Revised 2012 (Resolution 24)*

ACR–SPR 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 revised collaboratively by the American College of Radiology (ACR) and the Society for Pediatric Radiology (SPR) to guide interpreting physicians performing positron emission tomography/ computed tomography (PET/CT) with fluorodeoxyglucose (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. FDG-PET and CT are proven diagnostic procedures.

Techniques for registration and fusion of images obtained from separate PET and CT scanners have been available for years. 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 [3-18]. The advantages of having both PET and CT in a single device have resulted in rapid dissemination of this technology in the United States. This practice guideline pertains only to combined PET/CT devices.

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

The goal of FDG-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 therapeutic decisions.

II. DEFINITIONS

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

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

PET/CT acquisitions: The extent of scanning, which can be tailored to suit the specific indications.

1. Whole-body tumor imaging from the vertex of the skull through the feet.
2. Skull base to mid-thigh tumor imaging.
3. Limited area (e.g., brain-only, chest-only) tumor imaging.

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 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.

III. INDICATIONS

FDG-PET/CT imaging in oncology patients may provide guidance for choosing an appropriate course of action. Examinations should only be performed when there is reasonable expectation that the results will have an impact on patient care. Examples of indications for FDG-PET/CT include, but are not limited to, the following:

1. Evaluating an abnormality considered “indeterminate” by another imaging method in order to determine whether glucose metabolism in that abnormality favors a benign or malignant process.
2. Guiding initial or subsequent treatment strategy in patients with known malignancy.
3. Monitoring therapeutic efficacy.
4. Determining whether residual abnormalities in another imaging method represent persistent viable tumor or post-treatment changes (inflammation, fibrosis, or necrosis) after completion of therapy.
5. Attempting to localize the site of primary tumor when metastatic disease is discovered as the first manifestation of malignancy.

6. Localizing “occult” disease especially in the presence of clinical indicators such as elevated tumor markers.
7. Guiding specific clinical strategies, such as radiation therapy planning or directed biopsy.

FDG uptake varies in different tumor types. A continuing review of the literature is recommended to determine the most effective applications.

For the pregnant or potentially pregnant patient, see the ACR–SPR Practice Guideline for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation.

IV. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

A. Physician

All PET/CT examinations must be performed under the supervision of and interpreted by a physician who has the following qualifications:

Certification in Radiology or Diagnostic Radiology, Nuclear Radiology, or Nuclear Medicine by the American Board of Radiology, American Board of Nuclear Medicine, American Osteopathic Board of Radiology, American Osteopathic Board of Nuclear Medicine, the Royal College of Physicians and Surgeons of Canada, or the Collège des Médecins du Québec.

or

At a minimum, completion of a formal Accreditation Council of Graduate Medical Education (ACGME) approved general nuclear medicine program which must include 200 hours in radiation physics and 500 hours of preparation in instrumentation, radiochemistry, radiopharmacology, radiation dosimetry, radiation biology, radiation safety and protection, and quality control. In addition, 1,000 hours of clinical training in general nuclear medicine is required which must cover technical performance, calculation of dosages, evaluation of images, correlation with other diagnostic modalities, and interpretation.

and

1. Twenty hours of CME in PET
2. For oncologic PET/CT examinations, at least 80 studies must be interpreted or multi-read in the past 3 years.

If interpreting oncologic PET examinations, interpretation must include direct image correlation with CT or MRI. Teaching cases are acceptable with documented interpretation.

Continuing Experience

Read a minimum of 200 studies in 3 years in PET/CT (double reading is acceptable).

Continuing Education

Complete 150 hours (that includes 75 hours of Category 1 CME) in the prior 36 months pertinent to the physician’s practice patterns.

or

Complete 15 hours CME in the prior 36 months specific to the imaging modality or organ system (half of which must be category 1).

In addition, all physicians supervising and/or interpreting nuclear medicine examinations must satisfy all applicable state and federal regulations, as well as any institutional policies that pertain to the in vivo use of radiopharmaceuticals, performance if imaging procedures and the safe handling of radioactive materials.

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, 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 strongly 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 the American Board of Medical Physics (ABMP).

A Qualified Medical Physicist should meet the ACR Practice Guideline for Continuing Medical Education (CME). (ACR Resolution 17, 1996 – revised in 2012, Resolution 42).

The appropriate subfields of medical physics for this standard are Diagnostic Medical Physics, and Nuclear Medical Physics. (Previous medical physics certification categories including Radiological Physics, Medical Nuclear Physics, Diagnostic Radiological Physics, and Diagnostic Imaging Physics are also acceptable.)

Certification in Nuclear Medicine Physics and Instrumentation by the American Board of Science in Nuclear Medicine (ABSNM) is also acceptable.

A Qualified 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–SNM Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals.

Representatives of the SNM 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.arrt.org).

D. Radiation Safety Officer

The Radiation Safety Officer (RSO) must meet applicable requirements of the Nuclear Regulatory Commission (NRC) for training as specified in 10 CFR 35.50, or equivalent state regulations [22].

V. FDG PET/CT EXAMINATION SPECIFICATIONS

See the ACR–ASNR–SPR Practice Guideline for the Performance of Computed Tomography (CT) of the Extracranial Head and Neck, the ACR Practice Guideline for the Performance of Thoracic Computed Tomography (CT), and the ACR–SPR Practice Guideline for the Performance of Computed Tomography (CT) of the Abdomen and Computed Tomography (CT) of the Pelvis.

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)

Section VI. B, C, E, F, have been adapted from reference 23. [23]

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 (a minimum of 4 hours) and no oral or intravenous fluids containing sugar or dextrose.
3. Serum glucose analysis should be performed immediately prior to FDG administration.
4. Hydration, typically oral. In special circumstances, intravenous hydration, diuretic administration, or bladder catheterization can be used to reduce accumulated tracer activity in the urinary bladder.
5. Focused history regarding the reason for examination (symptoms, diagnoses, and recent imaging examinations), treatments and medications, recent trauma or infection, diabetes, and recent exercise. Specific details and dates should be obtained when possible.
6. Strategies to reduce unwanted FDG accumulation, particularly as applicable to children and adolescents.
    a. Warm blankets and warm uptake room during localization can decrease brown fat activity.
    b. Pre-medication for anxiety if indicated.
    c. Quiet uptake room (decrease anxiety).
    d. No strenuous activity 24 hours prior to injection (to decrease muscle uptake).
    e. Sedation in children younger than 5 years of age. (See the ACR–SIR Practice Guideline for Sedation/Analgesia.)
7. Patients should void prior to being positioned on the PET/CT table.

C. Radiopharmaceutical

For adults, the amount of FDG administered activity should be 370 to 740 MBq (10 to 20 mCi), and for children 3.7 to 5.2 MBq/kg (0.10 to 0.14 mCi/kg). Administered activity for children should be determined based on body weight and should be as low as reasonably achievable for diagnostic image quality[1]. When feasible, the

[1]For more specific guidance on pediatric dosing, please refer to the *Pediatric Radiopharmaceutical Administered Doses: 2010 North American Consensus Guidelines.*

radiopharmaceutical should be injected intravenously at a site contralateral to sites of known or suspected disease. 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. Lower administered activities may be appropriate with advances in PET/CT technology.

D. Protocol for CT Imaging

The CT performed as part of a PET/CT examination provides diagnostic information that may be relevant to both PET interpretation and overall patient care. A variety of protocols exist for performing the CT scan in the context of PET/CT scanning. In some cases, low dose CT scans are designed primarily to provide attenuation correction and anatomic localization. In other cases, the CT portion of the examination is performed as an optimized CT with parameters designed to lower image noise and the addition of intravenous and/or oral contrast material. If a diagnostic CT scan is requested as part of PET/CT, the CT protocol appropriate for the body region(s) requested should be used. Regardless of the CT technique used, a careful review of CT images is necessary for comprehensive interpretation of the PET/CT examination.

For a 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 diluted barium sulfate or diatrizoic acid 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 and should be avoided [24]; diluted barium sulfate and oral iodinated agents cause less overestimation and are less likely to have an adverse impact on PET image quality [24-27].

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 [28,29], but the impact is usually limited [25,30].

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 should be optimized so that the positions of the diaphragm that appears on the PET emission and the CT transmission images match as closely as possible.

If a single breath-hold technique is used for CT imaging, optimal alignment of the PET and CT images is obtained with respiration suspended in the quiet end-expiratory (end tidal volume) phase.

E. Protocol for PET Emission Imaging

Emission images are obtained at least 45 minutes following radiopharmaceutical injection. Emission image acquisition time typically varies from 1 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 device (as determined largely by the detector composition and acquisition method).

Semiquantitative estimation of FDG accumulation using the standardized uptake value (SUV) is based on local radioactivity concentration measured on images corrected for attenuation and normalized for the injected activity 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 device, among other factors. As the SUV is becoming a standard for determining tumor response over time, measures should be taken to minimize the factors which may affect it. These include using the same scanner configuration on subsequent examinations (including reconstruction algorithms, attenuation maps, etc.), maintaining the same time between injection and scanning, avoiding infiltration of injected activity, and using the same measurement techniques, (VOI volumes, max / peak / mean measurements). Some factors which affect SUV may be beyond control, such as serum glucose and fasting state.

Recording changes in the intensity of FDG uptake with semiquantitative measurements, expressed in absolute values and percent changes, may be appropriate in some clinical scenarios. However, the technical protocol and analysis of images need to be consistent in the two data sets.

F. Interpretation

With an integrated PET/CT system, the software packages typically provide a comprehensive platform for image review, including registered and aligned CT images, FDG-PET images, and PET/CT fusion images in the axial, coronal, and sagittal planes. In addition, maximum-intensity-projection (MIP) images of the PET examination should be reviewed in 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 high uptake can be seen 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 and cerebellar metastases, partially related to the high physiologic FDG uptake in the normal gray matter.

Although the pattern of FDG uptake and associated 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, semiquantitative estimates (e.g., SUV) may also be of value, especially for evaluating changes with time or therapy.

Tissues other than neoplastic disease may show substantial FDG uptake. Other conditions may lead to poor FDG uptake in neoplastic tissue. The following list, although not all-inclusive, includes the most commonly encountered situations in which FDG uptake is caused by processes other than malignant disease, and in which FDG uptake does not occur despite the presence of malignant disease:

1. Situations which can lead to false-positive FDG-PET/CT interpretation:
   a. Physiologic uptake
      - 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 inflammation (e.g., radiation pneumonitis).
      - Postchemotherapy changes, including inflammation and necrosis.
      - 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.
- Vascular inflammation, including vasculitis and atherosclerotic disease.

c. Benign tumor or tumor like conditions
- Pituitary adenoma.
- Adrenal adenoma.
- Thyroid gland follicular adenoma.
- Salivary gland tumors (e.g., Warthin's, pleomorphic adenoma).
- Colonic adenomatous polyps.
- Ovarian thecoma and cystadenoma.
- Giant cell tumor.
- Aneurysmal bone cyst.
- Fibrous cortical defects (in pediatric patients)
- Leiomyoma.

d. Hyperplasia and dysplasia conditions
- Graves' disease.
- Cushing's disease.
- Bone marrow hyperplasia (e.g., anemia, colony stimulating factor).
- Thymic rebound hyperplasia (after chemotherapy).
- Fibrous dysplasia.
- Paget's disease.

e. 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.

2. Situations that can lead to false-negative FDG-PET/CT interpretation:
- Small lesion size (< 2 x resolution of the system).
- Hyperglycemia and hyperinsulinemia.
- Recent therapy
  - Chemotherapy.
  - Radiotherapy.
  - Steroid therapy.
  - Certain low-grade or well-differentiated tumors, such as mucinous neoplasms including bronchoalveolar-subtype lung adenocarcinomas.
  - Prostate carcinoma.
  - Carcinoid tumor and islet cell tumors.
  - Medullary thyroid cancer.
  - Lobular carcinoma of the breast.
  - Hepatocellular tumors, including well-differentiated hepatocellular carcinoma.
  - Indolent lymphoma, including marginal zone lymphoma and small lymphocytic lymphoma.

VI. EQUIPMENT SPECIFICATIONS

See the ACR Technical Standard for Medical Nuclear Physics Performance Monitoring of PET/CT Imaging Equipment, the ACR–ASNR–SPR Practice Guideline for the Performance of Computed Tomography (CT) of the Extracranial Head and Neck, the ACR–SCBT-MR–SPR Practice Guideline for the Performance of Thoracic Computed Tomography (CT), and the ACR–SPR 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 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%.

2. For the CT scanner
   a. Spiral scan time: <5 seconds (<2 seconds 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.

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 PET, CT, and fused images with different percentages of PET and CT blending should also be available. The workstation should also have the capability to measure SUV, preferably with volumetric ROI.

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.

VII. DOCUMENTATION

A. Reporting should be in accordance with the ACR Practice Guideline for Communication of Diagnostic Imaging Findings.

The report should include the radiopharmaceutical used, the dose, and the dose and route of administration, as well as any other pharmaceuticals administered. The serum glucose level at the time of radiotracer administration should be reported. Details of oral or intravenous contrast agents, if used for the CTAC portion of the examination should also be reported, to include the volume, rate, and route of administration. Other information relevant to contrast administration, such as steroid preparation, prehydration, or dialysis history, should be included. The report should also include documentation of contrast reactions and subsequent treatment, if observed during the study.

The findings section should include description of the 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 in relation to the background uptake in normal hepatic parenchyma.

If the CT scan was requested and performed as a diagnostic examination, the CT component of the study should be reported separately to satisfy regulatory, administrative, or reimbursement requirements. In that case, the PET/CT report should refer to the diagnostic CT scan report for findings not related to the PET/CT combined findings [31-33].

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 [34,35].

VIII. EQUIPMENT QUALITY CONTROL

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

CT monitoring should be in accordance with the ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Computed Tomography (CT) Equipment.

The quality control (QC) procedures for PET/CT should include both the PET procedures and the CT procedures according to the ACR Technical Standards. 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. The QC procedures for the CT should include air and water calibrations in Hounsfield units for a range of kV. 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 PET and CT scanners should be checked periodically. Such a check should determine an offset between the PET and CT scanners that is incorporated into the fused image display to ensure accurate image alignment.

IX. RADIATION SAFETY IN IMAGING

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/p1531interim_web.pdf

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

Facilities should have and adhere to policies and procedures that require varying ionizing radiation examination protocols (plain radiography, fluoroscopy, interventional radiology, CT) to take into account patient body habitus (such as patient dimensions, weight, or body mass index) to optimize the relationship between minimal radiation dose and adequate image quality. Automated dose reduction technologies available on imaging equipment should be used whenever appropriate. If such technology is not available, appropriate manual techniques should be used.

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).

X. 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 web site (http://www.acr.org/guidelines).

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–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Computed Tomography (CT) Equipment.

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