

The American College of Radiology, with more than 30,000 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 guidelines and technical standards for radiologic practice to help advance the science of radiology and to improve the quality of service to patients throughout the United States. Existing practice guidelines and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

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

2002 (Res. 22)  
Amended 2006 (Res. 16g,17,36)  
Effective 1/01/03

## **ACR TECHNICAL STANDARD FOR MANAGEMENT OF THE USE OF RADIATION IN FLUOROSCOPIC PROCEDURES**

---

### **PREAMBLE**

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

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

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

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

### **I. INTRODUCTION**

Fluoroscopy is frequently used to assist in a wide variety of medical diagnostic and therapeutic procedures, both within and outside of radiology departments. Fluoroscopic equipment capabilities have changed dramatically in recent years. Under certain operating conditions, some fluoroscopic equipment is capable of producing very high radiation doses in short periods of time. There have been reports of serious skin injuries in some patients undergoing certain fluoroscopically guided procedures. Therefore, the use of fluoroscopy in medical institutions must be proactively managed to reduce patient radiation exposures to levels that are as low as reasonably achievable consistent with the medical demands of the procedures for which fluoroscopy is used. Management of the use of radiation must also ensure adequate safety of the medical personnel involved in these procedures.

### **II. GOAL**

The goal of this standard is to assist physicians and medical physicists in managing the use of radiation in fluoroscopic procedures so as to reduce radiation

exposures to levels that are as low as reasonably achievable consistent with the medical demands of the procedures.

### III. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

#### A. Physician

Fluoroscopically guided procedures must be performed by a physician with the following qualifications:

Certification in Radiology, Diagnostic Radiology or Radiation Oncology by the American Board of Radiology, the American Osteopathic Board of Radiology, the Royal College of Physicians and Surgeons of Canada, or Le College des Medecins du Quebec.

or

Completion of an Accreditation Council for Graduate Medical Education (ACGME) approved residency/fellowship program or an American Osteopathic Association (AOA) approved residency program that include 6 months of training in fluoroscopic imaging procedures. Documented successful completion of didactic course lectures and laboratory instruction in radiation physics, radiobiology, radiation safety, and radiation management applicable to the use of fluoroscopy, including passing a written examination in these areas.

or

Each facility should have a policy for credentialing other physicians who perform fluoroscopy, and the following is recommended:

Physicians whose residency did not include the above may still be considered as satisfying the qualifications if they have performed at least 10 procedures of each type for which they intend to use fluoroscopic guidance under the direction of a qualified physician who has met these standards and who certifies that the trainee meets minimum fluoroscopy safety standards. They must also have documented evidence of at least 4 hours of didactic course lectures and laboratory instruction in radiation physics, radiobiology, radiation safety, and radiation management applicable to the use of fluoroscopy, and should have satisfactorily passed an examination in these areas. Physicians involved in cardiovascular, biliary tract, and genitourinary tract interventional procedures should have at least 15 hours of didactic training in radiation physics, radiobiology, radiation safety, and radiation management applicable to the use of fluoroscopy, and have satisfactorily passed an examination in these areas.

and

For fluoroscopic procedures to be performed safely, certain fundamental knowledge and skills are

required. In addition to a basic understanding of anatomy, physiology, and pathophysiology, the physician should have sufficient knowledge of the clinical and imaging evaluation of patients to identify those for whom a specific procedure is indicated. The physician should evaluate a patient's clinical status to anticipate those patients who might be at increased risk, who require additional pre- or postprocedure care, and who have relative contraindications to the procedure.

#### Maintenance of Competence

The physician should regularly perform fluoroscopic procedures in sufficient numbers to maintain success and complication rates in accordance with accepted standards.

Competence must also be assured by continuing training on new pieces of equipment as they arrive in a department or division.

#### Continuing Medical Education

Continuing education should be in accordance with the [ACR Practice Guideline for Continuing Medical Education](#) (CME) and should include continuing education in radiation protection related to the use of fluoroscopy.

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

The appropriate subfields of medical physics for this standard are Diagnostic Radiological Physics or Radiological Physics.

Continuing education for a Qualified Medical Physicist should be in accordance with the [ACR Practice Guideline for Continuing Medical Education](#) (CME) and should include continuing education in radiation dosimetry, radiation protection, and equipment performance related to the use of fluoroscopy. (2006 - ACR Resolution 16g)

The medical physicist should regularly perform radiation measurements, dosimetric calculations, and equipment performance evaluations of fluoroscopic equipment of the

types being used in sufficient numbers to maintain competence in the performance of these activities.

The medical physicist must be familiar with the principles of imaging physics, radiation dosimetry, and radiation protection; the current guidelines of the National Council on Radiation Protection and Measurements (NCRP); laws pertaining to the performance of fluoroscopic equipment; the function, clinical uses, and performance specifications of the imaging equipment; and calibration processes and limitations of the instruments used for radiation measurement.

#### C. Radiologic Technologist and Radiation Therapist

Certification by the American Registry of Radiologic Technologists (ARRT) and/or unrestricted state license is required.

Technologists or radiation therapists assisting with fluoroscopy should be thoroughly trained in radiography of the organ systems involved in a fluoroscopic procedure.

### IV. PROCEDURAL SPECIFICATIONS

Only physicians with the qualifications outlined in this standard should operate a fluoroscopic system while exposing a patient to radiation, with the following exception. Registered and/or licensed radiologic technologists or radiation therapists may perform fluoroscopy only as a positioning or localizing procedure provided they are monitored by a supervising physician who is personally and immediately available. Such a supervising physician must meet the qualifications of this standard. The procedure must have prior written approval by the medical director of the appropriate department or service, and there must be written authority, policy, and procedures for designating technologists who perform such procedures.

The radiation exposure to the patient shall be the minimum required for the procedure being performed. Appropriate collimation should be used for the imaging task to reduce the size of the irradiated area when possible. The patient should be positioned as close as reasonably possible to the image receptor. Patient radiation exposure rate information that is based on measurements by the medical physicist should be readily available to the physician performing the procedures.

All personnel in the room during fluoroscopic procedures must wear a radiation protective apron. An apron with a lead equivalence of at least 0.35 mm is recommended. Thyroid and eyes should be protected if the potential exposure to the worker will exceed 25% of the annual regulatory dose limits for those organs. Protective aprons

and gloves shall be monitored at least annually for lead protection integrity.

Personnel routinely involved in fluoroscopic procedures must also be provided with at least one personnel radiation monitor approved by NVLAP (National Voluntary Laboratory Accreditation Program). Individuals must comply with state regulations regarding monitor placement. If a single monitor is normally worn outside the apron at the collar level, the institution or facility should consider providing additional monitors to be worn behind the apron for personnel involved in vascular interventional procedures and for pregnant personnel. Physicians who frequently perform interventional vascular, biliary tract, or genitourinary tract procedures should wear a finger monitor. The monitor should consistently be worn in the same location.

Special attention should be given to proper adjustment of X-ray tube voltage and current to reduce exposure rates. This is especially important for pediatric patients on systems with manual settings. Whenever possible, "last image hold" should be employed. Spot films or digital spot films should only be obtained when higher detail is needed. Full-time fluoroscopy should only be used sparingly.

Mobile X-ray fluoroscopic equipment shall be used only in rooms that provide shielding appropriate for the work load of the unit.

### V. EQUIPMENT SPECIFICATIONS

Examinations must be performed only with fluoroscopic image intensification and with radiographic equipment meeting all applicable federal and state radiation requirements. Equipment with "last image hold" capability is recommended.

Equipment must provide fluoroscopic image quality and recording (film, video, or digital) capability that is adequate for the procedures performed. Fluoroscopic equipment requirements for specific radiologic examinations are found in the guidelines or standards for those examinations. Equipment incapable of operating at tube voltages of at least 100 kVp must not be used for examinations other than for distal extremities.

Equipment performance monitoring should be in accordance with the [ACR Technical Standard for Diagnostic Medical Physics Performance Monitoring of Radiographic and Fluoroscopic Equipment](#).

New fluoroscopic systems used for vascular imaging procedures and systems capable of radiation exposure rates greater than 10 roentgens per minute at a distance of 30 cm from the image intensifier should be provided with

automated means of determining and displaying dose or dose-area-product to the physician guiding the fluoroscopic procedure.

## VI. DOCUMENTATION

Radiation dose related information provided by automated dosimetry systems should be recorded in the patient's permanent record for procedures involving more than 10 minutes of fluoroscopic exposure. If automated dosimetry data is not available, fluoroscopic exposure times should be recorded in the patient's medical record for such procedures.

In interventional procedures in which areas of skin are likely to receive a dose greater than 2 gray (200 rad), the location of those areas should be indicated in the medical record and provisions made for follow-up of those areas for determining radiation effects. In such circumstances there should be documentation in the medical record that the patient was advised of the potential for radiation injury to the skin and instructions given for proper follow-up. In repeat high-dose procedures, e.g., TIPS, consideration should be given to previous skin exposure.

## VII. RADIATION SAFETY IN IMAGING

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

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

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

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education Concerns

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

The quality assurance program should include the review of personnel radiation monitor results and patient radiation exposure and/or complications.

## ACKNOWLEDGEMENTS

This standard was developed according to the process described in the ACR Practice Guidelines and Technical Standards book by the Guidelines and Standards Committee of the Commission on Medical Physics.

Principal Drafter: Richard A. Geise, PhD

### Guidelines and Standards Committee

Nicholas Detorie, PhD, Chair

Robert L. Dixon, PhD

Laurie Elizabeth Gaspar, MD

Michael T. Gillin, PhD

John S. Kent, MS

Paul A. Larson, MD

Sandra B. McIntosh, PhD

Tariq A. Mian, PhD

Thomas G. Ruckdeschel, MS

Guy H. Simmons, PhD

Richard L. Morin, PhD, Chair, Commission

Charles K. Grimes, MD, CSC

## REFERENCES

1. Brinker JA, Pepine CJ, Block PC, et al. The use of radiographic devices by cardiologists: position statement. *J Am Coll Cardiol* 1995;25:1738-1739.
2. Cardella JF, Casarella WJ, DeWeese JA, et al. Optimal resources for the examination and endovascular treatment of the peripheral and visceral vascular systems. AHA intercouncil report on peripheral and visceral angiographic and interventional laboratories. *Circulation* 1994;89:1481-1493.
3. *Efficacy and Radiation Safety in Interventional Radiology*. Boston, Mass: World Health Organization; 2000.
4. *Exposure of the U.S. Population from Diagnostic Medical Radiation*. Bethesda, Md: National Council on Radiation Protection and Measurements; NCRP Report 100; 1989.
5. *Important Information: Recording Information in the Patient's Medical Record that Identifies the Potential for Serious X-ray-induced Skin Injuries Following Fluoroscopically Guided Procedures*. Rockville, Md: Food and Drug Administration; 1995.
6. Knautz MA, Abele DC, Reynolds TL. Radiodermatitis after transjugular intrahepatic portosystemic shunt. *South Med J* 1997;90:352-356.

7. Lichtenstein DA, Klapholz L, Vardy DA, et al. Chronic radiodermatitis following cardiac catheterization. *Arch Dermatol* 1996;132:663-667.
8. *Managing the Use of Fluoroscopy in Medical Institutions*. College Park, Md: American Association of Physicists in Medicine; AAPM Report 58; Task group 6, 1998.
9. *Public Health Advisory: Avoidance of Serious X-ray Induced Skin Injuries to Patients During Fluoroscopically Guided Procedures*. Rockville, Md: Food and Drug Administration; 1994.
10. *Radiation Protection for Medical and Allied Health Personnel*. Bethesda, Md: National Council on Radiation Protection and Measurements; NCRP Report 105; 1989.
11. Rosenthal LS, Beck TJ, Williams J, et al. Acute radiation dermatitis following radiofrequency catheter ablation of atrioventricular nodal reentrant tachycardia. *Pacing Clin Electrophysiol* 1997;20:1834-1839.
12. Shope TB. Radiation-induced skin injuries from fluoroscopy. *RadioGraphics* 1996;16:1195-1199.
13. Sovik E, Klow NE, Hellesnes J, et al. Radiation-induced skin injury after percutaneous transluminal coronary angioplasty. *Acta Radiol* 1996;37:305-306.
14. Wagner LK, Archer BR. *Minimizing Risks from Fluoroscopic X-rays; Bioeffects, Instrumentation, and Examination: a Credentialing Program from Physicians*. 3rd edition. Houston, Tex: Partners in Radiation Management; 2000.
15. Wagner LK, Eifel PJ, Geise RA. Potential biological effects following high X-ray dose interventional procedures. *J Vasc Interv Radiol* 1994;5:71-84.

The unit of ED is the sievert (Sv), though the older unit, the rem, is still in use. An accident that results in a whole body exposure of 4 Sv is very serious, perhaps life threatening. An accident resulting in a dose of 4 Sv only to the hand is serious but not life threatening.

Equivalent dose: different radiations have different biological effects as their energy is absorbed in tissue. For example, as a result of energy deposition differences, 1 Gy of alpha radiation produces much more severe reactions than 1 Gy of X or gamma radiation. This difference is adjusted by a quality factor (QF). The dose in rads times the QF yields the rem (radiation equivalent, man). The international unit for this radiation equivalency is the sievert (Sv) and is appropriately utilized when estimating long-term risk of radiation injury. Since the QF for X-ray or gamma radiation equals 1, then for pure gamma radiation: 100 rad = 100 cGy = 1,000 mGy = 1 Sv = 100 rem.

Exposure: a quantity used to indicate the amount of ionization in air produced by X-ray or gamma radiation. The unit is the roentgen (R). For practical purposes, one roentgen is comparable to 1 rad or 1 rem for X and gamma radiation. The SI (Système International d'Unités or international system of units) unit of exposure is the coulomb per kilogram (C/kg). One R =  $2.58 \times 10^{-4}$  C/kg.

Free-in-air dose: the radiation measured in air at any one specific point in space. Free-in-air dose is very easy to measure with current field instruments, and more meaningful doses such as midline tissue dose or dose to the blood-forming organs may be estimated by approximation.

Principles of dose reduction: the three factors of radiation dose reduction are time, distance, and shielding. Reduction of radiation exposure comes about by reducing the time of exposure and increasing the distance of the exposed from the radiation source and the amount of shielding between the source and the individual.

## APPENDIX A

### Quantities and Units – Definitions

Dose: a general term for the quantity of radiation or energy absorbed per unit mass. The unit of dose is the gray (Gy). An older unit still used in the literature is the rad (radiation absorbed dose). 1 Gy = 100 rad.

Dose rate: the dose of radiation per unit of time.

Effective dose (ED): ED must be calculated. It cannot be measured. It is calculated by multiplying actual organ doses by *tissue weighting factors*, which indicate each organ's relative sensitivity to radiation, and adding up the total of all the numbers. The sum of the products is the *effective whole-body dose* or simply *ED*. These weighting factors are designed so that the *ED* represents the dose that the total body could receive (uniformly) that would yield the same cancer risk as various organs getting different doses.