Revised 2020 (Resolution 14) *

ACR–ACNM–SNMMI–SPR PRACTICE PARAMETER FOR THE PERFORMANCE OF NEUROENDOCRINE TUMOR SCINTIGRAPHY

PREAMBLE

This document is an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. Practice Parameters and Technical Standards are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care[1]. For these reasons and those set forth below, the American College of Radiology and our collaborating medical specialty societies caution against the use of these documents 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 practitioner considering all the circumstances presented. Thus, an approach that differs from the guidance in this document, 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 this document when, in the reasonable judgment of the practitioner, such course of action is indicated by variables such as the condition of the patient, limitations of available resources, or advances in knowledge or technology after publication of this document. However, a practitioner who employs an approach substantially different from the guidance in this document may consider documenting in the patient record information sufficient to explain the approach taken.

The practice of medicine involves the science, and 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 the guidance in this document 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 purpose of this document is to assist practitioners in achieving this objective.

[1] Iowa Medical Society and Iowa Society of Anesthesiologists v. Iowa Board of Nursing 831 N.W.2d 826 (Iowa 2013) Iowa Supreme Court refuses to find that the *ACR Technical Standard for Management of the Use of Radiation in Fluoroscopic Procedures* (Revised 2008) sets a national standard for who may perform fluoroscopic procedures in light of the standard's stated purpose that ACR standards are educational tools and not intended to establish a legal standard of care. See also, Stanley v. McCarver, 63 P.3d 1076 (Ariz. App. 2003) where in a concurring opinion the Court stated that "published standards or guidelines of specialty medical organizations are useful in determining the duty owed or the standard of care applicable in a given situation" even though ACR standards themselves do not establish the standard of care.

I. INTRODUCTION

This practice parameter was revised collaboratively by the American College of Radiology (ACR), the American College of Nuclear Medicine (ACNM), the Society of Nuclear Medicine and Molecular Imaging (SNMMI), and the Society for Pediatric Radiology (SPR).

This practice parameter is intended to guide interpreting physicians performing neuroendocrine tumor scintigraphy in adult and pediatric patients. Properly performed imaging with gamma-emitting radiopharmaceuticals that localize in neuroendocrine tumors is a sensitive method for assessing certain tumors.

As with all scintigraphic examinations, correlation of findings with results of other imaging and nonimaging modalities, as well as with clinical information such as serum tumor biomarkers, is necessary for maximum diagnostic yield.

Application of this practice parameter should be in accordance with the ACR-ACNM-SNMMI-SPR Practice Parameter for the Use of Radiopharmaceuticals in Diagnostic Procedures [1].

Neuroendocrine tumor scintigraphy involves the intravenous administration of a gamma-emitting radiopharmaceutical that localizes in certain tumor tissues, allowing subsequent imaging. This practice parameter is limited to scintigraphic agents used for gamma camera imaging. Positron emission tomography (PET) imaging of neuroendocrine tumors is covered in the ACR–SPR Practice Parameter for Performing FDG-PET/CT in Oncology and the ACR Practice Parameter for the Performance of Gallium-68 DOTATATE PET/CT for Neuroendocrine Tumors [2,3].

II. INDICATIONS

Indications for neuroendocrine tumor scintigraphy include, but are not limited to, the following:

1. Detection of primary and metastatic neuroendocrine tumors
2. Neuroendocrine tumor staging
3. Assessment of response to therapy
4. Detection and restaging of residual disease after completion of therapy
5. Detection and restaging of recurrent disease in patients who had been free of disease after prior therapy
6. Evaluation of abnormal imaging and nonimaging findings in patients with a history of neuroendocrine tumors
7. Planning of treatment with radiopharmaceuticals using either empirical or dosimetric dosage calculations

Specific clinical applications depend on the specific radiopharmaceutical.

For information on radiation risks to the fetus, see the ACR–SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Patients with Ionizing Radiation [4].

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the ACR-ACNM-SNMMI-SPR Practice Parameter for the Use of Radiopharmaceuticals in Diagnostic Procedures [1].

IV. SPECIFICATIONS OF THE EXAMINATION

The written or electronic request for neuroendocrine tumor 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. (ACR Resolution 35 adopted in 2006 – revised in 2016, Resolution 12-b)

A. Radiopharmaceuticals

1. Radioiodinated Metaiodobenzylguanidine (MIBG)

MIBG is a chemical analog of norepinephrine. Iodine-123 (I-123-iodide)-labeled MIBG is used specifically for evaluating neuroendocrine tumors such as pheochromocytoma, paraganglioma, neuroblastoma, ganglioneuroma, ganglioneuroblastoma, carcinoid tumors, medullary thyroid carcinoma, Merkel cell tumor, and multiple endocrine neoplasia (MEN) type 2 syndromes [5-11].

In adults, the administered activity is 5.0 to 10 mCi (185 to 370 MBq) of I-123-iodide MIBG injected intravenously [5-7,11-13]. For children, the administered activity should be as low as reasonably achievable for diagnostic image quality [9,14,15]. For children, the minimum administered activity is 1.0 mCi (37 MBq), and the maximum administered activity is 8.8 mCi (326 MBq).

2. Indium-111 Pentetreotide (In111-pentetreotide)

In111-pentetreotide is an octapeptide similar to the active component of somatostatin [16-20]. It interacts with somatostatin receptors in both normal tissue and certain tumors, especially those of neuroendocrine origin that have high expression of somatostatin receptors (eg, sympathoadrenal system tumors [pheochromocytoma, neuroblastoma, ganglioneuroma, and paraganglioma]), gastroenteropancreatic tumors (GEP) [eg, carcinoid, gastrinoma, insulinoma, glucagonoma, vasoactive intestinal peptide (VIP) VIPoma, etc], medullary thyroid carcinoma, pituitary adenoma, Merkel cell carcinoma, and small-cell lung carcinoma [19]. However, certain nonneuroendocrine tumors and nonneoplastic conditions can express somatostatin receptors, resulting in In111-pentetreotide avidity [19].

The usual adult administered activity is 4 to 6 mCi (148 to 222 MBq). Administered activity in children should be determined based on body weight and should be as low as reasonably achievable for diagnostic image quality.

B. Patient Preparation and Imaging

1. Radioiodinated Metaiodobenzylguanidine (MIBG)

Patient Preparation: Many classes of drugs (eg, tricyclic antidepressants and sympathomimetic amines) may interfere with the uptake or vesicular storage of MIBG [5]. Patients should be screened for interfering medications, which should be discontinued whenever possible in coordination with the referring physician. For a majority of medications, a withdrawal time of 24 to 48 hours is sufficient; however, for some medications, a withdrawal period of up to several weeks is optimal [5,13]. Over-the-counter decongestants and "cold" remedies also should be discontinued. Thyroid blockade can be achieved by administering oral potassium iodide (130-300 mg/day) or potassium perchlorate (400-600 mg/day) [5-7,9,11]. Thyroid blockade may be administered 1 day prior to or at the time of planned radiopharmaceutical injection and should be continued for 1 to 2 additional days for I-123-iodide MIBG. Oral potassium iodide preparation includes tablets (65, 130, and 170 mg), supersaturated potassium iodide solution (SSKI; 1,000 mg/mL), or Lugol solution (1% solution contains 25.3 mg/mL). For solutions dispensed as drops, 1 drop is 0.05 mL (20 drops per milliliter). Suggested pediatric dosing of potassium iodide is 32 mg/day for children from 1 month to 3 years; 65 mg/day for children 3 to 13 years; and 130 mg/day for children over 13 years [9]. Newborns may receive 16 mg potassium iodide only on the day before tracer injection [9]. For I-123-iodide MIBG, breastfeeding should be discontinued for 3 days [21].

Imaging Technique: For I-123-iodide MIBG, imaging typically is performed at 24 hours (18-48 hours) after administration using low-energy or medium-energy collimators [5,6,22]. Total-body imaging (5-10 cm/min) or 500,000 counts static images are obtained. Single-photon emission CT (SPECT) or SPECT/CT imaging of areas of abnormality or clinical concern (128 × 128 × 16 matrix, 3° stops, 30 seconds per stop) should be performed and may be of additional diagnostic benefit [23-25].

2. In111-pentetreotide

Patient Preparation: For In111-pentetreotide imaging discontinuation of breastfeeding for 6 days is recommended [21]. No dietary restrictions are necessary; however, patients should be encouraged to drink fluids. A mild laxative taken the evening before the injection may facilitate detection of abdominal and pelvic lesions. The examination should be carefully considered in patients who have severely impaired renal function because this is the primary route of excretion for the radiopharmaceutical. Hemodialysis might improve image quality [19]. Temporary withdrawal of somatostatin analogue therapy prior to In111-pentetreotide imaging (eg, 1 day for short-acting and 3-4 weeks for long-acting somatostatin analogues) is controversial and should be performed (if feasible) in coordination with the referring physician [19]. In111-pentetreotide should not be administered through a total parenteral nutrition (TPN) line or injected into TPN solution. In patients with insulinoma or in patients with diabetes receiving high dosages of insulin, administration of pentetreotide can cause severe hypoglycemia; in these patients, blood glucose should be checked prior to pentetreotide administration, and an intravenous line with 5% dextrose in 0.9% NaCI (D5 NS) should be continuously infused prior to and during radiopharmaceutical administration.

Imaging Technique: Imaging with In111-pentetreotide is usually performed 4 to 24 hours, or 24 and 48 hours, after injection (172 and 245 keV photopeaks [19]). Additional imaging at 48 to 72 hours after injection may sometimes be helpful. Between 24 and 48 hours, laxative therapy can be administered to achieve clear physiologic bowel activity [19]. Planar imaging, SPECT, and SPECT/CT practice parameters are similar to those described in section VII.A.

V. DOCUMENTATION

Reporting should be in accordance with the ACR Practice Parameter for Communication of Diagnostic Imaging Findings [26].

The report should include the radiopharmaceutical used, the administered activity, and route of administration as well as any other pharmaceuticals administered, including their dose and route of administration.

A relevant oncologic history should also be included with a brief overview of any prior oncologic treatments, emphasizing the specific indication for the current study.

VI. EQUIPMENT SPECIFICATIONS

Equipment performance monitoring should be in accordance with the ACR–AAPM Technical Standard for Nuclear Medical Physics Performance Monitoring of Gamma Cameras [27].

For In111-labeled radiopharmaceuticals, medium-energy collimation (up to about 300 keV) is used. For I-123-iodide, a low-energy high-resolution or medium-energy collimator may be used. A SPECT/CT hybrid camera may provide additional diagnostic benefit, as discussed above.

VII. RADIATION SAFETY

Radiologists, medical physicists, non-physician radiology providers**,** radiologic technologists, and all supervising physicians have a responsibility for safety in the workplace by keeping radiation exposure to staff, and to society as a whole, "as low as reasonably achievable" (ALARA) and to assure that radiation doses to individual patients are appropriate, taking into account the possible risk from radiation exposure and the diagnostic image quality necessary to achieve the clinical objective. All personnel who work with ionizing radiation must understand the key principles of occupational and public radiation protection (justification, optimization of protection, application of dose constraints and limits) and the principles of proper management of radiation dose to patients (justification, optimization including the use of dose reference levels). https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1775_web.pdf

Facilities and their responsible staff should consult with the radiation safety officer to ensure that there are policies and procedures for the safe handling and administration of radiopharmaceuticals in accordance with ALARA principles. These policies and procedures must comply with all applicable radiation safety regulations and conditions of licensure imposed by the Nuclear Regulatory Commission (NRC) and by applicable state, local, or other relevant regulatory agencies and accrediting bodies, as appropriate. Quantities of radiopharmaceuticals should be tailored to the individual patient by prescription or protocol, using body habitus or other customized method when such guidance is available.

Nationally developed guidelines, such as the ACR's Appropriateness Criteria®, should be used to help choose the most appropriate imaging procedures to prevent unnecessary radiation exposure.

Additional information regarding patient radiation safety in imaging is available from the following websites – Image Gently® for children (www.imagegently.org) and Image Wisely® for adults (www.imagewisely.org). These advocacy and awareness campaigns provide free educational materials for all stakeholders involved in imaging (patients, technologists, referring providers, medical physicists, and radiologists).

Radiation exposures or other dose indices should be periodically measured by a Qualified Medical Physicist in accordance with the applicable ACR Technical Standards. Monitoring or regular review of dose indices from patient imaging should be performed by comparing the facility's dose information with national benchmarks, such as the ACR Dose Index Registry and relevant publications relying on its data, applicable ACR Practice Parameters, NCRP Report No. 172, Reference Levels and Achievable Doses in Medical and Dental Imaging: Recommendations for the United States or the Conference of Radiation Control Program Director's National Evaluation of X-ray Trends; 2006, 2009, amended 2013, revised 2023 (Res. 2d).

VIII. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION

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 and Improvement, Safety, Infection Control, and Patient Education appearing under the heading *ACR Position Statement on Quality Control and Improvement, Safety, Infection Control and Patient Education* on the ACR website (https://www.acr.org/Advocacy-and-Economics/ACR-Position-Statements/Quality-Control-and-Improvement).

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