Radiation Safety in Surgery
a view based on NCRP - 168

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No conflict of interest

Learning Objectives
- Understand the responsibilities of surgeons and others working in a FGI environment toward patient and worker radiation safety.
- Understand radiation protection requirements and actions necessary for personal safety while radiation is in use in the surgical environment.
- Gain familiarity with the knowledge base needed to safely perform or supervise FGA procedures in the surgical environment.
Operational and Training Resources

- NCRP-168 [2010]
  Radiation Dose Management for Fluoroscopically-Guided Interventional Procedures
- ICRP-117 [2010]
  Radiological Protection in Fluoroscopically Guided Procedures outside the Imaging Department
- AAPM TG-124 (in progress)
  A Guide for Establishing a Credentialing and Privileging Program for Users of Fluoroscopic Equipment in Healthcare Organizations
- VHA HANDBOOK 1105.04 [2012]
  Fluoroscopy Safety

Topics

- Surgical environments and related X-ray equipment
- Staff radiation monitoring
- Training & credentials
- Privileges
- Supervision

Environment and Equipment

- Surgical environments
  - Bedside
  - Emergency department
  - Traditional operating room
  - Hybrid operating room
- Equipment
  - Basic & advanced mobile C-arm
  - Fixed C-arm (usually with CBCT)
  - Full function CT
Wide range of even mobile equipment

Equipment selection

- An FGI procedure should be classified as a potentially-high radiation dose procedure if more than 5% of cases of that procedure result in $K_{aa}$ exceeding 3 Gy or $P_{ka}$ exceeding 300 Gy cm$^2$.
- If fluoroscopes are used routinely for procedures that have the potential for high patient doses, either they should be equipped to monitor $K_{aa}$ or they should be replaced.
- Fluoroscopes that are routinely used for pediatric procedures should be appropriately designed, equipped and configured for this purpose.

Wide range of environments
Operational Radiation Safety

- Each individual present in an FGI-procedure room while a procedure is in progress shall have appropriate radiation protection training.
- Each individual present in an FGI-procedure room while a procedure is in progress shall be provided with and shall use appropriate radiation protective equipment.

Staff Radiation Monitoring

- Determinations shall take into account the personal protective equipment used by each individual in order to properly assess compliance with occupational dose limits.
- Two personal dosimeters, one worn under the protective apron and a second worn at neck level outside protective garments, are preferred and should be used.
- Readings above or below the expected range (for the job) should be investigated.
Training

Risk based depth of training
- Patient safety
- Worker protection

Training Process

- Initial training
- Recurrent training
- Check flight on ‘new to you’ equipment
- Credentialing examination

Generic rad safety lectures are inappropriate

- Striking lack of really fundamental knowledge (including radiologists)
- Alphas and neutrons are seldom used for fluoroscopic purposes!
- No need to cover nuclear medicine and radioactive waste topics.
From a pretest

When you take your foot off the x-ray pedal, what occurs?
- X-rays (primary and secondary) immediately disappear.
- X-ray production slowly fades away over several seconds.
- X-rays are no longer produced but many continue to scatter around in the room for several seconds.
- X-ray production ceases but the patient emits radiation with a half-life of six hours.

Didactic Curriculum

- Physics of x-ray production and interaction;
- Technology of fluoroscopy machines, including modes of operation;
- Characterization of image quality and technical factors affecting image quality in fluoroscopy;
- Dosimetric quantities and units;
- Health effects of radiation;
- Principles of radiation protection in fluoroscopy;
- Applicable federal, state, and local regulations and requirements; and
- Techniques for minimizing dose to the patient and staff.

Hands-on training

- Training on the operation of each fluoroscope that is to be used clinically
  - Use of controls
  - Activation of various modes of operation
  - Radiation dose displays
  - Mechanical motions
  - Configuring system for clinical use
  - First level response to special situations.
- Influence of settings and geometry on patient and staff dose rates
Essential Safety-Related Knowledge

Privileges

- Clinical
  - Includes clinical experience with radiation use for specific procedures
- Appropriate radiation credentials
  - General
    - ‘Pilots license’ for each fluoroscope
- Recurrent training should be part of routine privilege review.

Supervision

- An FGI procedure shall be performed or supervised only by a physician or other medical professional with fluoroscopic and clinical privileges appropriate to the specific procedure.
Levels of supervision

TABLE 6.1—Levels of supervision for diagnostic x-ray tests, diagnostic laboratory tests and other diagnostic tests as defined by the Centers for Medicare and Medicaid Services (CMS, 2005).

- General supervision means the procedure is finished under the physician’s overall direction and control, but the physician’s presence is not required during the performance of the procedure. Under general supervision, the training of the nonphysician personnel who actually perform the diagnostic procedure and the maintenance of the necessary equipment and supplies are the continuing responsibility of the physician.

- Direct supervision in the office setting means the physician is required to be present in the office suite and immediately available to furnish assistance and direction throughout the performance of the procedure. It does not mean that the physician is required to be present in the room when the procedure is performed.

- Personal supervision means a physician is required to be in attendance in the room during the performance of the procedure.

Who can do what

- Highly variable due to differences in State regulations
  - X-ray technologists
  - Surgical technologists
  - Nurses
  - Mid-level practitioners
- Perhaps fluoro privileges for any permitted job title should be based on risk and supervision.

Responsibilities

- Primary operator (surgeon)
  - Patient: during and after the procedure
  - Staff: during the procedure
- Technical staff
  - Equipment configuration, technique optimization, etc.
- All staff
  - Personal radiation protection
  - Communication when appropriate to improve patient or worker safety
Radiation risk

- Radiation is not the only risk in the surgical environment.
- Radiation is seldom the major risk for either patients or staff.
- Optimizing overall safety requires much more than ALARA.