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The American College of Radiology will periodically define new practice guidelines and technical standards for radiologic practice to help advance the science of radiology and to improve the quality of service to patients throughout the United States. Existing practice guidelines and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

Each practice guideline and technical standard, representing a policy statement by the College, has undergone a thorough consensus process in which it has been subjected to extensive review, requiring the approval of the Commission on Quality and Safety as well as the ACR Board of Chancellors, the ACR Council Steering Committee, and the ACR Council. The practice guidelines and technical standards recognize that the safe and effective use of diagnostic and therapeutic radiology requires specific training, skills, and techniques, as described in each document. Reproduction or modification of the published practice guideline and technical standard by those entities not providing these services is not authorized.

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ACR TECHNICAL STANDARD FOR MEDICAL NUCLEAR PHYSICS PERFORMANCE MONITORING OF PET IMAGING EQUIPMENT

PREAMBLE

These guidelines are an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. They are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care. For these reasons and those set forth below, the American College of Radiology cautions against the use of these guidelines in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the guidelines, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in the guidelines when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations on available resources, or advances in knowledge or technology subsequent to publication of the guidelines. However, a practitioner who employs an approach substantially different from these guidelines is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment.

Therefore, it should be recognized that adherence to these guidelines will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of these guidelines is to assist practitioners in achieving this objective.

I. INTRODUCTION

All positron emission tomography (PET) imaging equipment should be tested on installation and monitored at least annually by a Qualified Medical Physicist or other qualified individual to ensure that it is functioning within the manufacturer's specifications and meets accepted performance standards. Additional or more frequent performance monitoring may be necessary in certain situations (e.g., after major equipment maintenance). Although it is not possible to consider all variations of equipment performance to be monitored, adherence to this standard will maximize image quality and help to ensure the accuracy of quantitative results in clinical procedures. Key points to consider are performance characteristics to be monitored, absorbed dose to the patients, qualifications of personnel, and follow-up procedures.

II. QUALIFICATIONS AND RESPONSIBILITIES OF A QUALIFIED MEDICAL PHYSICIST

A Qualified Medical Physicist is an individual who is competent to practice independently one or more of the

subfields in medical physics. The American College of Radiology (ACR) considers that certification and continuing education in the appropriate subfield(s) demonstrate that an individual is competent to practice one or more of the subfields in medical physics, and to be a Qualified Medical Physicist. The ACR recommends that the individual be certified in the appropriate subfield(s) by the American Board of Radiology (ABR) or for MRI, by the American Board of Medical Physics (ABMP) in magnetic resonance imaging physics.

The appropriate subfields of medical physics for this standard are Medical Nuclear Physics and Radiological Physics.

Continuing education for a Qualified Medical Physicist should be in accordance with the [ACR Practice Guideline for Continuing Medical Education \(CME\)](#). (2006 - ACR Resolution 16g)

The medical physicist must be familiar with the principles of radiation protection; the guidelines of the National Council on Radiation Protection and Measurements (NCRP); laws and regulations governing the use of the equipment being tested; the function, clinical uses, and performance specifications of the imaging equipment; and calibration processes and limitations of the instruments and the techniques used for testing performance. A medical physicist should maintain continuing competence in medical nuclear physics, including PET.

Individuals properly trained in obtaining data for performance monitoring may assist the medical physicist. The medical physicist must approve them in the techniques of performing tests, the function and limitations of the imaging equipment and test instruments, the reasons for the tests, and the importance of the test results. The medical physicist is responsible for and must be present during initial and annual surveys and must review, interpret, and approve all data as well as summarize the tests performed and the indicating conclusions, and provide a signed report.

III. PERFORMANCE CHARACTERISTICS TO BE MONITORED

A. Characteristics to be Monitored

The medical physicist must design a quality assurance (QA) program that includes regular testing procedures to insure proper operation on a daily basis. This program should be reviewed at least annually.

The procedures should include, as a minimum, those recommended by the manufacturer. Specific attention should be given to daily quality control (QC) for attenuation blanks, detector operation, and any necessary normalization scans. Additional procedures considered

important by the nuclear medicine community may be recommended.

The following characteristics shall be evaluated for the equipment to which they apply on at least an annual basis:

1. Spatial resolution (radial, tangential, and axial).
2. Count rate performance including count loss correction factor.
 - a. System dead time
 - b. Count rate versus activity
 - i. Prompt coincidences
 - ii. Random coincidences
 - iii. Background coincidences
 - iv. Net true coincidences
3. Sensitivity (cps/MBq/ml) in two-dimensional (2D) and three-dimensional (3D) modes as applicable.
4. Uniformity (plane-by-plane in 2D and 3D modes as applicable).
5. Attenuation-correction calibration accuracy (quantification).
6. Linearity of bed motion.
7. Reproducibility of transmission rod motion (extension and retraction) as applicable.
8. Reproducibility of lead septa motion (extension and retraction) as applicable.
9. Image contrast and full system test (phantom scan).

B. Acceptance Testing

Initial performance testing of imaging equipment shall be performed upon installation and should be completed before clinical use. This testing should be more comprehensive than periodic performance testing and shall be consistent with current acceptance testing practices.

C. Follow-Up Procedures and Written Survey Reports

The medical physicist shall report the findings to the physician(s), to the responsible professional(s) in charge of obtaining or providing necessary service to the equipment and, in the case of the consulting physicist(s), to the representative of the hiring party, and, if appropriate, initiate the required service. Action should be taken immediately by direct verbal communication if there is imminent danger to patients or staff using the equipment due to unsafe conditions. Written survey reports shall be provided in a timely manner consistent with the importance of any adverse findings. The medical physicist should confirm that the unit is performing in a safe and acceptable fashion as soon as possible after the required service is performed.

D. Organ Doses from Radiopharmaceuticals

A table of organ doses shall be prepared for all procedures that involve administration of radiopharmaceuticals to patients. The table shall specify the dosage schedule used at the facility. All organs that receive significant doses shall be included. Separate values for patient size and gender shall be tabulated where applicable. The table shall be reviewed at least annually and updated when any of the following occur: addition of new procedures and/or pharmaceuticals, changes in dosage schedules, change in route of administration, and availability of more accurate dosimetry data.

IV. RADIATION SAFETY IN IMAGING

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

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

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

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

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