ACR–SIR–SPR PRACTICE PARAMETER FOR THE PERFORMANCE OF IMAGE-GUIDED PERCUTANEOUS NEEDLE BIOPSY (PNB)

The American College of Radiology, with more than 40,000 members, is the principal organization of radiologists, radiation oncologists, and clinical medical physicists in the United States. The College is a nonprofit professional society whose primary purposes are to advance the science of radiology, improve radiologic services to the patient, study the socioeconomic aspects of the practice of radiology, and encourage continuing education for radiologists, radiation oncologists, medical physicists, and persons practicing in allied professional fields.

The American College of Radiology will periodically define new practice parameters 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 parameters and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

Each practice parameter 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 and approval. The practice parameters 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 parameter and technical standard by those entities not providing these services is not authorized.

PREAMBLE

This document is an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. Practice Parameters and Technical Standards are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care[1]. For these reasons and those set forth below, the American College of Radiology and our collaborating medical specialty societies caution against the use of these documents in litigation in which the clinical decisions of a practitioner are called into question.

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

The practice of medicine involves the science, and the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment. Therefore, it should be recognized that adherence to the guidance in this document will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The purpose of this document is to assist practitioners in achieving this objective.

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

I. INTRODUCTION

This practice parameter was revised collaboratively by the American College of Radiology (ACR), the Society of Interventional Radiology (SIR), and the Society for Pediatric Radiology (SPR).

For the purpose of this practice parameter, image-guided percutaneous needle biopsy (PNB) is an established, effective, and safe procedure for selected patients with suspected pathology. The patient is most likely to benefit when the procedure is performed in an appropriate environment by qualified providers [1-6]. This practice parameter outlines the principles for performing PNB.

For information on breast biopsy, see the ACR Practice Parameter for the Performance of Stereotactic/Tomosynthesis-Guided Breast Interventional Procedures or the ACR Practice Parameter for the Performance of Ultrasound-Guided Percutaneous Breast Interventional Procedures [7,8].

PNB is defined as image-guided percutaneous placement of a needle into an organ or lesion and obtaining tissue and/or cells for diagnosis.

For the purpose of this practice parameter, successful image-guided PNB is defined as the procurement of sufficient sample to allow for diagnosis of disease, monitoring therapy, or molecular testing. When biopsy results are nondiagnostic or discordant with the imaging findings and/or clinical presentation, a discussion between the referring provider, the provider performing the procedure, and the interpreting pathologist should occur.

II. INDICATIONS AND CONTRAINDICATIONS [3-6]

A. Indications for PNB include, but are not limited to, the following:

1. Establishing the benign or malignant nature of a lesion (the histologic subtype or grade of malignant disease).
2. Obtaining material for microbiologic analysis in patients with known or suspected infections.
3. Staging disease in patients with known or suspected malignancy when local spread or distant metastasis is suspected.
4. Determining the nature and extent of certain diffuse parenchymal diseases (eg, hepatic cirrhosis, renal transplant rejection, glomerulonephritis).
5. Obtaining tissue for biomarker, protein, or genotype analysis to guide therapy or inform prognosis.
6. Determining the primary malignancy in patients with presumed metastatic disease, benign from malignant processes, or malignancy with no known primary.
7. Determining treatment response.
8. For research purposes.

B. There are several relative contraindications to PNB. The clinical scenario should be considered with risks and benefits weighed before proceeding. When possible and applicable, relative contraindications should be corrected or the procedure should be modified accordingly.

Relative Contraindications to PNB include:

1. Uncorrectable coagulopathy [9-11]
2. Thrombocytopenia (and optional anticoagulants)
3. Hemodynamic instability or cardiopulmonary compromise
4. Marked hypertension when undergoing biopsy of a hypervascular organ or lesion [11].
5. Lack of safe trajectory for placement of a biopsy needle from skin to target lesion.
6. Inability to safely obtain sufficient material for biopsy indication.
7. Inability for patient to cooperate with or tolerate the procedure.
8. Nature of the lesion: pheochromocytoma/hepatic adenoma or lesions that have diagnostic imaging criteria (ie, hepatocellular carcinoma).

For the pregnant or potentially pregnant patient, see the ACR–SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Patients with Ionizing Radiation [12].

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

A. Physician

Core Privileging: This procedure is considered part of or amendable to image-guided core privileging.

Initial Qualifications

Image-based diagnosis and treatment planning require integrating the preprocedural imaging findings within the context of the patient's history and physical findings. Therefore, the physician must be clinically informed and understand the specific clinical questions to be answered and goals to be accomplished by PNB prior to the procedure to plan and perform the procedure safely and effectively.

The physician performing PNB must have knowledge of the benefits, alternatives, and risks of the procedure. The physician must have an understanding of imaging anatomy, imaging equipment, radiation safety considerations, and physiologic monitoring equipment, have access to adequate supplies and personnel to perform the procedure safely, and be able to manage complications.

The physician's experience in PNB is best documented by use of a formal case log submitted by the applicant. PNB procedures must be performed by a physician who has the following qualifications:

1. Certification in Radiology, Diagnostic Radiology or Interventional Radiology/Diagnostic Radiology (IR/DR) by the American Board of Radiology, the American Osteopathic Board of Radiology, the Royal College of Physicians and Surgeons of Canada (RCPSC), or the Collège des Médecins du Québec and has performed (with supervision) a sufficient number of PNB procedures to demonstrate competency as attested by the supervising physician(s).

or

2. Completion of radiology or interventional radiology residency program approved by the Accreditation Council for Graduate Medical Education, the RCPSC, the Collège des Médecins du Québec, or the American Osteopathic Association and has performed (with supervision) a sufficient number of PNB procedures to demonstrate competency as attested by the supervising physician(s).

or

3. Physicians whose residency or fellowship training did not include the above may still be considered qualified to perform PNB provided that the following can be demonstrated:

   The physician must have documented supervised image-guided procedural experience during which the physician performed and interpreted image-guided percutaneous biopsy procedures, serving as the primary operator, with outcomes within the quality improvement thresholds of this practice parameter.

and

4. Physicians meeting any of the qualifications in #1, #2, and #3 above must also have written evaluation that they are cognizant of all the following:
   a. Indications and contraindications for PNB .
   b. Appropriate credentialing by providers to use imaging equipment, particularly for radiation safety (eg, fluoroscopy/CT).
   c. Periprocedural and intraprocedural assessment, monitoring, and management of potential complications.
   d. Where applicable, pharmacology of local anesthetics, moderate sedation medications, and

recognition and treatment of adverse reactions and complications.

e. Imaging modalities that may be used for guidance during percutaneous procedures and knowledge to determine the safest and most optimal imaging modality for a specific PNB procedure .
f. Where applicable, principles of radiation protection, the hazards of radiation, and radiation monitoring requirements.
g. Where applicable, pharmacology of contrast agents and recognition and treatment of potential adverse reactions.
h.
i. Technical aspects of performing the procedure, including the various biopsy device types and sizes available and percutaneous needle placement and sampling techniques.
j. Anatomy, physiology, and pathophysiology of the structures being considered for PNB either as the target or in the trajectory of the needle.

The physician's experience in PNB is best documented by use of a formal case log submitted by the applicant. The written substantiation for #4 above should come from the director of interventional radiology, body imaging, or ultrasound or the chair of the radiology department of the institution in which the physician will be providing these services. Substantiation may also come from a prior institution in which the physician provided these services but only at the discretion of the current interventional director or chair who solicits the additional input.

Maintenance of Competence

Physicians must perform a sufficient number of overall procedures applicable to the spectrum of core privileges to maintain their skills, with acceptable success and complication rates as laid out in this parameter. Continued competence should depend on participation in a quality improvement program that monitors these rates. Consideration should be given to the physician's lifetime practice experience.

Continuing Medical Education

The physician's continuing medical education should be in accordance with the ACR Practice Parameter for Continuing Medical Education (CME) [13].

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

B. Qualified Medical Physicist

A Qualified Medical Physicist should have the responsibility for overseeing the equipment quality control program and for monitoring fluoroscopy and other cross-sectional imaging equipment, both upon installation and routinely on an annual basis. Medical physicists assuming these responsibilities should meet the following qualifications:

A Qualified Medical Physicist is an individual who is competent to practice independently in one or more of the subfields in medical physics. The American College of Radiology (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 to be 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 Physicists in Medicine, the American Board of Science in Nuclear Medicine (ABSNM), or the American Board of Medical Physics (ABMP).

The Qualified Medical Physicist should meet the ACR Practice Parameter for Continuing Medical Education (CME). [13].

The appropriate subfield of medical physics for this practice parameter is Diagnostic Medical Physics (previous medical physics certification categories including Radiological Physics, Diagnostic Radiological Physics, and Diagnostic Imaging Physics are also acceptable). (ACR Resolution 17, 1996 – revised in 2008, 2012, 2022, Resolution 41f)

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

C. Non-Physician Radiology Provider (NPRP)

NPRPs are all Non-Physician Providers (e.g., RRA, RPA, RA, PA, NP, ...) who assist with or participate in portions of the practice of a radiologist-led team (Radiologists = diagnostic, interventional, neurointerventional radiologists, radiation oncologists, and nuclear medicine physicians). The term "NPRP" does not include radiology, CT, US, NM, MRI technologists, or radiation therapists who have specific training for radiology related tasks (e.g., acquisition of images, operation of imaging and therapeutic equipment) that are not typically performed by radiologists.

The term 'radiologist-led team' is defined as a team supervised by a radiologist (i.e., diagnostic, interventional, neurointerventional radiologist, radiation oncologist, and nuclear medicine physician) and consists of additional healthcare providers including RRAs, PAs, NPs, and other personnel critical to the provision of the highest quality of healthcare to patients. (ACR Resolution 8, adopted 2020).

NPRPs can be valuable members of the radiology team but should not perform PNBs independent of supervision by physicians with training, experience, and privileges to perform the relevant procedures. See the ACR–SIR–SNIS–SPR Practice Parameter for the Clinical Practice of Interventional Radiology{American College of Radiology, 2019 #102} [14].

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

D. Technologist

The technologist, together with the physician and nursing personnel, is responsible for patient comfort and safety. The technologist should be able to prepare and position[2] the patient for the image-guided percutaneous procedure and, together with the nurse, monitor the patient during the procedure. The technologist should provide assistance to the physician as required, which may include operating the imaging equipment and obtaining images prescribed by the supervising physician. If intravenous contrast material is to be administered, qualifications for technologists performing intravenous injection should be in compliance with current ACR policy statements[3] and existing operating procedures or manuals at the facility. The technologist should also perform regular quality control testing of the equipment under supervision of the physicist.

Technologists should be certified by the American Registry of Radiologic Technologists (ARRT) or have an unrestricted state license with documented training and experience in the imaging modality used for the image-guided percutaneous procedure.

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[2] The American College of Radiology approves of the practice of certified and/or licensed radiologic technologists performing fluoroscopy in a facility or department as a positioning or localizing procedure only, and then only if monitored by a supervising physician who is personally and immediately available*. There must be a written policy or process for the positioning or localizing procedure that is approved by the medical director of the facility or department/service and that includes written authority or policies and processes for designating radiologic technologists who may perform such procedures. (ACR Resolution 26, 1987 – revised in 2007, Resolution 12m)

*For the purposes of this parameter, "personally and immediately available" is defined in manner of the "personal supervision" provision of CMS—a physician must be in attendance in the room during the performance of the procedure. Program Memorandum Carriers, DHHS, HCFA, Transmittal B-01-28, April 19, 2001.

[3] See the ACR–SPR Practice Parameter for the Use of Intravascular Contrast Media.

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

E. Diagnostic Medical Sonographer

The sonographer, together with the physician and nursing personnel, is responsible for patient comfort and safety. The sonographer should be able to prepare and position the patient for the image-guided percutaneous

procedure and, together with the nurse, monitor the patient during the procedure. The sonographer should provide assistance to the physician as required, which may include operating the imaging equipment and obtaining images prescribed by the supervising physician. The sonographer should also perform regular quality control testing of the equipment under supervision of the physicist.

Diagnostic medical sonographers involved in PNB should have documented training and experience in assisting with these procedures. When possible, they should be certified by the ARRT or by the American Registry for Diagnostic Medical Sonography. When applicable, they should have an unrestricted state license.

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

F. Other Ancillary Personnel

Other ancillary personnel who are qualified and duly licensed or certified under applicable state law may, under supervision by a radiologist or other qualified physician, perform specific interventional fluoroscopic or other image-guided procedures. Supervision by a radiologist or other qualified physician must be direct or personal and must comply with local, state, and federal regulations. Individuals should be credentialed for specific fluoroscopic and other image-guided interventional procedures and should have received formal training in radiation management and/or application of other imaging modalities as appropriate. See the ACR–AAPM Technical Standard for Management of the Use of Radiation in Fluoroscopic Procedures [15].

III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

G. Nursing Services

Nursing services, when deemed appropriate by the performing physician, are an integral part of the team for preprocedural, intraprocedural, and postprocedural patient management and education and are recommended in monitoring the patient during the procedure.

IV. PROCEDURE SPECIFICATIONS

A. Imaging Equipment and Facilities

1. The minimum requirements for facilities in which PNB is performed include:
    a. Ultrasound should be available. Appropriate transducers should be available to image the target lesion and guide percutaneous needle placement .
    b. Procedural CT and/or CT fluoroscopy equipment may be necessary to better demonstrate anatomy or guide needle placement, particularly in:
        i. Patients with lesions that are difficult to visualize or access with other imaging modalities or are in unusual or precarious locations.
        ii. Planning the optimal route of biopsy to avoid, when possible, transgression of vital structures.
        iii. Patients with unusual anatomy.
    c. When fluoroscopic guidance is used, a high-resolution unit with collimation capabilities is desirable. The ability to perform complex angle (eg, anteroposterior, lateral, or oblique) fluoroscopy views is often necessary to ensure proper needle placement. Overhead fluoroscopic tube suites are less desirable because of increased radiation exposure to personnel during this procedure.
    d. The facility should provide an area that is appropriate for patient preparation and recovery before and after the procedure. This may be within the radiology department, in a short-stay unit, or in a routine nursing unit as outlined in the Patient Care Section below. There should be immediate access to emergency resuscitation equipment. Personnel and equipment to diagnose and treat acute complications should be readily
    e. For patients undergoing thoracic procedures, appropriate equipment for decompression of a pneumothorax and urgent chest tube placement should be available.
    f. Access to laboratory facilities and/or blood bank with expertise in cytopathology, microbiology, and chemistry should be available. (These resources need not be located in the procedural area .)

2. Performance guidelines

   When using fluoroscopy or CT for PNB, a facility should meet or exceed the following imaging standards :

a.
b. Tight collimation should always be used to the extent possible. All personnel in the procedure room should wear protective garments (eg, aprons, thyroid collars, leaded eyeglasses) or stand behind protective barriers. The wearing of protective garments must be compliant to all applicable regulations.

   On units where The use of dose reduction pulsed fluoroscopy is recommended if available.

c. Radiation doses for X-ray guidance should be kept to a minimum. The operator will use only as much fluoroscopy as is necessary to complete the biopsy and evaluate for immediate complications. Fluoroscopic time can be reduced by the use of the "last image hold" capability [16]. Pulsed fluoroscopy can reduce the radiation rate and is recommended. See the ACR–AAPM Technical Standard for Management of the Use of Radiation in Fluoroscopic Procedures [15].
d. Radiation doses for CT guidance should be kept to a minimum. The operator will use only as much CT imaging as is necessary to complete the biopsy and evaluate for immediate complications. Lowering the milliampere-seconds (mAs), reducing kilovoltage (kVp), and/or decreasing axis coverage can substantially reduce radiation dose without compromising the imaging guidance procedure. The use of CT fluoroscopy may also provide adequate imaging guidance.

CT fluoroscopy mode uses one rotation volume scan, which can be reconstructed as a single thick slice or multiples of thinner slices covering the same volume. Reconstructing the thinner slices within CT fluoroscopy mode with set mAs will not affect patient radiation exposure; however, it will improve 3-D visualization of the region of interest. Imaging guidance software can also be used to facilitate percutaneous access to out-of-axial-plane target lesions .

IV. PROCEDURE SPECIFICATIONS

B. Physiologic Monitoring and Resuscitation Equipment

1. Appropriate equipment should be present to monitor the patient's heart rate, cardiac rhythm, blood pressure, oxygenation, and carbon dioxide levels when indicated. (See the ACR–SIR Practice Parameter for Minimal and/or Moderate Sedation/Analgesia [17,18].)
2. There should be ready access to emergency resuscitation equipment and drugs, to include the following: a defibrillator, oxygen supply with appropriate tubing and delivery systems, suction equipment, tubes for endotracheal intubation, laryngoscope, ventilation bag-valve-mask apparatus, and central venous line sets. Drugs for treating cardiopulmonary arrest, contrast reaction, vasovagal reactions, narcotic or benzodiazepine overdose, bradycardia, and ventricular dysrhythmias should also be readily available. Resuscitation equipment should be monitored and checked on a routine basis in compliance with institutional policies.
3. Any procedure performed using MRI guidance must have MRI-compatible emergency resuscitation equipment available [19].
4. Appropriate emergency equipment and medications must be immediately available to treat procedural complications or adverse reactions associated with administered medications. The equipment should be monitored and medications inventoried for drug expiration dates on a regular basis. The equipment, medications, and other emergency support must also be appropriate for the range of ages and/or sizes in the patient population.

IV. PROCEDURE SPECIFICATIONS

C. Acute Care Support

Although PNB complications rarely require urgent surgery, high-risk PNB procedures should be performed in an

environment where surgical intervention can be instituted promptly. The facility should have adequate surgical, anesthesia, and ancillary support. When these procedures are performed in a freestanding center, detailed protocols for the rapid transport and admission of patients to an acute-care hospital should be formalized in writing.

IV. PROCEDURE SPECIFICATIONS

D. Patient Care

1. Preprocedural care
    a. The physician performing the procedure must have knowledge of the following:
        i. Relevant clinical history, including indications for the procedure and medical conditions that may necessitate additional care, such as the need for general anesthesia or other measures.
        ii. Relevant preprocedure imaging.
        iii. Relevant physical examination findings, including assessment of the region of planned access.
        iv. Consideration of possible alternative means to obtain the desired tissue samples or diagnostic information, such as other methods for sampling (eg, endoscopic, bronchoscopic, laparoscopic, transjugular for liver) or laboratory studies.
        v. Laboratory results that inform risk for bleeding and other possible complications.
        vi. Relevant medications, such as anticoagulants, and allergies to medications and contrast agents.
    b. Informed consent must be obtained in compliance with all state laws and should comply with the ACR–SIR–SPR Practice Parameter on Informed Consent for Image-Guided Procedures [20].

2. Procedural care
    a. Adherence to the Joint Commission's current Universal Protocol for Preventing Wrong Site, Wrong Procedure, Wrong Person Surgery™ (also called "time out") is required for procedures in nonoperating room settings, including bedside procedures. The organization should have processes and systems in place for reconciling differences in staff responses during the "time out."
    b. Nursing personnel, technologists, and those directly involved in the patient's care during PNB should have protocols for use in standardizing care. These should include, but are not limited to:
        i. Equipment needed for the procedure and to manage potential
        ii. Patient monitoring.
    c. Protocols should be reviewed and updated periodically.

3. Postprocedural care
    a. Orders for postprocedure patient care should include frequency of obtaining vital signs and discharge instructions. Discharge instructions should include contact information for an appropriate resource that the patient or patient's representative can call to ask questions or express concerns about the development of complications or other issues.
    b. Specific anatomic considerations
        i. Thoracic cavity biopsies: appropriate imaging assessment for the presence of pneumothorax.
        ii. Peritoneal and other solid organ biopsies: appropriate imaging and/or laboratory studies to evaluate for acute complications when indicated.

IV. PROCEDURE SPECIFICATIONS

E. Specifics of the Procedure

1. All image-guided PNB procedures are performed for specific indications and should be tailored accordingly.
2. The physician should be aware of the various types and sizes of aspiration and core cutting needles that are available.
3. The physician should be cognizant of the different laboratory studies and be able to request the most appropriate based on clinical scenario.
4. Prior consultation with pathology may be useful in selected cases.

5. Postprocedure note should include the following: preprocedure diagnosis, postprocedure diagnosis, indications, procedure, operator, anesthesia/sedation, access, hemostasis, estimated blood loss, specimens obtained and where submitted, complications, findings, and plan. These elements can be placed in the report of the procedure.

V. DOCUMENTATION

Reporting should be in accordance with the ACR–SIR–SPR Practice Parameter for the Reporting and Archiving of Interventional Radiology Procedures [21].

VI. EQUIPMENT SPECIFICATIONS

Equipment performance monitoring should be in accordance with the ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Fluoroscopic Equipment [22] and ACR–AAPM Technical Standard for Diagnostic Medical Physics Performance Monitoring of Computed Tomography (CT) Equipment [23].

VII. RADIATION SAFETY IN IMAGING

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

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

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

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

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

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

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education appearing under the heading *Position Statement on QC & Improvement, Safety,*

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

IX. Common Complications

Although physicians should strive for 100% success without complications, in practice this is not reality. Complications will vary depending on the target organ, needle trajectory, number of passes, gauge of the biopsy device, patient labs, and clinical picture. These can include bleeding, infection, injury to surrounding structures, increased level of care, or death, among others. Providers should try to minimize complications by patient selection and procedure selection, and monitor rates of complications.

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