

Appropriate Use Criteria for Gastrointestinal Transit Scintigraphy

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From the Newsline editor: Appropriate use criteria (AUC) are statements that contain indications describing when and how often an intervention should be performed under the optimal combination of scientific evidence, clinical judgment, and patient values while avoiding unnecessary provisions of services. SNMMI is a qualified provider-led entity under the Medicare Appropriate Use Criteria program for advanced diagnostic imaging, allowing referring physicians to use SNMMI AUC to fulfill the requirements of the 2014 Protecting Access to Medicare Act. SNMMI follows a balanced multidisciplinary approach to guidance development by including various stakeholders in the development process. For background and a detailed explanation of this development process, see <http://www.snmmi.org/ClinicalPractice/content.aspx?ItemNumber=15665>. This Newsline article is a summary of the complete text of the AUC, which is available at www.snmmi.org/auc.

EXECUTIVE SUMMARY

The appropriate use of scintigraphy for studying gastrointestinal (GI) motility requires not only an understanding of the normal physiology and pathophysiology of the various disorders that can affect the GI tract but also an understanding of the numerous methods and associated technical details of the current clinically available modalities for studying GI motility. Developing recommendations on the appropriate use of GI transit scintigraphy requires input from experts in the fields of nuclear medicine, radiology, and gastroenterology. This document has therefore been prepared with input from representatives with this expertise from various professional societies (Appendix A). These experts reviewed the current literature with the methodology described below and established appropriateness ratings for a wide range of clinical scenarios experienced by patients who have symptoms associated with suspected abnormal GI function. The appropriate use criteria (AUC) delineated in this report are intended to assist referring medical practitioners in the diagnosis and management of patients with symptoms thought to arise from altered GI motility in the esophagus, stomach, small bowel, and colon.

INTRODUCTION

Direct measurement of GI motility is classically performed by a gastroenterologist by placing a tube or catheter-based probe within the GI tract to directly measure pressure changes within a lumen, electrical signals, or pH. Recently, less invasive

wireless motility capsules have been introduced (1,2). The advantages of scintigraphy for studying GI motility still remain valid despite the long time that has elapsed since the first application of a radiolabeled meal to measure gastric emptying (GE). Scintigraphy is noninvasive, does not disturb normal physiology, and can provide accurate quantification of the bulk transit of an orally administered radiolabeled solid or liquid meal. Compared with radiographic methods, scintigraphy involves low radiation exposure of the patient, is quantifiable, and uses commonly ingested foods rather than barium or nonphysiological radiopaque markers.

Gastroenterologists and primary care physicians are often faced with a wide range of symptoms in a patient, including early satiety, pain, nausea, vomiting, bloating, diarrhea, constipation, or difficulty passing a bowel movement. GI symptoms in patients often overlap and may or may not be associated with meal ingestion. It is difficult to assess whether a patient's symptoms are due to an underlying structural pathology or are functional. The authors of this AUC document recognize that management of these patients is complex and the decision to perform any diagnostic study must take into consideration the entire patient presentation. The recommendations in this document do not preclude the use of other testing. Referring health care providers should always consider the patient history, physical findings, and results of previously acquired tests before using GI scintigraphy studies. This AUC document is presented to assist health care practitioners in the appropriate use of GI scintigraphy in evaluating patients with GI tract symptoms. It is not intended to replace good clinical judgment.

As scintigraphy does not provide detailed anatomic images of the GI tract, it is particularly important to make sure an anatomic cause for the patient's symptoms has been excluded before assuming that the patient has a nonstructural primary motility disorder. This is typically performed by using radiographic imaging or endoscopic methods.

In reviewing the literature on GI transit scintigraphy, it is apparent that although some studies such as GE and esophageal transit have been available for over 50 y, the use of scintigraphy to image and quantify GI motility continues to undergo modernization and advancement. Methods such as esophageal transit scintigraphy (ETS) that were established many years ago have been replaced in many centers by more advanced manometric techniques, although they remain in limited use in select institutions where there is clinical expertise that is often not available in other institutions. GE studies continue to evolve with

advances that permit simultaneous measurement of other indices of gastric motility, such as accommodation and antral contractions (3–5). Because of such advancements, this AUC report may need to be updated as newer and more specialized techniques are developed.

As with many imaging studies, few multicenter studies have examined clinical outcomes. Our appropriateness ratings are influenced by the clinical experience of the expert panel, which included both imaging specialists and gastroenterologists who perform, order, and use these studies in the diagnosis and management of patients with a wide range of GI symptoms.

These AUC recommendations are intended to apply primarily to adults. Because no well-defined normal values for radiolabeled meals have been established in children (due to concerns about radiation exposure of children involved in research) and because established GI transit protocols require development of normal values, this committee felt that pooled data on normal values in children in the literature were insufficient to confirm the validity of GI transit studies in children. Many sites have, however, developed institutional experience that may be used to validate their local study procedures.

This document may also be useful for nuclear medicine physicians, radiologists, and technologists, as well as for developers of clinical decision support tools as guidance in validating requests for imaging patients with GI tract symptoms. Radiology benefit managers and other third-party payers may also use these AUC. It is our intention that the AUC be used to help ensure the appropriate ordering of GI motility scintigraphic testing in patients with GI symptoms who lack appropriate diagnosis and treatment.

ESOPHAGEAL TRANSIT SCINTIGRAPHY (ETS)

Introduction/Background

There are several tests of esophageal motor function. The decision about which diagnostic study to use for esophageal dysmotility depends on the patient's symptoms. If dysphagia is present, a barium swallow or endoscopy is usually performed first to exclude an anatomic lesion. Manometry is considered the gold standard for diagnosis of primary esophageal motility disorders, including achalasia, scleroderma, diffuse esophageal spasm, impaired lower esophageal sphincter (LES) relaxation, hypertensive LES, and non-specific esophageal motility disorders. Manometry, however, has limitations: it provides only an indirect measure of peristalsis, as the pressure waves recorded do not always correlate with the aboral forces applied to a solid or liquid bolus in the esophagus; the presence of a manometric tube itself may affect normal physiology; and quantification of the volume of retained solids or liquids in the esophagus is not possible.

Early scintigraphy studies of esophageal transit demonstrated a high sensitivity for detecting a wide range of esophageal motility disorders but a low sensitivity for disorders

with intact peristalsis but high-amplitude contractions or isolated elevated pressures in the LES (6,7). The use of manometry potentially supplemented by ETS for equivocal manometry results will, in large part, be determined by local expertise and availability.

Summary of Recommendations

Clinical scenarios for esophageal transit (often performed with gastroesophageal reflux [GER] studies) are presented in Table 1. Esophageal manometry, barium swallow radiography, and pH monitoring are typically used for first-line evaluation of patients with suspected esophageal dysmotility and GER. Use of ETS is limited by the availability of local expertise with experience in the methodology, but, when available, such expertise is most commonly used when there are equivocal or nondiagnostic findings from first-line studies.

GE OF SOLIDS (SOLID NUTRIENT OR EQUIVALENT)

Introduction/Background

GE studies are usually ordered to confirm or exclude whether gastroparesis (delayed GE) is a cause of the patient's symptoms. Gastroparesis is usually associated with upper GI symptoms, which include nausea (92% of patients), vomiting (84%), abdominal fullness or distention (75%), and early satiety (60%) (8). Etiologies for gastroparesis include diabetes; postgastric surgical conditions; infections (especially postviral); neuromuscular, autoimmune, and connective tissue diseases; and idiopathic disease.

Patients often do not have well-defined GI symptoms and present with concerns about dyspepsia (symptoms of any pain or discomfort thought to originate in the upper GI tract). The goal of diagnosing delayed GE is to identify patients who will benefit from a prokinetic drug or other treatment to alleviate symptoms. A GE study is indicated for patients with suspected gastroparesis or dyspepsia after an anatomic cause for symptoms has been excluded. A GE study may also be indicated in the absence of dyspeptic symptoms, such as those with severe GER not responding to acid suppressants (to see whether delayed GE contributes to reflux), those requiring a workup to identify a diffuse GI motility disorder, and those who are diabetic and have poor glycemic control. GE studies can also be used to assess patients for dumping syndrome, in which GE is rapid. Classically, this occurs after surgery but is now being described in patients with autonomic dysfunction, cyclic vomiting syndrome, and functional dyspepsia.

Gastric emptying scintigraphy is currently the gold standard method for measuring GE and is the standard to which other diagnostic tests have been compared. It should be performed by using the currently accepted, standardized low-fat solid meal that is endorsed by the American Neurogastroenterology and Motility Society and SNMMI (9–11). Advantages of this test include good tolerability of the meal by the majority of patients, validated multicenter

TABLE 1
Clinical Scenarios for Esophageal Transit (Often Performed with Gastroesophageal Reflux Studies)

| Scenario no. | Description | Appropriateness | Score |
|--------------|--|--------------------|-------|
| 1 | Dysphagia (e.g., symptoms of achalasia, scleroderma, diffuse esophageal spasm, hypertensive lower esophageal sphincter, nonspecific motility disorder, esophageal outflow obstruction) | Appropriate | 7 |
| 2 | Quantification of response to therapy (treatment for achalasia) | Appropriate | 7 |
| 3 | Aspiration | May be appropriate | 4 |
| 4 | Rumination | May be appropriate | 4 |
| 5 | Gastroesophageal reflux (e.g., symptoms of liquid or solid regurgitation, heartburn) | May be appropriate | 5 |
| 6 | Pre- and post-fundoplication | May be appropriate | 5 |

normal values, and a reproducible methodology. Patients who cannot tolerate the current egg-based solid meal can be tested with the nutritional supplement Ensure PLUS (12,13). The advantages of this substitute meal are that it uses the same imaging protocol and that it has normal GE values that are similar to those of the solid egg-based meal. A rice-based solid meal substitute that is gluten free and vegan has documented normal values but may not be widely available (14). Although many variations of solid and liquid GE meals are used by some diagnostic facilities, they are not recommended until they have had sufficient validation in the literature.

Recently, a nonnutrient water-only GE test was compared with the standard solid meal and showed a delay in water GE in 32% of patients with normal solid GE (15,16). The potential advantages of a water-only meal are meal tolerability, a shorter acquisition time, and added sensitivity. Currently only single-center data support the use of a nonnutrient water meal.

To fully integrate the results of a GES test into patient management, it is important to document GI symptoms, prior surgical procedures, and all drugs in use (17). An abbreviated list of interfering medications includes the

TABLE 2
Clinical Scenarios for Gastric Emptying of Solids (Including Postinfectious Symptoms)

| Scenario no. | Description | Appropriateness | Score |
|--------------|--|--------------------|-------|
| 1 | Symptoms of gastroparesis (e.g., symptoms of diabetic or idiopathic) | Appropriate | 9 |
| 2 | Functional dyspepsia (e.g., symptoms of upper abdominal pain/discomfort, early satiety, nausea, vomiting, bloating, postprandial fullness) | Appropriate | 9 |
| 3 | Postsurgical-induced symptoms of dyspepsia, questionable rapid gastric emptying (e.g., symptoms of postsurgical gastroparesis, postvagotomy gastroparesis) | Appropriate | 9 |
| 4 | Poorly controlled diabetes without dyspeptic symptoms | May be appropriate | 5 |
| 5 | Poorly controlled gastroesophageal reflux without dyspeptic symptoms | May be appropriate | 6 |
| 6 | Suspected generalized GI motility disorder (intestinal pseudoobstruction) | May be appropriate | 6 |
| 7 | Cyclic vomiting syndrome | May be appropriate | 6 |
| 8 | Anorexia nervosa | May be appropriate | 5 |
| 9 | Suspected impaired gastric accommodation (e.g., symptoms of early satiety, postprandial fullness, and/or abdominal pain) | Appropriate | 7 |
| 10 | Pre- and/or postbariatric surgery | May be appropriate | 5 |
| 11 | Postsurgical evaluation (for neurostimulator, pyloroplasty, pyloromyotomy, partial gastric resection) | May be appropriate | 6 |
| 12 | Postsurgical treatment | May be appropriate | 6 |
| 13 | Postsurgical neurostimulator placement | May be appropriate | 6 |
| 14 | Postsurgical pyloroplasty | May be appropriate | 6 |
| 15 | Following surgical or endoscopic pyloromyotomy | May be appropriate | 6 |
| 16 | Postsurgical partial gastric resection | May be appropriate | 6 |

following: anticholinergics; calcium channel blockers; clonidine; proton pump inhibitors; tricyclic antidepressants; lithium; exenatide; liraglutide; pramlintide; dopamine agonists; progesterone-containing agents; nicotine by smoking and/or use of containing agents; medications containing opioids, octreotide, or other somatostatin analogs; and tetrahydrocannabinol by smoking and/or use of its ingestible derivatives. Interfering medications should be stopped for 3 d or 6–10 half-lives of the drug. Concealed use of an illicit drug can be an overlooked reason for GI symptoms and GE dysfunction. In patients with diabetes, blood glucose must be checked and documented immediately before the test to avoid slowing of GE due to hyperglycemia (18–21).

Summary of Recommendations

Clinical scenarios for gastric emptying of solids (including postinfectious symptoms) are presented in Table 2. GES remains the standard for measuring both solid and liquid GE. Recent advances in GES now permit additional measurements of gastric motility, including intragastric meal distribution, gastric accommodation response, and antral contraction frequency and amplitude. Although current treatments for gastroparesis are limited, it is anticipated that these newer measures of gastric dysmotility may lead to improved treatment.

GE OF LIQUIDS (NUTRIENT AND NONNUTRIENT/WATER MEALS)

Introduction/Background

Determination of GE rates of a nonnutrient water meal is not well established. Use of a water meal dates back to the early use of a saline load test for gastric outlet obstruction. There is limited evidence for the existence of a subset of patients with gastroparesis with normal solid GE but abnormal GE of water (15,16). Use of a water meal has not

been validated in multicenter studies. Because water by definition has no caloric value, it is clinically of greater pertinence to address the GE of a nutrient liquid meal. A nutrient liquid meal is indicated for patients referred for GES who have egg and/or gluten allergies or other reasons for intolerance of the standard solid meal. The GE characteristics of a validated liquid nutrient meal are similar to those of the standard solid meal but with a slightly faster emptying rate (12,13,22).

Summary of Recommendations

Clinical scenarios for gastric emptying of liquids (nonnutrient/water meal) are presented in Table 3. GES of solids remains the gold standard for measuring GE. There are limited data on the clinical value of liquid GE alone. Liquid GE is, however, typically combined with solids when additional small-bowel or colonic transit studies are needed. A substitute liquid meal can be of clinical value for patients who cannot tolerate the standard radiolabeled egg meal.

SMALL-BOWEL TRANSIT

Introduction/Background

The function of the small bowel is to transport food as it empties from the stomach and to mix it with bile and with pancreatic and intestinal secretions to facilitate absorption over the bowel mucosal surface. Measurement of small-bowel transit is complex because entry of a meal into the small intestine depends on GE and because small-bowel chyme spreads over a large distance as it progresses toward the colon. There is no simple small-bowel peristaltic pattern. Antegrade and retrograde movements of intestinal chyme occur in the jejunum and ileum, with some areas progressing rapidly and others slowly. Jejunal peristaltic activity is typically more rapid and intense, with slowing of peristalsis seen in the ileum (23).

TABLE 3
Clinical Scenarios for Gastric Emptying of Liquids (Nonnutrient/Water Meal)

| Scenario no. | Description | Appropriateness | Score |
|--------------|--|--------------------|-------|
| 1 | Symptoms of gastroparesis (e.g., symptoms of diabetic vs. idiopathic) if solid emptying is normal | Appropriate | 7 |
| 2 | Functional dyspepsia (e.g., symptoms of upper abdominal pain/discomfort, early satiety, nausea, vomiting, bloating, postprandial fullness) | Appropriate | 7 |
| 3 | Poorly controlled diabetes without dyspeptic symptoms | May be appropriate | 4 |
| 4 | Poorly controlled gastroesophageal reflux without dyspeptic symptoms | Rarely appropriate | 3 |
| 5 | Suspected generalized GI motility disorder (intestinal pseudoobstruction) | Rarely appropriate | 3 |
| 6 | Cyclic vomiting syndrome | Rarely appropriate | 3 |
| 7 | Anorexia nervosa | May be appropriate | 4 |
| 8 | Gastrostomy evaluation | May be appropriate | 5 |
| 9 | Unable to tolerate solid meal | Appropriate | 8 |
| 10 | After a normal solid meal when symptoms suggest gastric motility disorder | Appropriate | 8 |
| 11 | Small-bowel transit study (when combined with liquid gastric emptying) | Appropriate | 7 |

TABLE 4
Clinical Scenarios for Small-Bowel Transit

| Scenario no. | Description | Appropriateness | Score |
|--------------|--|--------------------|-------|
| 1 | Symptoms of small bowel dysmotility (e.g., symptoms of nausea, vomiting, bloating, constipation, diarrhea, abdominal distention) | Appropriate | 7 |
| 2 | Suspected small intestinal bacterial overgrowth | May be appropriate | 5 |
| 3 | Suspected generalized gastrointestinal motility disorder (e.g., drug-induced, idiopathic, or genetic) | Appropriate | 8 |
| 4 | Suspected intestinal pseudoobstruction (e.g., unexplained small-bowel dilation) | Appropriate | 8 |

The simplest approach to scintigraphic measurement of small-bowel transit is to measure orocecal transit time by imaging the leading edge of radiotracer transit through the bowel. Accurately defining the leading edge (the first visualized arrival of activity in the cecum), however, requires frequent (every 10–15 min) and prolonged imaging because of the stasis in the terminal ileum.

An alternative scintigraphic method of measuring small-bowel transit does not attempt to characterize the complex temporal or spatial peristaltic small-bowel patterns or leading-edge transit but simply measures the overall bulk movement of radiotracer as it progresses distally into the terminal ileum. Typically, the radiolabeled meal collects in a terminal ileal reservoir. This region is also referred to as the ileocolonic junction. The recent SNMMI/European Association of Nuclear Medicine guideline on small-bowel transit recommends use of the percentage of administered liquid meal that has accumulated in the terminal ileum at 6 h after meal ingestion as a simple index of small-bowel transit (24). Small-bowel transit is considered normal if >40% of administered activity has progressed into the terminal ileum or passed into the cecum and ascending colon at 6 h. Small-bowel transit is delayed if activity persists in multiple loops of small bowel at 6 h and if little activity (<40%) arrives in the terminal ileum reservoir. The amount of colon filling at 6 h has also been used as an index of small-bowel transit. The wireless motility capsule has been shown to correlate well with scintigraphy for measuring small-bowel transit (1).

Indications for small-bowel transit testing have been proposed in prior consensus publications. Authors of a review article by the American and European Neurogastroenterology

and Motility societies proposed that small-bowel transit testing should be considered for those with unexplained nausea, vomiting, bloating, distention, or other manifestations of small intestinal bacterial overgrowth (SIBO) or dysmotility (2). The authors of an older review commented that symptoms of small-bowel dysmotility are similar to those of gastroparesis and that small-bowel transit testing could be considered for those patients with persistent symptoms despite normal GE rates (25).

Summary of Recommendations

Clinical scenarios for small-bowel transit are presented in Table 4. The investigations cited in this systematic review support the endorsement of the panel for use of small-bowel scintigraphy as an appropriate diagnostic test in patients with symptoms of small-bowel dysmotility and SIBO. The available data suggest that a subset of patients with symptoms of presumed upper and/or lower gut origin will exhibit delayed small-bowel transit. However, there is not yet convincing literature that specifically documents that small-bowel transit delays will influence additional management decisions or affect outcomes of any treatments for patients with functional GI disorders.

COLON TRANSIT

Introduction/Background

Colonic motility regulates slow mixing and movement of its contents so that the colon can absorb water and electrolytes and transform liquid chyme into semisolids or solids in the sigmoid colon. Rhythmic phasic contractions aided by tonic contractions cause slow distal propulsion and mixing of colonic contents. In addition, infrequent high-amplitude

TABLE 5
Clinical Scenarios for Colon Transit

| Scenario no. | Description | Appropriateness | Score |
|--------------|--|-----------------|-------|
| 1 | Symptoms of large-bowel (colon) dysmotility (e.g., symptoms of constipation, bloating, abdominal pain, non-diarrhea-dominant irritable bowel syndrome) | Appropriate | 8 |
| 2 | Suspected generalized gastrointestinal motility disorder | Appropriate | 8 |
| 3 | Suspected intestinal pseudoobstruction (e.g., unexplained megacolon) | Appropriate | 8 |

TABLE 6
Clinical Scenarios for Whole-Gut Transit

| Scenario no. | Description | Appropriateness | Score |
|--------------|--|-----------------|-------|
| 1 | Suspected pan-gastrointestinal motility disorder (e.g., unable to differentiate upper from lower gastrointestinal motility disorder) | Appropriate | 8 |
| 2 | Presurgical evaluation of colonic inertia | Appropriate | 8 |

(>100 mm Hg) propagating contractions produce mass movements that deliver a large column of stool into the rectum. Thereafter, in healthy individuals, controlled evacuation of stool normally occurs between once in 3 d and up to 2 to 3 times a day. A key question in patients with chronic constipation is to identify whether there is colonic inertia, generalized slow colon transit, pelvic floor dysfunction, functional outlet obstruction, or irritable bowel syndrome (IBS) (26). Colonic motility and transit time are tested to determine whether a patient with symptoms of constipation has abnormal colonic transit and whether a specific area of the colon is involved.

Colon transit can be imaged by using serial radiographs after ingestion of radiopaque markers with a meal.

Radiographs are obtained for several days (up to 7) to count the number of markers remaining in segments of the colon (right, left, and rectosigmoid regions) or throughout the colon. The radiopaque marker test is not physiological, however, for the assessment of transit of intestinal chime. In contrast, 2 scintigraphic methods that have been most commonly applied to provide a more dynamic assessment of colonic transit use oral ¹¹¹In-diethylenetriamine pentaacetic acid (¹¹¹In-DTPA). These methods are described in detail in a consensus practice guideline (27). The wireless motility capsule is a newer technique that has been shown to correlate well with scintigraphy and radiopaque markers for measuring colon transit (1).

Summary of Recommendations

Clinical scenarios for colon transit are presented in Table 5. Colonic transit scintigraphy can be used to distinguish motility disorders that affect colonic transit from those that affect the whole gut. Disorders of colonic transit that cause constipation can be further differentiated into slow-intestinal-transit and normal-transit constipation. In addition, this test may identify patients who have intestinal pseudoobstruction and distal colonic disorders, such as delayed rectosigmoid transit or dysfunction and disorders of the pelvic floor.

WHOLE-GUT TRANSIT

Introduction/Background

Whole-gut transit scintigraphy (WGTS) refers to a combined study that includes measurement of GE, small-bowel, and colonic transit after administration of a dual-isotope, solid-liquid meal (28–30). These studies are helpful for

evaluating patients whose symptoms cannot be classified as either upper or lower GI in origin or where a functional and not an organic cause is suspected (31). The wireless motility capsule has been shown to correlate well with scintigraphy for measuring whole-gut transit (1).

Summary of Recommendations

Clinical scenarios for whole-gut transit are presented in Table 6. Substantial evidence exists that WGTS helps in localizing a site or sites of abnormal GI motility, thus helping yield a diagnosis and directing therapy in patients with a wide range of both upper and lower GI tract symptoms.

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Marta Cremonesi, PhD, 2020 Loevinger–Berman Award Recipient

The SNMMI Medical Internal Radiation Dose (MIRD) Committee announced on January 8 the selection of Marta Cremonesi, PhD, as the 2020 Loevinger–Berman Awardee, recognizing a lifetime of achievements and contributions to medical internal dosimetry. “Marta Cremonesi is an authority in the field of internal dosimetry and one of the pioneers of the initial applications of radiopeptides, in a career that began over 20 years ago. Over time, she has passionately continued her work in all fields of radionuclide therapy, exhibiting both meticulous scientific rigor and extraordinary productivity,” said Lisa Bodei, MD, PhD, a long-time colleague and collaborator. “Her contributions to the definition of the renal impact and tolerability of peptide-receptor radionuclide therapy are considered to constitute the standard of care for anyone involved in this treatment. Marta has defined the field both with her scientific skills and the generosity with which she has shared her knowledge and experience.”

Cremonesi is a medical physicist based in Italy and has served as the Director of the Radiation Research Unit of the European Institute of Oncology of Milan since 2014. Her career shows a dedicated commitment to internal dosimetry for radiopharmaceuticals in general and targeted radionuclide therapy in particular, including several Good Clinical Practice clinical trials using radiopharmaceuticals for diagnosis and therapy. Respected as an authority in the field, she

has presented more than 40 sessions and more than 180 communications and posters at meetings worldwide and has been an author on more than 100 publications, including 11 books.

Cremonesi will be the 21st recipient of the Loevinger–Berman Award since its conception in 1999. The award will be presented at the SNMMI 2020 Annual Meeting in New Orleans, LA, during the Loevinger–Berman Award continuing education session.

This award, sponsored by the Education and Research Foundation for Nuclear Medicine and Molecular Imaging, was established in 1999 by the MIRD Committee in honor of Robert Loevinger, PhD, and Mones Berman, PhD, internal dosimetry pioneers who formulated the MIRD schema for internal dose calculations. The Loevinger–Berman award recognizes innovation and excellence in the nuclear medicine subspecialty of internal radiation dosimetry through research and development, significant publication contributions, or advancement of the understanding of internal dosimetry in relationship to risk and therapeutic efficacy.

SNMMI



**Marta Cremonesi,
PhD**