdomen. If a single-head camera is used, a posterior image can be obtained immediately after the anterior image. If a dual-head camera is available, these images can be obtained simultaneously. Sequential images and computer data acquisitions are performed at 5-15 minute intervals for 90 minutes or longer. An ROI is drawn over the stomach, and a time-activity curve is generated. In normal patients, the radiopharmaceutical exits the stomach in an approximately linear fashion once gastric emptying is well underway. The meal composition, caloric and fat content, patient position, and processing must be standardized.

3. Combined liquid-solid phase

   A solid-phase study (see Section VII.F.2 above) may be combined with the liquid-phase study (see Section VII.F.1 above), using indium-111 DTPA for the liquid phase and technetium-99m sulfur colloid for the solid phase. With the use of sufficiently different administered doses it is possible to acquire data simultaneously using photopeaks of both radionuclides.

G. Aspiration of Gastric or Pharyngeal Contents

The radiopharmaceutical employed is technetium-99m sulfur colloid. The patient should have nothing by mouth or by tube feeding prior to the examination. The length of time that the patient should refrain from intake depends on the patient's age and the clinical circumstances, but in most cases 4 hours would be sufficient**.**

1. Aspiration of pharyngeal contents

   A drop of technetium-99m sulfur colloid containing no more than 0.5 millicurie (18.5 MBq) is placed on the dorsal surface of the posterior portion of the tongue. Images of the chest are obtained in the posterior projection over the course of 1 hour. Radioactivity detected in the bronchi or lungs suggests aspiration.

2. Aspiration of gastric contents

   Radioactive markers are placed for anatomic reference. An administered activity of 0.5 millicurie (18.5 MBq) of technetium-99m sulfur colloid is placed in a small amount of the patient's feeding, administered orally, by nasogastric tube, or by gastrostomy tube depending on the clinical situation and in consultation with the referring clinician. If the material is administered orally, once the feeding

is completed, an additional nonradioactive liquid feeding is given to clear any remaining radioactivity from the esophagus. Images of the thorax are obtained immediately after ingestion (as a baseline) and serially for 60 minutes thereafter. If aspiration during sleep is suspected in children, it may be more practical to have the infant or small child nap in bed or in a bassinet and then return to the department for delayed imaging. Radioactivity seen in the lungs suggests the diagnosis of aspiration. Imaging is terminated after the radioactivity has cleared from the stomach.

H. Peritoneal Imaging

1. Evaluation of patency of peritoneovenous shunts

   Technetium-99m sulfur colloid or technetium-99m MAA is administered in an administered activity of 0.5-5.0 millicuries (18.5-185 MBq) directly into the peritoneal cavity, using aseptic technique. On occasion, normal saline (50-200 ml) can be used to facilitate distribution. An immediate image over the abdomen may be helpful to determine that the radiopharmaceutical is intraperitoneal and not loculated. If the shunt is functioning correctly, serial images obtained over 1 or 2 hours may reveal radiopharmaceutical in the shunt tube, and radioactivity will eventually appear in the liver and spleen (with technetium-99m sulfur colloid – see Section VI.B) or lungs (with technetium-99m MAA).

2. Detection of congenital fenestrations or traumatic perforations of the diaphragm

   Technetium-99m sulfur colloid or technetium-99m MAA is administered intraperitoneally as described in Section VII. H.1. Occasionally, the radiopharmaceutical can be instilled with up to 500 ml of sterile normal saline, in order to facilitate movement into the pleural cavity. If activity appears in the pleural space, the diagnosis of perforated diaphragm is confirmed.

3. Demonstration of peritoneal loculation of fluid

   Technetium-99m sulfur colloid or technetium-99m MAA is administered intraperitoneally as described in Section VII.H.1. Imaging will reveal the distribution of the radiopharmaceutical in the peritoneal cavity.

VIII. DOCUMENTATION

Reporting should be in accordance with the ACR Practice Guideline for Communication of Diagnostic Imaging Findings.

IX. EQUIPMENT SPECIFICATIONS

A gamma camera with a high-sensitivity LEAP/GAP or diverging collimator may be used for technetium-99m-labeled radiopharmaceuticals. A medium-energy collimator is needed for indium-111. If available, a gamma camera head size of 250-300 mm is recommended for small children; for adults, a gamma camera head size of $\geq$ 400 mm is preferred. If quantification is desired, a parallel hole collimator is usually employed. A matrix size of 64 x 64 is sufficient for detector heads of $\leq$ 300 mm. For larger detector heads, 128 x 128 or finer may be preferred in order to keep pixel size acceptably small.

X. RADIATION SAFETY IN IMAGING

Radiologists, radiologic technologists, and all supervising physicians have a responsibility to minimize radiation dose to individual patients, to staff, and to society as a whole, while maintaining the necessary diagnostic image quality. This is the concept “As Low As Reasonably Achievable (ALARA).”

Facilities, in consultation with the medical physicist, should have in place and should adhere to policies and procedures, in accordance with ALARA, to vary examination protocols to take into account patient body habitus, such as height and/or weight, body mass index or lateral width. The dose reduction devices that are available on imaging equipment should be active or manual techniques should be used to moderate the exposure while maintaining the necessary diagnostic image quality. Patient radiation doses should be periodically measured by a medical physicist in accordance with the appropriate ACR Technical Standard. 2006 (Res. 17)

XI. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION CONCERNS

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR policy on Quality Control Improvement, Safety, Infection Control, and Patient Education Concerns appearing elsewhere in the ACR Practice Guidelines and Technical Standards book.

Equipment performance monitoring should be in accordance with the ACR Technical Standard for Medical

Nuclear Physics Performance Monitoring of Nuclear Medicine Imaging Equipment.

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