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ACR–SPR PRACTICE PARAMETER FOR THE PERFORMANCE OF SINGLE PHOTON EMISSION COMPUTED TOMOGRAPHY (SPECT) BRAIN PERFUSION IMAGING, INCLUDING BRAIN DEATH EXAMINATIONS

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 care¹. 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 physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the practice parameters, 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 practice parameters 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 practice parameters. However, a practitioner who employs an approach substantially different from these practice parameters 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 practice parameters 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 practice parameters is to assist practitioners in achieving this objective.

¹ *Iowa Medical Society and Iowa Society of Anesthesiologists v. Iowa Board of Nursing*, ___ N.W.2d ___ (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 has been revised collaboratively by the American College of Radiology (ACR) and the Society for Pediatric Radiology (SPR).

Single-photon emission computed tomography (SPECT) brain perfusion imaging using lipophilic radiopharmaceuticals that cross the blood-brain barrier and localize in normal brain tissue is a proven and useful procedure to define the regional distribution of brain perfusion, evaluate a variety of brain abnormalities, and corroborate the clinical impression of brain death in appropriate situations [1-3].

Application of this practice parameter should be in accordance with the [ACR–SPR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals](#) [4].

The goal of SPECT brain perfusion imaging is to detect abnormalities in regional cerebral perfusion by producing images of diagnostic quality.

II. INDICATIONS

A. Clinical indications for SPECT brain perfusion imaging examinations include, but are not limited to:

1. Evaluating patients with suspected dementia [3,5]
2. Localizing epileptic foci preoperatively [6]
3. Diagnosing encephalitis [7]
4. Monitoring and assessing vascular spasm following subarachnoid hemorrhage [8]
5. Mapping of brain perfusion during interventions [2,3,9]
6. Detecting and evaluating cerebrovascular disease [1-3,10]
7. Predicting the prognosis of patients with cerebrovascular accidents [10-12]
8. Corroborating the clinical impression of brain death (note that these examinations can be performed with SPECT or planar technique. See section IV.H.) [13-21]

B. For other indications, such as neuropsychiatric disorders and chronic fatigue syndrome, the findings of SPECT brain perfusion imaging have not been fully characterized [1,22,24]. In human immunodeficiency virus (HIV) encephalopathy, SPECT brain perfusion imaging can detect altered brain perfusion.

C. For information on radiation risks to the fetus, see the [ACR–SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation](#) [25].

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the [ACR–SPR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals](#) [4].

IV. SPECIFICATIONS OF THE EXAMINATION

A. Nuclear Medicine Examination Request

The written or electronic request for a SPECT brain perfusion examination should provide sufficient information to demonstrate the medical necessity of the examination and allow for its proper performance and interpretation.

Documentation that satisfies medical necessity includes 1) signs and symptoms and/or 2) relevant history (including known diagnoses). 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)

In addition to data needed to document medical necessity, optimal interpretation often requires additional relevant patient data. These data should include additional patient history, such as past and current drugs and medications use (including when last taken) and trauma, neurologic and psychiatric findings (eg, Folstein mini-mental examination, neuropsychological test, etc), neurodiagnostics (eg, electroencephalography), and results of recent brain imaging examinations (eg, CT, magnetic resonance imaging [MRI] [13]).

B. Radiopharmaceuticals

Either technetium-99m bicisate (ethyl cysteinate dimer [ECD]) or technetium-99m exametazime (hexamethyl propylene amine oxime [HMPAO]) stabilized or unstabilized is used.

1. Radiopharmaceutical preparation
 - a. Use fresh generator eluate (<2 hours old) for optimal results with technetium-99m HMPAO [26].
 - b. Use only eluate from a technetium-99m generator which was previously eluted within 24 hours.
 - c. Radiochemical purity determinations should be performed on each vial prior to patient administration, using the method outlined in the package insert.
2. Radiopharmaceutical administration
 - a. Technetium-99m ECD: radiopharmaceutical should be injected intravenously no more than 6 hours after reconstitution.
 - b. Technetium-99m HMPAO: stabilized radiopharmaceutical should be injected intravenously no more than 4 hours after reconstitution; unstabilized radiopharmaceutical should be injected no more than 30 minutes after reconstitution.
 - c. When examinations are performed to localize a seizure focus during a seizure, the radiopharmaceutical should ideally be injected within 30 seconds of the onset of seizure activity.
3. Interval between injection and imaging
 - a. Technetium-99m ECD: for best image quality, a minimum interval of 45 minutes is recommended, although images obtained after a 20-minute interval are interpretable. It is important to standardize the interval between injection and imaging and keep it under 3 hours.
 - b. Technetium-99m HMPAO: Images should be obtained >90 minutes after injection for best image quality, although images obtained after 40 minutes are interpretable.
 - c. Patients should be instructed to void within 2 hours postinjection to minimize radiation exposure.
4. Administered Activity
 - a. Adult: 555 to 1110 MBq (15 to 30 mCi)
 - b. Pediatric ECD: 9.9 MBq/kg (0.3 mCi/kg; minimum 100 MBq (2.7 mCi)
 - c. Pediatric HMPAO: 14.0 MBq/kg (0.4 mCi/kg); minimum 110 MBq (3.0 mCi)

C. Patient Preparation

1. Prerival
Patients should be instructed to avoid caffeine, alcohol, and other drugs known to affect intracranial perfusion for at least 24 hours and to avoid smoking cigarettes for at least the day of the examination.
2. Preinjection
 - a. Evaluate the patient for his/her ability to cooperate.

- b. Explain the procedure to the patient or to the responsible family member or health care proxy.
 - c. Achieve a consistent environment at the time of injection and during uptake:
 - i. Place the patient in a quiet, dimly lit room with no direct light source facing the patient's eyes. Whether the eyes are covered or the patient is instructed to open or close his/her eyes should be according to department policy and should be followed consistently.
 - ii. Ensure that the patient is seated or reclining comfortably.
 - iii. Place intravenous access at least 10 minutes prior to injection.
 - iv. Instruct the patient not to speak, read, or move prior to, during, and up to 5 minutes after injection.
3. Precautions
- a. Cognitively impaired patients must be closely observed at all times.
 - b. Patients with neurologic deficits may require special care.
 - c. Patients undergoing epilepsy evaluation should have EEG monitoring during injection.

D. Intervention: Acetazolamide Administration

A cerebral perfusion imaging examination may be performed following the administration of acetazolamide in patients with cerebrovascular disease to evaluate cerebrovascular reserve [1,3]. The indications include evaluation of cerebrovascular reserve in transient ischemic attack (TIA), completed stroke, and/or vascular anomalies (eg, arteriovenous malformation) and to aid in distinguishing vascular from neuronal causes of dementia.

1. Contraindications and adverse reactions
 - a. Known sulfa allergy (skin rash, bronchospasm, and anaphylactic reaction) and advanced liver disease. In case of sulfa allergy contraindication, an alternative method is to use 5% carbon dioxide by inhalation to evaluate cerebrovascular reserve. Usually the technetium-99m ECD or technetium-99m HMPAO is administered intravenously (IV) during the first 1 to 2 minutes of a 5-minute inhalation. Carbon dioxide inhalation can cause side effects of headache and nausea.
 - b. May induce migraine in patients with migraine history
 - c. Generally avoid within 3 days of acute stroke or recent transient ischemic attack.
2. Protocols

Various protocols have been used. The 2-day technique is simple and preferable. Typically, the acetazolamide challenge examination is performed first. If this examination is normal, consideration may be given to omitting the baseline examination. If a baseline examination is performed, allow sufficient time for residual activity to clear (typically 24 to 48 hours).
3. Administered Dose (injected IV slowly)
 - a. Adult: Acetazolamide 1000 mg
 - b. Pediatric: Acetazolamide 14 mg/kg

Wait 15 to 20 minutes after administering acetazolamide before injecting radiopharmaceutical.

4. Acetazolamide is a diuretic. The patient should be instructed to void immediately before image acquisition begins. Acquisition and processing are identical to those of a non-acetazolamide-enhanced examination.
5. Adverse effects

Mild vertigo, tinnitus, paresthesias, and, rarely, nausea may be experienced. These are generally self-limited and do not require specific treatment. Patients may experience postural hypotension when rising from a supine or sitting position and should be appropriately warned and assisted, if necessary.

E. Image Acquisition

1. The patient should void prior to imaging for maximum comfort during the examination.
2. The patient should be positioned for maximum comfort. Minor obliquity of head orientation can be corrected in most systems during processing.
3. The patient's head should be positioned in the middle of the field of view with the intercanthal line at a 90° angle to the axis of rotation and parallel to the horizontal plane. The entire brain (cerebrum and cerebellum) should be included in the field of view. The head should be lightly restrained to facilitate patient cooperation in minimizing motion during acquisition.
4. Sedation should be avoided if possible. If sedation is required, it should be given at least 5 minutes after injection of radiopharmaceutical and preferably just prior to image acquisition. In rare circumstances, sedation may need to be administered prior to radiopharmaceutical administration to obtain an interpretable examination, particularly in young children.
5. Ensure that there is no patient movement during image acquisition.
6. SPECT/CT imaging may be performed.

See equipment specifications below in section VI.

F. Data Processing

1. Iterative reconstruction is preferred to filtered back-projection.
2. Attenuation correction should be performed in all cases unless a specific application or circumstance dictates otherwise [27]. If calculated attenuation correction is used, the contours should include the scalp and should be defined individually for each transaxial slice. If slice-specific attenuation correction software is not available, it is acceptable to review non-attenuation-corrected images. If SPECT/CT imaging is performed, the low-dose, noncontrast CT images may be used for attenuation correction and image fusion.
3. Transaxial data should be reformatted into at least 3 orthogonal planes. Transaxial sections should be generated relative to a repeatable anatomic orientation (eg, the anterior commissure–posterior commissure [AC-PC] line) and coronal and sagittal sections orthogonal to the transaxial [27]. Additional sections along a plane parallel to the long axis of the temporal lobes may be useful, particularly in assessment of temporal lobe epilepsy [27].
4. SPECT/CT or software fusion of cross-sectional imaging with SPECT may be useful.

G. Image Interpretation

1. All examinations should be interpreted with the knowledge of all clinical data and results of other imaging studies, especially MRI and CT.
2. The extent of normal variability must be appreciated during the scan interpretation. Substantial variability may be noted between normal individuals and between examinations of a single subject obtained at different times.
3. Images should be viewed on a computer display rather than film or paper copy to permit interactive adjustment of contrast, background subtraction, and color table.

4. Unprocessed projection images should be assessed in cinematic display prior to viewing of tomographic sections for the presence and degree of patient motion, target-to-background ratio, and other potential artifacts. Inspection of the projection data in sinogram form may be useful [28].
5. Three-dimensional volume or surface renderings may be useful in appreciating overall patterns of disease.
6. Caution must be used in selecting levels of contrast and background subtraction. Noncontinuous color scales may be confusing or misleading if abrupt color changes occur in the range of expected gray matter activity. Thresholding, if used, must be based upon knowledge of a normal database for specific radiopharmaceuticals and instruments used in acquiring the examination. Artifacts can be created when inappropriate thresholding is performed.
7. Images obtained as part of a seizure evaluation should be correlated with the relevant electroencephalogram (EEG) data and clinical observations. The timing of radiopharmaceutical injection relative to observed seizure activity should be noted [3,6]. The scintigraphic appearance and extent of seizure foci may change dramatically depending on the exact timing of radiopharmaceutical injection relative to seizure onset. Ictal and interictal examinations should be compared for optimal patient evaluation. Ideally the patient should be seizure-free for 24 hours for the examination to be considered interictal.
8. Quantitative analysis and comparison with normal database values can be used to detect asymmetry in cerebral perfusion or other focal or diffuse abnormalities and is recommended for adults [28].

H. Brain Death Examinations

1. Goal

To corroborate the clinical impression of brain death by determining the presence or absence of intracranial perfusion [13]
2. Indications
 - a. As part of a standardized institutional protocol for establishing brain death
 - b. In situations in which hypothermia or coma caused by barbiturates or other medications impedes evaluation by other modalities
 - c. In situations in which the referring and interpreting physicians agree that evidence for the presence or absence of intracranial perfusion would be helpful
3. Administered Activity
 - a. Technetium-99m ECD and technetium-99m HMPAO
 - i. Adhere to package insert and quality control instructions to ensure optimal image quality.
 - ii. Adult: 555 to 1110 MBq (15 to 30 mCi)
 - iii. Pediatric (ECD): 9.9 MBq/kg (0.3mCi/kg); minimum 100 MBq (2.7 mCi)
 - iv. Pediatric (HMPAO): 14.0 MBq/kg (0.38 mCi/kg); minimum 110 MBq (3.0 mCi)
 - b. Technetium-99m diethylenetriaminepentaacetic acid (DTPA) and technetium-99m pertechnetate
 - i. Agents that cross the blood-brain barrier (eg, technetium-99m ECD or HMPAO) are preferred. If they are not available, technetium-99m DTPA or pertechnetate may be used.
 - ii. Adult (DTPA/Pertechnetate): 555 to 1100 MBq (15 to 30 mCi)
 - iii. Pediatric (DTPA): 6.6 MBq/kg (0.2 mCi/kg); minimum 34 MBq (1.0 mCi)
 - iv. Pediatric (pertechnetate): 9.5 MBq/kg (0.3 mCi/kg); minimum 80 MBq (2.0 mCi)
4. Patient

Prior to setting up the gamma camera, the team performing the examination should evaluate a number of patient factors. If the bed or patient must be moved, the team must avoid placing undue tension or

compression on life support lines. Caution must be taken when positioning the gamma camera detector(s) to avoid compromising any such lines or transcalvarial cerebrospinal fluid pressure monitors. Injection of the radiopharmaceutical must be made directly into a vein or through an IV line that is not being used for infusion of vasoactive medications or transfusion of blood. If available, a central venous line is preferable for injection.

5. Examination

Dynamic blood flow imaging is recommended but optional for technetium-99m ECD and technetium-99m HMPAO. If radiopharmaceuticals such as technetium-99m DTPA or technetium-99m pertechnetate are used, dynamic blood flow imaging of the head and neck is mandatory.

For technetium-99m HMPAO and technetium-99m ECD, immediate planar static image acquisition for 500,000 to 1,000,000 counts in the anterior view is recommended. Lateral and posterior images are obtained as needed. SPECT or SPECT/CT imaging may be performed.

6. Other considerations

The President's Council on Brain Death (1982) determined that of the 4 examinations available to establish the presence or absence of brain death, 2 (clinical examination and properly performed 4-vessel cerebral angiography) are diagnostic and 2 (electroencephalography and cerebral scintigraphy) are confirmatory. Thus, one may corroborate the clinical impression by determining the absence of intracranial perfusion with cerebral scintigraphy. According to a recent evidence-based review, radiopharmaceutical examinations remain an acceptable corroborative test [20].

A technically adequate examination is mandatory for interpretation. The absence of demonstrable radiopharmaceutical activity within the brain is consistent with the absence of intracranial perfusion (cerebral and cerebellar) but is not sufficient by itself to make the diagnosis of brain death and should be corroborated with other clinical, neurodiagnostic, and imaging findings.

V. DOCUMENTATION

Reporting should be in accordance with the [ACR Practice Parameter for Communication of Diagnostic Imaging Findings](#) [29].

The report should include the radiopharmaceutical, administered activity, and route of radiopharmaceutical administration, as well as any other pharmaceuticals administered, also with dosage and route of administration.

Direct communication of the results of the examination to a physician from the referring clinical service is mandatory for brain death examinations.

VI. EQUIPMENT SPECIFICATIONS

For planar imaging, any gamma camera equipped with a low-energy all-purpose/general all-purpose (LEAP/GAP) or high-resolution collimator may be used.

For SPECT imaging, a multiple-detector instrument or a dedicated brain imaging system is preferred to a single-head gamma camera system. A SPECT/CT system may be used, if available.

The following is recommended for SPECT imaging:

A. The smallest radius of rotation possible with appropriate patient safeguards should be used [27].

B. Low-energy high-resolution or ultrahigh-resolution collimators may be used. Fan-beam or other focused collimators are preferable to parallel-hole collimators because they provide improved resolution and higher count

rates. However, care must be taken to ensure that the entire brain is visualized in all projections to avoid the problem of “incomplete” views. When parallel-hole collimation is used, care should be taken to ensure that adequate counts are obtained.

C. A 128 x 128 or greater acquisition matrix is preferred. Camera zoom should be set to produce a pixel size of 3.5 mm or less.

D. Continuous acquisition may provide shorter total scan duration when compared to a step-and-shoot technique. When continuous acquisition is used, angular sampling should be 3° or less.

E. If SPECT/CT imaging is performed, all additional relevant quality control (QC) procedures should be used. See the [ACR–AAPM Technical Standard for Medical Physics Performance Monitoring of SPECT-CT Equipment](#) [30].

F. Segmentation of data acquisition into multiple sequential acquisitions will permit exclusion of bad data, eg, removing segments of projection data with patient motion. The scan may be repeated if there is excessive patient motion.

VII. RADIATION SAFETY

Radiologists, medical physicists, registered radiologist assistants, 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 that work with ionizing radiation must understand the key principles of occupational and public radiation protection (justification, optimization of protection and application of dose limits) and the principles of proper management of radiation dose to patients (justification, optimization and the use of dose reference levels)

http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1578_web-57265295.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 and that they are adhered to in accordance with ALARA. 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 state and/or other regulatory agencies. Quantities of radiopharmaceuticals should be tailored to the individual patient by prescription or protocol

Nationally developed guidelines, such as the ACR [Appropriateness Criteria](#)[®], should be used to help choose the most appropriate imaging procedures to prevent unwarranted radiation exposure.

Additional information regarding patient radiation safety in imaging is available at the Image Gently[®] for children (www.imagegently.org) and Image Wisely[®] for adults (www.imagewisely.org) websites. 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 measured and patient radiation dose estimated for representative examinations and types of patients by a Qualified Medical Physicist in accordance with the applicable ACR technical standards. Regular auditing of patient dose indices should be performed by comparing the facility’s dose information with national benchmarks, such as the ACR Dose Index Registry, the 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. (ACR Resolution 17 adopted in 2006 – revised in 2009, 2013, Resolution 52).

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 *Position Statement on QC & Improvement, Safety, Infection Control, and Patient Education* on the ACR website (<http://www.acr.org/guidelines>).

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

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Collaborative Committee – members represent their societies in the initial and final revision of this practice parameter

ACR

Richard K.J. Brown, MD, FACR, Chair
Murray D. Becker, MD, PhD
Kirk A. Frey, MD, PhD
Marguerite T. Parisi, MD, MS
Levi Sokol, MD

SPR

Hedieh K. Eslamy, MD
Michael J. Gelfand, MD
Gerald A. Mandell, MD, FACR
S. Ted Treves, MD

Committee on Practice Parameters and Technical Standard – Nuclear Medicine and Molecular Imaging
(ACR Committee responsible for sponsoring the draft through the process)

Bennett S. Greenspan, MD, MS, FACR, Co-Chair
Christopher J. Palestro, MD, Co-Chair
Kevin P. Banks, MD
Murray D. Becker, MD, PhD, FACR
Richard K.J. Brown, MD, FACR
Erica J. Cohen, DO, MPH
Shana Elman, MD
Joanna R. Fair, MD
Perry S. Gerard, MD, FACR
Erin C. Grady, MD
Edward D. Green, MD
Warren R. Janowitz, MD, JD, FACR
Chun K. Kim, MD
Charito Love, MD
Joseph R. Osborne, MD, PhD
Darko Pucar, MD, PhD
Rathan M. Subramaniam, MD, PhD, MPH

Committee on Practice Parameters – Pediatric Radiology

(ACR Committee responsible for sponsoring the draft through the process)

Beverley Newman, MB, BCh, BSc, FACR, Chair

Lorna P. Browne, MB, BCh

Timothy J. Carmody, MD, FACR

Brian D. Coley, MD, FACR

Lee K. Collins, MD

Monica S. Epelman, MD

Lynn Ansley Fordham, MD, FACR

Kerri A. Highmore, MD

Sue C. Kaste, DO

Tal Laor, MD

Terry L. Levin, MD

Marguerite T. Parisi, MD, MS

Sumit Pruthi, MBBS

Nancy K. Rollins, MD

Pallavi Sagar, MD

M. Elizabeth Oates, MD, Chair, Commission on Nuclear Medicine and Molecular Imaging

Jacqueline A. Bello, MD, FACR, Chair, Commission on Quality and Safety

Matthew S. Pollack, MD, FACR, Chair, Committee on Practice Parameters and Technical Standards

Marta Hernanz-Schulman, MD, FACR, Chair, Commission on Pediatric Radiology

Comments Reconciliation Committee

Eric J. Stern, MD, Chair

Amy L. Kotsenas, MD, Co-Chair

Murray D. Becker, MD, PhD

Jacqueline A. Bello, MD, FACR

Richard K.J. Brown, MD, FACR

Hedieh K. Eslamy, MD

Kirk A. Frey, MD, PhD

Michael J. Gelfand, MD

Bennett S. Greenspan, MD, MS, FACR

Marta Hernanz-Schulman, MD, FACR

William T. Herrington, MD, FACR

Gerald A. Mandell, MD, FACR

Beverley Newman, MB, BCh, BSc, FACR

M. Elizabeth Oates, MD

Christopher J. Palestro, MD

Marguerite T. Parisi, MD, MS

Matthew S. Pollack, MD, FACR

Levi Sokol, MD

Timothy L. Swan, MD, FACR, FSIR

S. Ted Treves, MD

REFERENCES

1. Camargo EE. Brain SPECT in neurology and psychiatry. *J Nucl Med.* 2001;42(4):611-623.
2. Catafau AM. Brain SPECT in clinical practice. Part I: perfusion. *J Nucl Med.* 2001;42(2):259-271.
3. Holman BL, Devous MD, Sr. Functional brain SPECT: the emergence of a powerful clinical method. *J Nucl Med.* 1992;33(10):1888-1904.

4. American College of Radiology. ACR-SPR technical standard for diagnostic procedures using radiopharmaceuticals. 2016; Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/RadioPharm.pdf>. Accessed June 19, 2015.
5. Borghesani PR, DeMers SM, Manchanda V, Pruthi S, Lewis DH, Borson S. Neuroimaging in the clinical diagnosis of dementia: observations from a memory disorders clinic. *J Am Geriatr Soc.* 2010;58(8):1453-1458.
6. Markand ON, Spencer SS, Anderson AR. SPECT in epilepsy. *J Neuroimaging.* 1995;5 Suppl 1:S23-33.
7. Masdeu JC, Van Heertum RL, Abdel-Dayem H. Viral infections of the brain. *J Neuroimaging.* 1995;5 Suppl 1:S40-44.
8. Cooke D, Koppula B, Seiler D, et al. Semiquantitative software SPECT analysis in aneurysmal subarachnoid hemorrhage-related vasospasm. *Nucl Med Commun.* 2010;31(1):53-58.
9. Juni JE. Taking brain SPECT seriously: reflections on recent clinical reports in The Journal of Nuclear Medicine. *J Nucl Med.* 1994;35(12):1891-1895.
10. Ueda T, Yuh WT. Single-photon emission CT imaging in acute stroke. *Neuroimaging Clin N Am.* 2005;15(3):543-551, x.
11. Masdeu JC, Brass LM. SPECT imaging of stroke. *J Neuroimaging.* 1995;5 Suppl 1:S14-22.
12. Wintermark M, Sesay M, Barbier E, et al. Comparative overview of brain perfusion imaging techniques. *J Neuroradiol.* 2005;32(5):294-314.
13. Al-Shammri S, Al-Feeli M. Confirmation of brain death using brain radionuclide perfusion imaging technique. *Med Princ Pract.* 2004;13(5):267-272.
14. Harding JW, Chatterton BE. Outcomes of patients referred for confirmation of brain death by 99mTc-exametazime scintigraphy. *Intensive Care Med.* 2003;29(4):539-543.
15. Lu G, Shih WJ, Ryo UY. Findings on Tc-99m HMPAO brain imaging in brain death. *Clin Nucl Med.* 1996;21(11):891-893.
16. Munari M, Zucchetta P, Carollo C, et al. Confirmatory tests in the diagnosis of brain death: comparison between SPECT and contrast angiography. *Crit Care Med.* 2005;33(9):2068-2073.
17. Nakagawa TA, Ashwal S, Mathur M, Mysore M. Clinical report-Guidelines for the determination of brain death in infants and children: an update of the 1987 task force recommendations. *Pediatrics.* 2011;128(3):e720-740.
18. Okuyaz C, Gucuyener K, Karabacak NI, Aydin K, Serdaroglu A, Cingi E. Tc-99m-HMPAO SPECT in the diagnosis of brain death in children. *Pediatr Int.* 2004;46(6):711-714.
19. Spieth M, Abella E, Sutter C, Vasinrapee P, Wall L, Ortiz M. Importance of the lateral view in the evaluation of suspected brain death. *Clin Nucl Med.* 1995;20(11):965-968.
20. Wijdicks EF, Varelas PN, Gronseth GS, Greer DM. Evidence-based guideline update: determining brain death in adults: report of the Quality Standards Subcommittee of the American Academy of Neurology. *Neurology.* 2010;74(23):1911-1918.
21. Sinha P, Conrad GR. Scintigraphic confirmation of brain death. *Semin Nucl Med.* 2012;42(1):27-32.
22. Ethical clinical practice of functional brain imaging. Society of Nuclear Medicine Brain Imaging Council. *J Nucl Med.* 1996;37(7):1256-1259.
23. Masdeu JC, Abdel-Dayem H, Van Heertum RL. Head trauma: use of SPECT. *J Neuroimaging.* 1995;5 Suppl 1:S53-57.
24. Lewis DH, Mayberg HS, Fischer ME, et al. Monozygotic twins discordant for chronic fatigue syndrome: regional cerebral blood flow SPECT. *Radiology.* 2001;219(3):766-773.
25. American College of Radiology. ACR-SPR practice parameter for imaging pregnant or potentially pregnant adolescents and women with ionizing radiation. 2013; Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/Pregnant-Pts.pdf>. Accessed June 19, 2015.
26. Hung JC, Corlija M, Volkert WA, Holmes RA. Kinetic analysis of technetium-99m d,1-HM-PAO decomposition in aqueous media. *J Nucl Med.* 1988;29(9):1568-1576.
27. Devous MD. SPECT functional brain imaging. Technical considerations. *J Neuroimaging.* 1995;5 Suppl 1:S2-13.
28. Imabayashi E, Matsuda H, Asada T, et al. Superiority of 3-dimensional stereotactic surface projection analysis over visual inspection in discrimination of patients with very early Alzheimer's disease from controls using brain perfusion SPECT. *J Nucl Med.* 2004;45(9):1450-1457.

29. American College of Radiology. ACR practice parameter for communication of diagnostic imaging findings. 2014; Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/CommunicationDiag.pdf>. Accessed June 19, 2015.
30. American College of Radiology. ACR-AAPM technical standard for medical physics performance monitoring of SPECT-CT equipment. 2014; Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/SPECT-CT-Equip.pdf>. Accessed June 19, 2015.

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