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ACR PRACTICE GUIDELINE FOR PERFORMING FDG-PET/CT IN ONCOLOGY

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 of 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

This guideline has been developed by the American College of Radiology (ACR) to guide interpreting physicians performing positron emission tomography/computed tomography (PET/CT) with fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG) for oncologic imaging in adult and pediatric patients.

FDG-PET is a scintigraphic technique that provides three-dimensional information about the rate of glucose metabolism in the body and is a sensitive method for detecting, staging, and monitoring the effects of therapy for many malignancies. CT uses an external source of radiation to provide three-dimensional images of the density of the tissues in the body. CT images provide information about the size and shape of organs and abnormalities within the body. Combined PET/CT devices [1,2] provide both the metabolic information from FDG-PET and the anatomic information from CT in a single examination. The information obtained by PET/CT has been shown to be more accurate in evaluating patients with known or suspected malignancy than either PET or CT alone or PET and CT obtained separately but interpreted together [3-10].

FDG-PET and CT are proven diagnostic procedures. The advantages of having both PET and CT in a single device have resulted in rapid dissemination of this technology in the United States. Techniques for registration and fusion of images obtained from separate PET and CT scanners have been available for several years and have been shown to improve diagnostic accuracy [11-18]. This practice guideline, however, pertains only to combined PET/CT devices.

Several issues related to PET/CT have arisen and include equipment specifications, image acquisition protocols, supervision, interpretation, professional qualifications, and safety. A discussion of these issues by representatives of the ACR, the Society of Nuclear Medicine, and the Society of Computed Body Tomography and Magnetic Resonance is available [19,20].

II. GOAL

The goal of PET/CT imaging in oncology is to enable the interpreting physician to 1) distinguish benign from malignant disease, 2) determine the extent of disease, 3) detect residual and recurrent tumors, 4) monitor the effect of therapy, and 5) guide therapy.

III. DEFINITIONS

For the purposes of this guideline, the following definitions apply:

PET/CT fusion: The simultaneous display (superimposed or not) of registered PET and CT image sets. When superimposed, the image sets are typically displayed with the PET data color-coded onto the grayscale CT data.

PET/CT registration: The process of taking PET and CT image sets that represent the same body volume and aligning them such that there is a voxel-by-voxel match for the purpose of combined image display (fusion) or image analysis.

PET/CT scanner: A device that includes a single patient table for obtaining a CT scan or PET scan, or both. If the patient stays reasonably immobile between the scans, the PET and CT data are aligned and can be accurately fused.

IV. INDICATIONS

Indications for PET/CT include, but are not limited to, the following:

1. Evaluating an abnormality detected by another imaging method to determine the level of metabolism and the likelihood of malignancy.
2. Searching for an unknown primary tumor when metastatic disease is discovered as the first manifestation of cancer.
3. Staging patients with known malignancy.

4. Monitoring the effect of therapy on known malignancies.
5. Determining if residual abnormalities on imaging studies following treatment represent tumor or post-treatment inflammation, fibrosis, or necrosis.
6. Detecting recurrence, especially in the presence of elevated tumor markers.
7. Assisting in treatment planning.

PET/CT does not work equally well for all tumors. A continuing review of the literature is recommended to determine the most effective applications.

For the pregnant or potentially pregnant patient, see the [ACR Practice Guideline for Imaging Pregnant or Potentially Pregnant Adolescents and Women with ionizing radiation](#).

V. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

A. Physician

1. All PET/CT examinations must be performed under the supervision of and interpreted by a physician who has the following qualifications:
 - a. Certification in Radiology or Diagnostic Radiology by the American Board of Radiology, American Osteopathic Board of Radiology, the Royal College of Physicians and Surgeons of Canada, or Le College des Medecins du Quebec; and involvement with the interpretation, reporting, and/or supervised review of 300 PET and/or PET/CT examinations in the past 36 months; 15 hours of PET and PET/CT CME (AMA category 1), at least 8 of which are PET/CT; and meets the physician training and experience requirements of the [ACR Practice Guideline for Performing and Interpreting Diagnostic Computed Tomography \(CT\)](#)¹, and the physician qualifications in the [ACR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals](#).

or

¹Should include cases that are representative of the following areas: abdomen, chest, neck, and pelvis. In meeting the requirements of the ACR Practice Guideline for Performing and Interpreting Diagnostic CT, physicians who are certified by the ABNM and have completed the ACGME approved nuclear medicine residency program, can count up to 100 hours of didactic training in CT toward satisfying the 200 hours requirement in the guideline, and 500 CT cases interpreted under the supervision of a physician qualified under the [ACR Practice Guideline for Performing and Interpreting Diagnostic Computed Tomography](#).

- b. Completion of an Accreditation Council for Graduate Medical Education (ACGME) approved diagnostic radiology residency program or an American Osteopathic Association (AOA) approved diagnostic radiology residency program; and involvement with the interpretation, reporting, and supervised review of 500 or more PET and/or PET/CT examinations in the past 36 months; 15 hours of PET and PET/CT CME (AMA category 1), at least 8 of which are PET/CT; and meets the physician training and experience requirements of the [ACR Practice Guideline for Performing and Interpreting Diagnostic Computed Tomography \(CT\)](#)¹, and the physician qualifications in the [ACR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals](#).

or

- c. Certification in Nuclear Medicine by the ABNM or in special competence in nuclear medicine by the ABR; and involvement with the interpretation, reporting, and/or supervised review 300 PET and/or PET/CT examinations in the past 36 months; 15 hours of PET and PET/CT CME (AMA category 1), at least 8 of which are PET/CT; and meets the physician training and experience requirements of the [ACR Practice Guideline for Performing and Interpreting Diagnostic Computed Tomography \(CT\)](#)¹, and the physician qualifications in the [ACR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals](#).

or

Physicians in the certification/training categories in a, b, and c above, but without the recent PET or PET/CT involvement specified may achieve the required PET/CT training experience equivalent by completing and documenting the following:

- i. Physician category a: 150 PET and/or PET/CT interpretations in a supervised situation,² at least 100 of which are PET/CT, and 15 hours of PET and/or PET/CT CME, at least 8 of which are

PET/CT. The physician training requirements of the [ACR Practice Guideline for Performing and Interpreting Diagnostic Computed Tomography \(CT\)](#) and the physician qualifications in the [ACR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals](#) must be met.

- ii. Physician category b: 200 PET and/or PET/CT interpretations in a supervised situation,² at least 150 of which are PET/CT, and 25 hours of PET and/or PET/CT CME, at least 8 of which are PET/CT. The physician training requirements of the [ACR Practice Guideline for Performing and Interpreting Diagnostic Computed Tomography \(CT\)](#) and the physician qualifications in the [ACR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals](#) must be met.

- iii. Physician category c: 150 PET and/or PET/CT interpretations in a supervised situation,² at least 100 of which are PET/CT, and 15 hours of PET and/or PET/CT CME, at least 8 of which are PET/CT. The physician training requirements of the [ACR Practice Guideline for Performing and Interpreting Diagnostic Computed Tomography \(CT\)](#) and the physician qualifications in the [ACR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals](#) must be met.

or

- d. Physicians not board certified in radiology or nuclear medicine, or not trained in a diagnostic radiology residency or nuclear medicine program who assume the responsibilities of supervising, interpreting, and reporting PET/CT examinations, should meet the following criteria: completion of an ACGME approved residency program plus 80 hours of PET and PET/CT CME, at least 40 of which are PET/CT, and supervision, interpretation, and reporting of 500 PET/CT cases in a supervised situation. In addition, these physicians must meet the training requirements in the [ACR Practice Guideline for Performing and Interpreting Diagnostic Computed Tomography \(CT\)](#) and the qualifications in the [ACR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals](#).

²Acceptable ways to have PET/CT and CT case interpretations in a supervised situation include practice-based learning locally or in a visiting fellowship, learning in an interactive live case based on conference where an interpretation is rendered and then scored or critiqued, or distance learning such as over the Internet, in an interactive case-based format where an interpretation is rendered and then scored or critiqued, under the supervision or review of physicians expert in the field.

- and
2. The physician shall have documented training in the physics of nuclear medicine and diagnostic radiology. Additionally, the physician must demonstrate training in the principles of radiation protection; the hazards of radiation exposure to patients, radiological personnel and the public; handling radiopharmaceuticals; and the appropriate regulatory and monitoring requirements.

and

 3. The physician should be thoroughly acquainted with the many morphologic, pathologic, and physiologic radiopharmaceutical distributions with artifacts demonstrated on PET/CT. Additionally, the supervising physician should have appropriate knowledge of alternative imaging methods, including the use and indications for general radiography and specialized studies such as angiography, ultrasonography, magnetic resonance imaging (MRI), and alternative nuclear medicine studies.

and

 4. The physician should be familiar with patient preparation for the examination. The physician must have training in and knowledge of the properties of radiopharmaceuticals used as well as in the recognition and treatment of adverse effects of contrast materials that may be employed.

and

 5. The physician shall have the responsibility for reviewing all indications for the examination; specifying the radiopharmaceutical dose and the type, dose, and administration rate of any contrast materials employed; specifying imaging technique and protocol; treating and documenting of any adverse reactions and relevant patient counseling; interpreting images; generating official interpretations (final reports); and maintaining the quality of the images and the interpretations.

The required qualifications set forth in section V.A above will become applicable by July 1, 2009. Until then the physician should work toward achieving these requirements in a supervised situation or where expert consultation is readily available.

Maintenance of Competence

All physicians performing PET/CT examinations should demonstrate evidence of continuing competence in the interpretation and reporting of those examinations. If competence is assured primarily based on continuing experience, a minimum of 75 examinations per year is recommended in order to maintain the physician's skills. Because a physician's practice or location may preclude

this method, continued competency can also be assured through monitoring and evaluation that indicates acceptable technical success, accuracy of interpretation, and appropriateness of evaluation.

B. 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 ACR considers certification and continuing education and experience in the appropriate subfield(s) to demonstrate that an individual is competent to practice one or more of the subfields in medical physics and is a Qualified Medical Physicist. The ACR recommends that the individual be certified in the appropriate subfield(s) by the American Board of Radiology (ABR), the Canadian College of Physics in Medicine, 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 Diagnostic Radiological Physics and Radiological Physics.

A Qualified Medical Physicist should meet the [ACR Practice Guideline for Continuing Medical Education \(CME\)](#). (ACR Resolution 17, 1996 – revised in 2008, Resolution 7)

The medical physicist or other qualified scientist performing services in support of nuclear medicine facilities should meet all of the following criteria:

1. Advanced training directed at the specific area of responsibility (e.g., radiopharmacy, medical physics, health physics or instrumentation).
2. Licensure, if required by state regulations.
3. Documented regular participation in continuing education in the area of specific involvement to maintain competency.
4. Knowledge of radiation safety and protection and of all rules and regulations applying to the area of practice.

C. Radiologic and Nuclear Medicine Technologist

See the [ACR Practice Guideline for Performing and Interpreting Diagnostic Computed Tomography \(CT\)](#) and the [ACR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals](#).

Representatives of the Society of Nuclear Medicine and the American Society of Radiologic Technologists (ASRT) met in 2002 to discuss the training of technologists for PET/CT. The recommendations from that consensus conference and the plans for training technologists for PET/CT are given in [21]. As a consequence of this conference and ensuing educational

recommendations, cross-training and continuing educational programs have been developed to educate radiologic, radiation therapy, and nuclear medicine technologists in PET/CT fusion imaging.

The Nuclear Medicine Technology Certification Board (NMTCB) has developed a PET specialty examination that is open to appropriately educated and trained, certified, or registered nuclear medicine technologists, registered radiologic technologists, CT technologists, and registered radiation therapists, as defined on the NMTCB Web site (www.nmtcb.org). The American Registry of Radiologic Technologists (ARRT) offers a CT certification examination for qualified radiologic technologists and allows certified or registered nuclear medicine technologists who have met the educational and training requirements to take this examination. Eligibility criteria are located on the ARRT Web site (www.rrt.org).

VI. SPECIFICATIONS OF THE EXAMINATION

A. The written or electronic request for an FDG-PET/CT 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)

See the [ACR Practice Guideline for the Performance of Computed Tomography \(CT\) of the Extracranial Head and Neck in Adults and Children](#), the [ACR Practice Guideline for the Performance of Pediatric and Adult Thoracic Computed Tomography \(CT\)](#), and the [ACR Practice Guideline for the Performance of Computed Tomography \(CT\) of the Abdomen and Computed Tomography \(CT\) of the Pelvis](#).

Sections VI. B, C, E, F below have been copied from an article in the *Journal of Nuclear Medicine Technology*, "Procedure Guideline for Tumor Imaging with ¹⁸F-FDG

PET/CT 1.0," with permission from the Society of Nuclear Medicine. [22].

B. Patient Preparation

The major goals of preparation are to minimize tracer uptake in normal tissues, such as the myocardium and skeletal muscle, while maintaining uptake in target tissues (neoplastic disease). The preparation should include, but not be limited to, the following:

1. Pregnancy testing when appropriate.
2. Fasting instruction and no oral or intravenous fluids containing sugar or dextrose (4 to 6 hours).
3. Serum glucose analysis immediately prior to FDG administration.
4. Hydration (a loop diuretic, without or with bladder) catheterization, may be used to reduce accumulated urinary tracer activity in the bladder.
5. Keeping the patient in a warm room 30 to 60 minutes prior to injection and until the time of FDG injection to help minimize brown fat uptake. Lorazepam or diazepam given prior to injection of FDG may reduce uptake by brown adipose tissue or skeletal muscle. Beta-blockers may also reduce uptake by brown fat.
6. Focused history regarding diabetes, recent exercise, dates of diagnosis and treatments, medications, and recent trauma or infections.

C. Radiopharmaceutical

For adults, the amount of radiopharmaceutical administered should be 370 to 740 MBq (10 to 20 mCi); and for children, 5.18 to 7.4 MBq/kg (0.14 to 0.20 mCi/kg). The radiopharmaceutical should be injected at a site contralateral to the site of concern. With PET/CT, the radiation dose to the patient is the combination of the dose from the PET radiopharmaceutical and the dose from the CT portion of the study.

D. Protocol for CT Imaging

The PET/CT examination can be performed either as a diagnostic PET/CT scan with the CT scan obtained for attenuation correction and anatomic correlation or as a diagnostic PET scan and an optimized CT scan, with or without contrast. If a diagnostic CT scan is requested, the CT protocol appropriate for the body region(s) requested should be used. If the CT scan is obtained for attenuation correction and anatomic correlation, the CT parameters should be set to minimize patient radiation dose, while still ensuring that the CT images are of sufficient quality to allow for accurate anatomic correlation of PET findings.

For the diagnostic CT scan of the abdomen and/or pelvis, an intraluminal gastrointestinal contrast agent may be administered to provide adequate visualization of the gastrointestinal tract unless medically contraindicated or unnecessary for the clinical indication. This may be a positive contrast agent such as dilute barium or Gastrografin, or a negative contrast agent such as water. Highly concentrated barium collections may result in an attenuation-correction artifact that leads to a significant overestimation of the regional FDG concentration [23]; dilute barium and oral iodinated agents cause less overestimation and do not impact image quality [23-26].

When indicated, the CT scan can be performed with intravenous contrast material using appropriate injection techniques. High intravascular concentrations of intravenous contrast agents may cause an attenuation-correction artifact on the PET image [27, 28], but the impact is limited [24,29].

PET and CT findings should be correlated with each other. Clinically important findings on the CT scan should be reported.

Breathing patterns during CT acquisition - for PET/CT the position of the diaphragm should match as closely as possible on the PET emission and the CT transmission images.

E. Protocol for PET Emission Imaging

Emission images are obtained at least 45 minutes following radiopharmaceutical injection. Emission image acquisition time varies from 2 to 5 minutes or longer per bed position for body imaging and is based on the administered activity, patient body weight, and the sensitivity of the PET tomograph (as determined largely by detector composition and acquisition method).

Semiquantitative estimation of tumor glucose metabolism using the standardized uptake value (SUV) is based on relative lesion radioactivity measured on images corrected for attenuation and normalized for the injected dose and body weight, lean body mass, or body surface area. The accuracy of SUV measurements depends on the accuracy of the calibration of the PET tomograph, among other factors. The reproducibility of SUV measurements depends on the reproducibility of clinical protocols, and is affected by dose infiltration, time of imaging after FDG administration, type of reconstruction algorithms, type of attenuation maps, size of the region of interest, changes in uptake by organs other than the tumor, methods of analysis (e.g., max, mean), etc. This measurement is performed on a static emission image typically acquired more than 45 minutes postinjection.

A change of intensity of uptake with semiquantitative measurements, expressed in absolute values and percent

change, may be appropriate in some clinical scenarios. However, the technical protocol and analysis of images need to be more consistent in the two sets of images.

F. Interpretation

With an integrated PET/CT system, typically the software packages provide registered and aligned CT images; FDG-PET images and fusion images in the axial, coronal, and sagittal planes; and maximum-intensity-projection (MIP) images for review in the 3D-cine mode. FDG-PET images with and without attenuation correction should be available for review.

Normal and variable physiologic uptake of FDG can be seen to some extent in every viable tissue, including the brain, myocardium (where the uptake is significant in some patients despite prolonged fasting), breast, liver, spleen, stomach, intestines, kidneys and urine, muscle, lymphoid tissue (e.g., tonsils), bone marrow, salivary glands, thymus, uterus, ovaries, testes, and brown adipose tissue.

On whole-body scans, studies have shown that FDG-PET imaging of the brain is relatively insensitive for detecting cerebral metastases, partially related to the high physiologic FDG uptake in the gray matter.

Although the pattern of FDG uptake and specific CT findings as well as correlation with history, physical examination and other imaging modalities are usually the most helpful in differentiating benign from malignant lesions, semi-quantitative estimates (e.g., SUV) may also be of value, especially for evaluating changes with time or therapy.

Processes other than malignancies may cause false-positive and false-negative results. The following list, although not all-inclusive, includes the most commonly encountered causes:

1. False-positive findings
 - a. Physiologic uptake that may lead to false-positive interpretations
 - Salivary glands and lymphoid tissue in the head and neck
 - Thyroid
 - Brown adipose tissue
 - Thymus, especially in children
 - Lactating breast
 - Areola
 - Skeletal and smooth muscle (more marked with hyperinsulinemia)
 - Gastrointestinal (e.g., esophagus, stomach, bowel)
 - Urinary tract structures (containing excreted FDG)
 - Female genital tract (e.g., uterus during menses, corpus luteum cyst)

- b. Inflammatory processes
 - Postsurgical inflammation/infection/hematoma, biopsy site, amputation site
 - Postradiation (e.g., radiation pneumonitis)
 - Postchemotherapy
 - Local inflammatory disease, especially granulomatous processes (e.g., sarcoidosis, fungal and mycobacterial disease)
 - Ostomy site (e.g., trachea, colon) and drainage tubes
 - Injection site
 - Thyroiditis
 - Esophagitis, gastritis, inflammatory bowel disease
 - Acute and occasionally chronic pancreatitis
 - Acute cholangitis and cholecystitis
 - Osteomyelitis, recent fracture sites, joint prostheses
 - Lymphadenitis
- c. Benign neoplasms
 - Pituitary adenoma
 - Adrenal adenoma
 - Thyroid follicular adenoma
 - Salivary glands tumors (e.g., Warthin's, pleomorphic adenoma)
 - Colonic adenomatous polyps and villous adenoma
 - Ovarian thecoma and cystadenoma
 - Giant cell tumor
 - Aneurysmal bone cyst
 - Leiomyoma
- d. Hyperplasia/dysplasia
 - Graves' disease
 - Cushing's disease
 - Bone marrow hyperplasia (e.g., anemia, cytokine therapy)
 - Thymic rebound hyperplasia (after chemotherapy)
 - Fibrous dysplasia
 - Paget's disease
- e. Ischemia
 - Hibernating myocardium
- f. Artifacts
 - Misalignment between PET and CT data can cause attenuation correction artifacts. PET images without attenuation correction and fusion images can be used to help identify these artifacts.
 - Inaccuracies in converting from polychromatic CT energies to the 511 keV energy of annihilation radiation can cause artifacts around metal or dense barium, although these artifacts are less common with newer conversion algorithms.
- g. False-negative findings
 - Small size (< 2 x resolution of the system)
 - Tumor necrosis
 - Recent chemotherapy or radiotherapy
 - Recent high-dose steroid therapy
 - Hyperglycemia and hyperinsulinemia
 - Some low-grade tumors (e.g., sarcoma, lymphoma, brain tumor)
 - Tumors with large mucinous components
 - Some hepatocellular carcinomas, especially well-differentiated tumors
 - Some genitourinary carcinomas, especially well-differentiated tumors
 - Prostate carcinoma, especially well-differentiated tumors
 - Some neuroendocrine tumors, especially well-differentiated tumors
 - Some thyroid carcinomas, especially well-differentiated tumors
 - Some bronchioloalveolar carcinomas
 - Some lobular carcinomas of the breast
 - Some skeletal metastases, especially osteoblastic or sclerotic tumors
 - Some osteosarcomas

VII. EQUIPMENT SPECIFICATIONS

See the [ACR Technical Standard for Medical Nuclear Physics Performance Monitoring of PET/CT Imaging Equipment](#), the [ACR Practice Guideline for the Performance of Computed Tomography \(CT\) of the Extracranial Head and Neck in Adults and Children](#), the [ACR Practice Guideline for the Performance of Pediatric and Adult Thoracic Computed Tomography \(CT\)](#), and the [ACR Practice Guideline for the Performance of Computed Tomography \(CT\) of the Abdomen and Computed Tomography \(CT\) of the Pelvis](#).

A. Performance Guidelines

For patient imaging, the PET/CT scanner should meet or exceed the following specifications:

1. For the CT scanner
 - a. Spiral scan time: <5 sec (<2 sec is preferable)
 - b. Slice thickness and collimation: <5 mm (<2 mm is preferable)
 - c. Limiting spatial resolution: >8 lp/cm for >32 cm display field of view (DFOV) and >10 lp/cm for <24 cm DFOV
2. For the PET scanner
 - a. In-plane spatial resolution: <6.5 mm
 - b. Axial resolution: <6.5 mm
 - c. Sensitivity (3D): >4.0 cps/kBq

- d. Sensitivity (2D): >1.0 cps/kBq
 - e. Uniformity: <5%
3. For the combined PET/CT scanner
 - a. Maximum co-scan range (CT and PET): >160 cm
 - b. Maximum patient weight: >350 lb
 - c. Patient port diameter: >59 cm

B. Appropriate emergency equipment and medications must be immediately available to treat adverse reactions associated with administered medications. The equipment and medications should be monitored for inventory and drug expiration dates on a regular basis. The equipment, medications, and other emergency support must also be appropriate for the range of ages and sizes in the patient population.

C. A fusion workstation with the capability to display CT, PET, and fused images with different percentages of CT and PET blending should also be available.

D. PET/CT scanning done specifically for radiation therapy planning should be performed with a flat table top, immobilization devices as needed, and the use of appropriate positioning systems.

VIII. DOCUMENTATION

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

In addition, the procedure section should include the dose of radiopharmaceutical, route of administration, uptake time, field of view, patient positioning, and baseline glucose level.

The findings section should include description of location, extent, and intensity of abnormal FDG uptake in relation to normal comparable tissues and describe the relevant morphologic findings related to PET abnormalities on the CT images. An estimate of the intensity of FDG uptake can be provided with the SUV; however, the intensity of uptake may be described as mild, moderate, or intense or in relation to the background uptake in normal hepatic parenchyma (average SUV weight: 2.0 to 3.0, maximum SUV: 3.0 to 4.0). If the CT scan was requested and performed as a diagnostic examination, the CT component of the study may be reported separately, if necessary to satisfy regulatory, administrative, or reimbursement requirements. In that case, the PET/CT report can refer to the diagnostic CT scan report for findings not related to the PET/CT combined findings.

When PET/CT is performed for monitoring therapy, a comparison of extent and intensity of uptake may be summarized as metabolic progressive disease, metabolic

stable disease, metabolic partial response, or metabolic complete response using published criteria for these categories [30].

IX. EQUIPMENT QUALITY CONTROL

PET performance monitoring should be in accordance with the [ACR Technical Standard for Medical Nuclear Physics Performance Monitoring of Nuclear Medicine Imaging Equipment](#)³, and the [ACR Technical Standard for Medical Nuclear Physics Performance Monitoring of PET/CT Imaging Equipment](#).

CT monitoring should be in accordance with the [ACR Technical Standard for Medical Physics Performance Monitoring of Computed Tomography \(CT\) Equipment](#).

The quality control (QC) procedures for PET/CT should include both the CT procedures and the PET procedures according to the ACR Technical Standards. The QC procedures for the CT should include air and water calibrations in Hounsfield units for a range of kV. The QC procedures for PET should include a calibration measurement of activity in a phantom containing a known radionuclide concentration, generally as a function of axial position within the scanner field of view. A daily check on the stability of the individual detectors should also be performed to identify detector failures and drifts.

In addition, for PET/CT, the alignment between the CT and PET scanners should be checked periodically. Such a check should determine an offset between the CT and PET scanners that is incorporated into the fused image display to ensure accurate image alignment.

X. 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 concept is known as “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; if not, manual techniques should be used to moderate the exposure while maintaining the necessary diagnostic image quality. Periodically, radiation exposures should be

³In 2008, this standard was revised and renamed: [ACR Technical Standard for Medical Nuclear Physics Performance Monitoring of Gamma Cameras](#).

measured and patient radiation doses estimated by a medical physicist in accordance with the appropriate ACR Technical Standard. (ACR Resolution 17, adopted in 2006 – revised in 2009, Resolution 11)

XI. 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 Concerns appearing elsewhere in the ACR Practice Guidelines and Technical Standards book.

In all pediatric patients, the lowest exposure factors should be chosen that would produce images of diagnostic quality.

For specific issues regarding CT quality control, see the [ACR Practice Guideline for Performing and Interpreting Diagnostic Computed Tomography \(CT\)](#).

For specific issues regarding PET and PET/CT quality control, see section IX on Equipment Quality Control.

Equipment performance monitoring should be in accordance with the [ACR Technical Standard for Medical Nuclear Physics Performance Monitoring of Computed Tomography \(CT\) Equipment](#).

ACKNOWLEDGEMENTS

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