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**The SNM will periodically define new procedure guidelines for nuclear medicine practice to help advance the science of nuclear medicine and to improve the quality of service to patients throughout the United States. Existing procedure guidelines will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.**

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Revised 2010\*

## **THE SNM PROCEDURE GUIDELINE FOR HEPATOBILIARY SCINTIGRAPHY 4.0**

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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, the Society of Nuclear Medicine (SNM) 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 of available resources, or advances in knowledge or technology subsequent to publication of the guidelines.

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 document has been developed and revised collaboratively by the Society of Nuclear Medicine (SNM) Hepatobiliary Scintigraphy Task Force with input from the American College of Radiology (ACR) and the European Association of Nuclear Medicine (EANM). The Task Force assembled by the SNM included representatives from the other two organizations.

Optimally performed hepatobiliary scintigraphy is a very sensitive method for detecting numerous disorders involving the liver and biliary system. It is generally accepted that scintigraphic findings are not always specific. Therefore, it is crucial to correlate findings on hepatobiliary scintigraphy with clinical information and findings of other relevant modalities in order to arrive at a correct diagnosis. Adjunctive pharmacologic maneuvers may enhance diagnostic utility of hepatobiliary scintigraphy and provide quantitative assessment necessary for certain specific applications.

## II. GOALS

The purpose of this procedure guideline is to assist nuclear medicine practitioners in recommending, performing, interpreting, and reporting the results of hepatobiliary scintigraphy in adults and children.

The goal of hepatobiliary scintigraphy is to provide diagnostic and management assistance to physicians who are involved in the care of patients with liver and biliary system ailments.

## III. DEFINITIONS

Hepatobiliary scintigraphy is a radionuclide diagnostic imaging study (including planar, SPECT, or hybrid imaging, such as SPECT/CT) that evaluates hepatocellular function and the biliary system by tracing the production and flow of bile from the liver, and its passage through the biliary system into the small intestine. Sequential (or dynamic) images of the liver, biliary tree and gut are obtained. Computer acquisition and analysis, including pharmacological interventions, are employed according to varying indications and individual patient needs.

## IV. EXAMPLES OF CLINICAL AND RESEARCH INDICATIONS

### A. Indications:

1. Functional biliary pain syndromes in adults (*1-11*)
2. Functional biliary pain syndromes in pediatric patients (*12-17*)
3. Acute cholecystitis (*11, 18-30*)
4. Right upper quadrant pain variants, as defined by the American College of Radiology Appropriateness criteria (*31*)
5. Biliary system patency (*11, 32-35*)
6. Bile leak (*11, 36-40*)
7. Neonatal hyperbilirubinemia (biliary atresia versus neonatal hepatitis “syndrome”) (*11, 41-43*)

8. Assessment of biliary enteric bypass (e.g., Kasai procedure) (11, 44, 45)
9. Assessment of liver transplant (11, 46-51)
10. Afferent loop syndrome (52-56)
11. Assessment of choledochal cyst (11, 57-64)
12. Calculation of gallbladder ejection fraction (11)
13. Functional assessment of the liver prior to partial hepatectomy (65, 66)
14. Demonstration of anomalous liver lobulation (67)
15. Enterogastric (duodenogastric) reflux assessment (68-71)
16. Esophageal bile reflux after gastrectomy (72)
17. Sphincter of Oddi dysfunction (73-77)

B. Contraindications:

1. Hypersensitivity to a hepatobiliary compound (78)

C. Warnings:

1. For pregnant or potentially pregnant patients see the SNM Procedure Guidelines for General Imaging
2. Theoretical possibility of allergic reactions should be considered in patients who receive multiple doses of hepatobiliary compound (78)

## V. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

Refer to Section V of the SNM Procedure Guideline for General Imaging.

## VI. PROCEDURE/SPECIFICATIONS OF THE EXAMINATION

A. Request

The physician should review all available pertinent clinical, laboratory, and radiological information about the patient prior to the study. Additional information specifically related to hepatobiliary scintigraphy includes:

1. History of previous surgeries, especially biliary and gastrointestinal.
2. Time of most recent meal.
3. Current medications, including the time of their most recent administration (with particular attention to opioid compounds).
4. Results of bilirubin and liver enzyme levels.
5. Results of gallbladder or abdominal ultrasound.

B. Patient Preparation and Precautions

To permit timely gallbladder visualization, the adult patient must have fasted for a

minimum of two and preferably six hours prior to administration of the radiopharmaceutical. Children should be instructed to fast for 2 to 4 hours, while infants need to fast for only 2 hours prior to radiotracer injection. In the latter group, clear liquids are permissible, if medically necessary.

Fasting for longer than 24 hours (including those on total parenteral nutrition), can result in non-filling of the gallbladder within the normally expected timeframe. In these cases the patient may be pretreated with sincalide, see VI.E.1 below.

Interference by opioids can be minimized by delaying the study for a time corresponding to 4 half-lives of a medication. In some cases the effect can be reversed with naloxone hydrochloride. Additional details are listed in VI.G. (“Sources of Error”).

### C. Radiopharmaceutical

$^{99m}\text{Tc}$ -disofenin (DISIDA, 2,6-diisopropylacetanilido iminodiacetic acid) or  $^{99m}\text{Tc}$ -mebrofenin (BRIDA, bromo-2, 4,6-trimethylacetanilido iminodiacetic acid) is administered intravenously in activities of 111-185 MBq (3-5 mCi) for adults; higher administered activity may be needed in hyperbilirubinemia. Hepatic extraction of mebrofenin is significantly better than that of disofenin in moderate to severe hepatic dysfunction.

The administered activity for infants and children is 1.8-2.59 MBq/kg (0.05-0.07 mCi/kg) with a minimum administered activity of 18.5 MBq (0.5 mCi). Mebrofenin is preferred in neonates with hyperbilirubinemia with a minimum administered activity of 37 MBq (1.0 mCi), as up to 24 hour delayed images are often necessary.

### D. Protocol/Image Acquisition

#### 1. Image Acquisition

A large field of view gamma camera equipped with a low energy all-purpose or high-resolution collimator is recommended. Whenever possible, continuous (dynamic) computer acquisition (usually in the anterior or left anterior oblique view) should be performed (1 frame/min). The image matrix of 128 by 128 is optimal on a standard large field of view camera. In pediatric patients an appropriate electronic acquisition zoom should be used. Initial imaging is usually acquired dynamically, starting at injection and continuing for 60 min. When visualization of the gallbladder is the end-point, the study can be stopped when activity is seen in the gallbladder. Additional views (e.g., right lateral, left or right anterior oblique) may be obtained as needed to clarify anatomy. To resolve a concern for common bile duct obstruction (highly unlikely in the presence of gallbladder visualization), demonstration of tracer activity in the small bowel may need to be pursued.

The digital data can be reformatted to 4-6 min images for filming or

digital display. Cinematic display of the data may reveal additional information not readily apparent on reformatted display. Image intensity scaling should be study-relative rather than individual frame-relative. The former allows for appreciation of activity changes over time.

When acute cholecystitis is suspected and the gallbladder is not seen within 60 min, delayed images for up to 3-4 hr should be obtained, or morphine augmentation (see VI.F.2.) may be employed in lieu of delayed imaging. Delayed imaging at 18-24 hr (79, 80) may be necessary in some cases (e.g., severely ill patient, severe hepatocellular dysfunction, suspected common bile duct obstruction, suspected biliary atresia).

If the patient is being studied for a biliary leak, 2-4 hour delayed imaging (or longer delays in some cases) and patient-positioning maneuvers (e.g., decubitus views) may be helpful. Any drainage bags should be included in the field of view if the biliary origin of a leak or fistula is in question. In patients with suspected leak it may be helpful to acquire simultaneous imaging in the right lateral or other views on a multi-headed camera.

## 2. Processing

- a. Gallbladder ejection fraction (GBEF): Using the immediate pre-sincalide and the post-sincalide images, regions of interest (ROI) are drawn around the gallbladder (taking into account patient motion) and adjacent liver (background) using any standard nuclear medicine software package. The liver background ROI is selected taking care to exclude ductal activity. GBEF is calculated from the gallbladder time-activity curve as:

$$\text{GBEF (\%)} = \frac{(\text{net GB cts}_{\text{max}} - \text{net GB cts}_{\text{min}}) \times 100}{\text{Net GB cts}_{\text{max}}}$$

Where (net GB cts<sub>max</sub>) is maximal counts in the gallbladder corrected for the background and (net GB cts<sub>min</sub>) is counts in the gallbladder corrected for the background.

- b. Hepatocellular function may be assessed by deconvolution analysis from ROI over the liver and heart (hepatic extraction fraction) or by analysis of a heart ROI for tracer clearance from the blood pool (81-83).

## E. Interventions

A variety of pharmacologic or physiologic interventions may enhance the diagnostic value of the examination. Appropriate precautions should be taken to promptly detect and treat any adverse reactions caused by these interventions. It is important to be familiar with all contraindications and warnings detailed in package inserts of the pharmaceuticals listed below.

1. Sincalide pretreatment: Sincalide, a synthetic C-terminal octapeptide of cholecystokinin (CCK) can be used to empty the gallbladder prior to radiopharmaceutical administration. This can facilitate filling of the gallbladder with radioactive bile. This maneuver is particularly helpful in patients who fasted longer than 24 hours, which results in a full gallbladder that would not be likely to fill further with radioactive bile.

Sincalide, in doses of 0.02 µg/kg that was given intravenously over 3 minutes, has been shown to result in consistent refilling of the gallbladder during subsequent one hour of imaging (84, 85). A slower infusion (15-60 min) may be preferred for pre-treatment, as it is known to cause a more complete emptying of the gallbladder (86, 87) and less likely to result in abdominal cramps.

In patients suspected of Sphincter of Oddi dysfunction because of persistent abdominal colic post-cholecystectomy, sincalide pretreatment cholescintigraphy can be used as a diagnostic screening test (73). Sincalide (0.02 µg/kg) is administered intravenously over 3 minutes and the imaging starts 15 minutes later in anterior projection, continued for 60 minutes. ROIs are placed over the liver parenchyma and the common bile duct to generate the time-activity curves. The interpretation criteria are based on the scoring system designed by the test developers (73).

2. Morphine Sulfate: When acute cholecystitis is suspected and the gallbladder is not seen by 30-60 min, morphine sulfate, 0.04 mg/kg or a standard 2 mg dose, may be administered intravenously over 2-3 min (25, 28). If the cystic duct is patent, flow of bile into the gallbladder will be facilitated by morphine-induced temporary spasm of the sphincter of Oddi. Tracer activity should be present in the small bowel at the time of morphine injection. A second injection of radiopharmaceutical, 74 MBq (2 mCi), may be necessary prior to morphine administration if the remaining liver/biliary tree activity appears insufficient to permit visualization of gallbladder filling or it can be given routinely prior to morphine (25). Imaging is continued for another 30-60 minutes following morphine administration. This time should be extended if there is poor hepatocyte function. Contraindications to the use of morphine include increased intracranial pressure in children (absolute), respiratory depression in non-ventilated patients (absolute), morphine allergy (absolute) and acute pancreatitis (relative).
3. Sincalide stimulation: Gallbladder contractility may be evaluated by determining GBEF following sincalide stimulation. The study involves an intravenous administration of sincalide and multiple methodologies exist. Knowledge of validated GBEF in normal people is essential in determining which patient is exhibiting an abnormal result. The following summarizes expected GBEF for tested techniques. It is presented in the following format: sincalide dose (µg/kg), time of infusion (min), GBEF (mean±standard deviation), GBEF range, and number of normal individuals studied.
  - a. 0.04, 3, 43±26%, 15-88%, 12. (84)

- b. 0.02, 3, 35±17%, 17-59%, 6. (84)
- c. 0.02, 3, 56±27, 0-100%, 23. (86)
- d. 0.01, 3, 46±20, 12-74%, 20. (88)
- e. 0.01, 10, 76±16, 37-96%, 13. (89) (Subjects were pre-screened with 3 min sincalide stimulation, those with GBEF<35% GBEF were excluded.)
- f. 0.02, 15, 76±22, 32-98%, 15. (90)
- g. 0.02, 15, 57±29, -2-98, 60. (87)
- h. 0.01, 30, 64±20, 26-95%, 14. (86)
- i. 0.02, 30, 70±22, 17-97%, 23 (86)
- j. 0.02, 30, 71±25, 8-99%, 60. (87)
- k. 0.015, 45, 75±12, >40% (95% confidence limits), 40. (3)
- l. 0.01, 60, 68±16, 15-88%, 20. (88)
- m. 0.02, 60, 84±16, 38-100%, 60. (87)

The best validated normal data-set with greatest number of normal volunteers involved points to infusion of 0.02 µg/kg over 60 minutes as one which can result in least variability of normal values (87) and may be considered the method of choice. The normal GBEF with this methodology should be ≥38%. Effectiveness of this method in chronic gallbladder disease has not been reported to date.

A data-set with infusion of 0.015 µg/kg over 45 minutes and GBEF measured at 60 minutes showed acceptable variability (3). For this method authors suggest GBEF≥40% as normal. This methodology is the only one that has a prospective, randomized study that supports its use in patients with chronic acalculous gallbladder disease.

Sincalide infusions over shorter times (VI.E.3.a-j) showed concerning number of normal subjects with very low GBEF that would be commonly reported as pathological (2, 87), raising a false-positive rate.

4. Fatty meal stimulation: Gallbladder ejection fraction measurement using a fatty meal challenge instead of sincalide has also been described. (91, 92) This approach is not as reproducible in normal subjects (has greater variability) as the sincalide methodology described in the preceding section.
5. Phenobarbital: In jaundiced infants in whom biliary atresia is suspected, pre-treatment with phenobarbital, 5 mg/kg/day, may be given orally in two divided doses daily for a minimum of 3 - 5 days prior to the hepatobiliary imaging study to enhance the biliary excretion of the radiotracer and increase the specificity of the test. (41) It may be useful to document therapeutic phenobarbital levels prior to starting the study.
6. Ursodeoxycholic Acid: In jaundiced infants in whom biliary atresia is suspected, pretreatment with ursodeoxycholic acid is an alternative. (43) The dose is 20 mg/kg/day in 2 divided doses (12 hours apart) for 2-3 days prior to the scan. This medication is continued until the test is over. In comparison to phenobarbital, ursodeoxycholic acid does not cause a

sedative effect on infants. Another advantage to consider is shorter premedication.

#### F. Interpretation

1. Normal: A normal hepatobiliary scan is characterized by rapid uptake of tracer into the hepatic parenchyma and rapid clearance of cardiac blood pool activity, followed sequentially by activity in the intra- and extrahepatic biliary ductal system, gallbladder and small bowel. All these structures should be seen within one hour. Gallbladder filling implies a patent cystic duct and excludes acute cholecystitis with a high degree of certainty. When patient preparation induces preferential bile flow to the gallbladder (such as in some cases of sincalide pre-treatment), activity in the small intestine may not be seen during the first hour (or even longer than 2 hours) in normal individuals (93).
2. Acute cholecystitis: The hallmark of acute cholecystitis (acalculous as well as calculous) is persistent gallbladder non-visualization by 3-4 hr of passive imaging or by 30 min post morphine administration.

A pericholecystic hepatic band of increased activity (“rim sign”) is a sign of severe late stage acute cholecystitis and has been associated with severe phlegmonous/gangrenous acute cholecystitis, a surgical emergency (94).

3. Chronic cholecystitis and clinical settings associated with physiologic failure of the gallbladder to fill with radiotracer (e.g., prolonged fasting for >24-48 hr, severely ill or post-operative hospitalized patients) may result in gallbladder non-filling within the first hour, but may be separated from acute cholecystitis using low dose intravenous morphine (see above) or delayed imaging. In chronic cholecystitis the gallbladder will usually be seen within 30 min of morphine administration or on 3 - 4 hr delayed images, while true cystic duct obstruction (acute cholecystitis) will result in persistent gallbladder non-visualization. In a properly prepared patient, appearance of the gallbladder after the bowel has a significant correlation with chronic cholecystitis.
4. Reduced gallbladder ejection fraction in response to sincalide occurs in calculous and acalculous biliary diseases (i.e., chronic acalculous cholecystitis, cystic duct syndrome, sphincter of Oddi spasm). It may also be associated with various non-biliary diseases and conditions, as well as caused by a variety of medications (e.g., morphine, atropine, calcium channel blockers, octreotide, progesterone, indomethacin, theophylline, benzodiazepines, histamine-2 receptor antagonists).
5. Common bile duct obstruction: Delayed biliary-to-bowel transit beyond 60 min raises the suspicion for partial common bile duct (CBD) obstruction, although this may be seen as a normal variant in up to 20% of individuals. With high grade CBD obstruction, there is usually prompt liver uptake but no secretion of the radiotracer into biliary ducts. With prolonged obstruction, concomitant hepatic dysfunction may be seen. With partial biliary obstruction,

radiotracer fills the biliary system but clears poorly proximal to the obstruction. Clearance into the bowel may or may not be seen. Severe hepatocellular dysfunction may also demonstrate delayed biliary-to-bowel transit.

6. Biliary leak: A bile leak is present when tracer is found in a location other than the liver, gallbladder, bile ducts, bowel or urine. This may be seen more easily using a cinematic display or decubitus positioning (see above).
7. Biliary atresia: Biliary atresia can be excluded scintigraphically by demonstrating transit of radiotracer into the bowel. Failure of tracer to enter the gut is consistent with biliary atresia, but can also be caused by hepatocellular disease or immature intrahepatic transport mechanisms. Renal or urinary excretion of the tracer (especially in diaper) may be confused with bowel activity and is a potential source of erroneous interpretation.
8. Duodenogastric bile reflux: During a hepatobiliary scan, activity may reflux from the duodenum into the stomach. If the bile reflux is marked and occurs in a symptomatic patient it is highly correlated with bile gastritis (95, 96), a cause of epigastric discomfort.
9. Post-cholecystectomy sphincter of Oddi dysfunction: Sphincter of Oddi dysfunction may have the appearance of partial common bile duct obstruction with prominent retention of radiotracer in the common bile duct (97). Various visual, quantitative and semiquantitative scintigraphic parameters of bile clearance after sincalide stimulation has been used in conjunction with image analysis (see VI.E.1).

#### G. Sources of Error

1. The causes of a false-positive study (gallbladder non-visualization in the absence of acute cholecystitis) include:
  - a. Insufficient fasting (<2 - 4 hr)
  - b. Prolonged fasting (>24 hr), especially total parenteral nutrition (despite Sincalide pre-treatment and Morphine augmentation)
  - c. Severe hepatocellular disease
  - d. High grade common bile duct obstruction
  - e. Severe intercurrent illness (despite sincalide pre-treatment and morphine augmentation)
  - f. Pancreatitis (rare)
  - g. Rapid biliary-to-bowel transit (insufficient tracer activity remaining in the liver for delayed imaging)

- h. Severe chronic cholecystitis
  - i. Previous cholecystectomy
2. The causes of a false-negative study (gallbladder visualization in the presence of acute cholecystitis) are rare, but include:
- a. Bowel loop simulating gallbladder (drinking 100-200 ml water may remove the radiopharmaceutical from the duodenum and allow differentiation of gall bladder from bowel). Review of dynamic images in a cine display may also be helpful. A right lateral view should be obtained in order to better distinguish between activity in the duodenum from that of the gallbladder.
  - b. Acute acalculous cholecystitis
  - c. The presence of the “dilated cystic duct” sign simulating gallbladder. If this sign is present, morphine should not be given.
  - d. Bile leak due to gallbladder perforation
  - e. Congenital anomalies simulating gallbladder
  - f. Activity in the kidneys simulating gallbladder or small bowel (may be clarified by a lateral image).

## VII. DOCUMENTATION/REPORTING

### A. Goals of a Nuclear Medicine Report

Refer to Section VII of the SNM Procedure Guideline for General Imaging.

### B. Direct communication

Refer to Section VII of the SNM Procedure Guideline for General Imaging.

### C. Written communication

Refer to Section VII of the SNM Procedure Guideline for General Imaging.

### D. Contents of a Nuclear Medicine Report

- 1. Study Identification
- 2. Patient Demographics
- 3. Clinical Information

Indication for the study (e.g., suspected acute cholecystitis, common bile duct obstruction, or bile leak, etc.). It is useful to include medications in this part of historical review, especially the last dose of potentially interfering ones. The last oral food intake is also useful to record.

4. Comparison/correlative imaging data
5. Procedure Description
  - a. Radiopharmaceutical and activity administered
  - b. Other medications given, their dosage and time of administration with regard to tracer injection (e.g., pre-treatment with sincalide, phenobarbital or morphine)
  - c. Duration of imaging, special or delayed views obtained
6. Description of Findings
 

Include the appearance of the liver, intrahepatic ducts, common bile duct, the presence and time of tracer appearance in the gallbladder and/or small bowel, any unusual activity (e.g., bile leak, enterogastric reflux, etc.), any quantitative data generated (e.g., GBEF)
7. Study limitations, patient reactions to drugs administered
 

If there is an allergic or other adverse reaction to the radiopharmaceutical or other administered pharmaceuticals, it must be clearly stated in the findings and impression sections of the report.

The gastrointestinal symptoms elicited by sincalide infusion are related to the rapid infusions and not observed with the recommended slower infusion techniques of 45 and 60 minutes. Gastrointestinal symptoms during the shorter sincalide infusion have no specificity for gallbladder pathology (98); therefore, those symptoms should not be part of the study report.
5. Impression
 

This should be concise, as precise as possible, should address the clinical question, provide a differential diagnosis and make recommendations if appropriate.

Any urgent or unexpected findings should be directly communicated to the referring physician and the communication should be documented.

## VIII. EQUIPMENT SPECIFICATION

A large field of view gamma camera equipped with a low energy all-purpose or high-

resolution collimator is recommended. A SPECT or SPECT/CT camera may be used for detection of biliary leak location (38) or for estimation of a liver remnant function in patients preparing for partial hepatectomy (66).

## IX. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION CONCERNS

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

## X. RADIATION DOSIMETRY

Refer to Section X of the SNM Procedure Guideline for General Imaging for general guidance.

### Radiation Dosimetry for Adults\*

Radiopharmaceuticals	Administered Activity	Organ Receiving the Largest Radiation Dose	Effective Dose
	MBq (mCi)	mGy per MBq (rad per mCi)	mSv per MBq (rem per mCi)
<sup>99m</sup> Tc-Disofenin	56–180 i.v.	0.11	0.017
<sup>99m</sup> Tc-Mebrofenin	(1.5–5.0)	Gallbladder Wall (0.41)	(0.063)

\* ICRP 80 (99)

### Radiation Dosimetry for Children\*

Radiopharmaceuticals	Administered Activity	Age	Organ Receiving the Largest Radiation Dose	Effective Dose
	MBq (mCi)	(y)	mGy per MBq (rad per mCi)	mSv per MBq (rem per mCi)
<sup>99m</sup> Tc-Disofenin <sup>99m</sup> Tc-Mebrofenin	18.5 – 111 i.v. (0.5 – 3.0)	1	0.95 Gallbladder Wall (3.5)	0.10 (0.37)
		5	0.29 Colon (1.1)	0.045 (0.17)
		10	0.18 Colon (0.67)	0.029 (0.11)
		15	0.12 Gallbladder Wall (0.44)	0.021 (0.078)

\* ICRP 80 (99)

### The Pregnant or Potentially Pregnant Patient

Administration of radiopharmaceuticals to the pregnant or potentially pregnant patients is addressed in the SNM Procedure Guidelines for General Imaging. Physician must consider the indication for the test, potential benefit of information it may provide towards improved care of the patient, as well as potential risk it may pose to the fetus. Dose estimates to the fetus were provided by Russell et al. (100) that allow physician to make the best possible informed recommendation to an individual patient. However, no information about possible placental crossover of hepatobiliary compounds is available.

Stage of Gestation	Fetal Dose mGy per MBq (rad per mCi)
Early	0.017 (0.063)
3 months	0.015 (0.056)
6 months	0.012 (0.044)
9 months	0.0067 (0.025)

### The Breastfeeding Patient

Administration of radiopharmaceuticals to the breastfeeding patients is addressed in the SNM Procedure Guidelines for General Imaging. ICRP Publication 106, Appendix D recommends that lactating patients who receive  $^{99m}\text{Tc}$ -iminodiacetic acid compounds require no interruption of breastfeeding (101).

## XI. ACKNOWLEDEMENTS

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**XIII. BOARD OF DIRECTORS APPROVAL DATES:**

Version 1.0 June 11, 1995

Version 2.0 June 6, 1998

Version 3.0 June 23, 2001

Version 4.0 June 4, 2010