Fluoroscopy
“Minimizing Dose”
Minimizing Risks from Fluoroscopic Procedures

Physicians involved in performing diagnostic and interventional procedures that require the use of fluoroscopy must be aware of the risks associated with radiation exposure to the patient, the physician and the staff. Knowledge of core principles associated with radiation exposure during fluoroscopy is essential for obtaining the required image quality while minimizing the dose and duration of radiation exposure. In conjunction with these core principles, a working knowledge of exposure thresholds for deterministic response to ionizing radiation is necessary.

Recent incidents have been well documented that describe serious systemic illness and localized injuries that resulted from exposure to radiation during fluoroscopy. This program will provide an overview of ALARA (as low as reasonably achievable); a concept that encourages the consideration of every factor that might affect exposure to radiation. ALARA minimizes the risk to patient, physician and staff. This program will describe areas to help provide safe use of fluoroscopic equipment.

Why is this important?

In March, 2009, the National Council on Radiation Protection and Measurement released a critical report that indicated that radiation dose to the United States population had risen dramatically since the early 1980’s.

IR procedures are the third largest contributor to medical radiation to the US public. Children are more sensitive to radiation effects and have a longer life span during which manifest possible changes as a result of radiation exposure.

Children who undergo interventional procedures may have a chronic illness and receive a higher lifetime cumulative dose secondary to repeat procedures and exposure.
Objectives

- Describe available radiation dose monitoring strategies.
- Understand the importance and methods of pre-procedure patient assessment including a review of previous radiologic exams, disease processes and anatomical considerations that may increase sensitivity to radiation.
- Define deterministic risk thresholds (and their different reporting metrics/metrics hierarchy) that are considered to be an SRDL (substantial radiation dose level).
- Utilize radiation safety principles to reduce the amount of radiation used to achieve desired clinical result.
- Plan patient follow up activities for any SRDL to include periodic patient assessments for signs and symptoms of radiation deterministic response in the area of procedure.
- Define a personal plan for minimizing exposure to radiation for self and others assisting in a given procedure in accordance with evidence based standards.
Modern fluoroscopic equipment is capable of delivering very high radiation doses.

Adverse radiation effects are often misdiagnosed, they occur infrequently but have the potential for serious complications.

There have been serious skin injuries in patients undergoing fluoroscopically guided procedures.

Deterministic injuries can be severe requiring multiple interventions and cause permanent disfigurement. Frequency is estimated between 1:10,000–1:100,000. The true risk is unknown because these injuries are often not recognized or reported.

Clinical Radiation Management for Fluoroscopically Guided Interventional Procedures Vol. 257 p. 332 November 2010
While many patients derive great benefit from fluoroscopically guided procedures, some suffer injuries.

Exposure to radiation should produce sufficient benefit to offset the risk.

Dose management should be employed anytime ionizing radiation is used for clinical purposes.

Any exposure to ionizing radiation should adhere to the ALARA (as low as reasonably achievable) principle.

As procedures have become increasingly complex, they have greater opportunity to cause harm.

Management of the use of radiation must also ensure adequate safety of the medical personnel involved in these procedures.

Clinical Competence statement on physician knowledge to optimize patient safety and image quality in fluoroscopically guided invasive cardiovascular procedures. Circulation February 1, 2005
Why Training?

Core Imaging Techniques

- X-Ray Fluoroscopy
- X-Ray Cinefluorography

Makes invasive cardiovascular procedures possible
By late 1994, the Food and Drug Administration (FDA) had received a sufficient number of reports of injuries to call attention to the problem with an advisory that later appeared on the Web site (http://www.fda.gov/cdrh/fluor.html).

Injuries cited in the literature and the FDA are likely only a small fraction of the total that actually occur. In addition, it may be suspected that there is the potential for X-ray–guided procedures to cause other less clearly attributable adverse effects, such as neoplasia.

The core principle governing the use of ionizing radiation is ALARA (As Low As Reasonably Achievable).

The ALARA principle confers a responsibility on all physicians to minimize the radiation injury hazard to their patients, to their professional staff, and to themselves.
Why Training

To practice the ALARA Principle the physician must possess a basic knowledge

How to operate the X-Ray equipment and use its Dose saving features (including but not limited to)

- Collimation
- FPS
- SID
- MAG
- Cine
- Table height
- Last image hold

Understanding of:

- Radiation Physics
- Radiation Biology
- Radiation Safety
- X-Ray Image Formation

ACCF/AHA/HRS/SCAI
Basic Principles of Radiation in the Fluoroscopy Setting
The International Commission on Radiological Protection (ICRP) defines fluoroscopically-guided interventional procedures as “procedures comprising guided therapeutic and diagnostic interventions, by percutaneous or other access, usually performed under local anesthesia and/or sedation, with fluoroscopic imaging used to localize the lesion/treatment site, monitor the procedure, and control and document the therapy”.

## Potentially High Dose FGI Procedures

<table>
<thead>
<tr>
<th>Pacemaker Placement</th>
<th>Pulmonary Embolization</th>
<th>Percutaneous Jejunostomy</th>
<th>Nephrostomy</th>
<th>Venous Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thrombolysis</td>
<td>Tumor Ablation</td>
<td>Pulmonary Angiography</td>
<td>Nerve Blocks</td>
<td>Biopsy</td>
</tr>
<tr>
<td>Embolization</td>
<td>Angioplasty</td>
<td>Percutaneous Biliary Drainage</td>
<td>Vertebroplasty</td>
<td>Fluid Collection Aspiration</td>
</tr>
<tr>
<td>Thoracentesis</td>
<td>Stent Placement</td>
<td>Stone Extraction</td>
<td>Kyphoplasty</td>
<td>Abscess Drainage</td>
</tr>
<tr>
<td>Percutaneous Gastrostomy</td>
<td>Radiofrequency Ablation</td>
<td>Inferior Vena Cava Filter Placement</td>
<td>Diagnostic Angiography</td>
<td>Hysterosalpingography</td>
</tr>
<tr>
<td>Chest – Tube Placement</td>
<td>Stent–Graft Placement</td>
<td>Transjugular Intrahepetic Porosystemic Shunt</td>
<td>Diagnostic Venography</td>
<td>Percutaneous Cholecystostomy</td>
</tr>
</tbody>
</table>

Interventional procedures are always performed by a physician.

Simple low dose fluoroscopic imaging (i.e. barium swallow) may be performed by a qualified non-physician practitioner.

Each state independently defines those non-physicians.

Facilities may elect to further limit fluoroscopic privileges (physicians and non-physicians) to individuals with specific credentials.

Interventionalists vary in their level of training in radiation safety.

Interventional cardiology fellows receive training in radiation physics and safety.
Complying with Joint Commission Standard

- Joint Commission has identified peak skin dose > 15 Gy as a sentinel event.
- Sentinel Event: Prolonged fluoroscopy with cumulative dose >1500 rads to a single field or any delivery of radiotherapy to the wrong region or > 25% above the planned dose.
- Can be associated with death or major permanent loss of function.
- Outcomes often occur for months or years after the event.
- The parameters related to the Fluoroscopy dose are set higher than relevant practice guidelines as the Sentinel Events Policy goal is to promote patient safety improvement not regulate practice.
- Should only occur in extreme cases, is considered to be preventable and is reviewable under the Sentinel event policy via root cause analysis.
- Underreported

http://www.jointcommission.org/assets/1/18/Radiation_Overdose.pdf
### Radiation-Induced Skin Injuries – FDA

<table>
<thead>
<tr>
<th>Effect</th>
<th>Typical Threshold Absorbed Dose (Gy)*</th>
<th>Hours of Fluoroscopic &quot;On Time&quot; to Reach Threshold* at:</th>
<th>Time to Onset of Effect++</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Usual Fluoro Dose Rate of 0.02 Gy/min (2 rad/min)</td>
<td>High-Level Dose Rate of 0.2 Gy/min (20 rad/min)</td>
</tr>
<tr>
<td>Early transient erythema</td>
<td>2</td>
<td>1.7</td>
<td>0.17</td>
</tr>
<tr>
<td>Temporary epilation</td>
<td>3</td>
<td>2.5</td>
<td>0.25</td>
</tr>
<tr>
<td>Main erythema</td>
<td>6</td>
<td>5.0</td>
<td>0.50</td>
</tr>
<tr>
<td>Permanent epilation</td>
<td>7</td>
<td>5.8</td>
<td>0.58</td>
</tr>
<tr>
<td>Dry desquamation</td>
<td>10</td>
<td>8.3</td>
<td>0.83</td>
</tr>
<tr>
<td>Invasive fibrosis</td>
<td>10</td>
<td>8.3</td>
<td>0.83</td>
</tr>
<tr>
<td>Dermal atrophy</td>
<td>11</td>
<td>9.2</td>
<td>0.92</td>
</tr>
<tr>
<td>Telangiectasis</td>
<td>12</td>
<td>10.0</td>
<td>1.00</td>
</tr>
<tr>
<td>Moist desquamation</td>
<td>15</td>
<td>12.5</td>
<td>1.25</td>
</tr>
<tr>
<td>Late erythema</td>
<td>15</td>
<td>12.5</td>
<td>1.25</td>
</tr>
<tr>
<td>Dermal necrosis</td>
<td>18</td>
<td>15.0</td>
<td>1.50</td>
</tr>
<tr>
<td>Secondary ulceration</td>
<td>20</td>
<td>16.7</td>
<td>1.67</td>
</tr>
</tbody>
</table>

* The unit for absorbed dose is the gray (Gy) in the International System of units. One Gy is equivalent to 100 rad in the traditional system of radiation units.
+ Time required to deliver the typical threshold dose at the specified dose rate.
++ Time after single irradiation to observation of effect.
Roentgen (R): this classical unit of exposure has been replaced because it only represented the amount of ionizations collected in air from x-rays.

rad: a unit of dose describing the absorbed dose (100 ergs/gm)

rem: a unit of effective dose (E) which includes the aspect of biological risk. 1 rem = 1 rad x QF, where QF is the quality factor that includes risk estimates. For medical x-rays, QF=1, so 1 rad = 1 rem

The SI (systems international) equivalent for the rad is the gray (Gy) and for the rem is the sievert (Sv).

100 rads is equal to 1 Gy.

Most modern equipment reports dose in SI units.
**Radiation Physics and Dosimetry**

**Explanation of Radiation Dose**

- **DAP**: Provides information on the total amount of radiation existing the x-ray tube. (primary beam dose x the area of the beam)

- **Air Kerma**: Is the dose to a point above the tube known as the IRP or interventional reference point.

- **Absorbed Dose**: The concentration of energy deposited locally in tissue.

- **Equivalent Dose**: Designed for radiation types with notably different properties that interact aggressively with organs and tissue.

- **Effective Dose**: The attributed whole body dose for the purpose quantifying health risk.

- **Fluoroscopy Time**: Poor indicator of dose.
What are the Risks?
Radiation induced cancer

- Radiation induced heritable effects

Radiation induced injuries
Radiation Physics and Dosimetry

Two Broad Classifications

**Deterministic**
- Known threshold
- Biological Response

**Stochastic**
- Cumulative long term effect
- Avg. 10-20 year latency period

Radiation Health Effects
# Effects of Radiation on Patient

## Skin and Hair (Deterministic Effects)

### TABLE II. Chronology and Severity of Tissue Reactions From Single-Delivery Radiation Dose

<table>
<thead>
<tr>
<th>Single site (Gy) acute skin dose</th>
<th>Prompt (&lt;2 weeks)</th>
<th>Early (2–8 weeks)</th>
<th>Mid term (6–52 weeks)</th>
<th>Long term (&lt;40 weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–2</td>
<td>No observable effects expected</td>
<td>Epilation</td>
<td>Recovery from hair loss</td>
<td>None expected</td>
</tr>
<tr>
<td>2–5</td>
<td>Transient erythema</td>
<td>Epilation</td>
<td>Recovery; high doses cause prolonged erythema and permanent partial epilation</td>
<td>Recovery; higher dose cause dermal atrophy/induration</td>
</tr>
<tr>
<td>5–10</td>
<td>Transient erythema</td>
<td>Erythema, epilation</td>
<td>Prolonged erythema permanent epilation</td>
<td>Telangiectasia; dermal atrophy/induration</td>
</tr>
<tr>
<td>10–15</td>
<td>Transient erythema</td>
<td>Erythema, epilation; dry/moist desquamation</td>
<td>Dermal atrophy with secondary ulceration; atrophy/induration; High dose dermal necrosis surgical repair likely</td>
<td>Telangiectasia; dermal</td>
</tr>
<tr>
<td>&gt;15</td>
<td>Transient erythema; Very high dose causes moist desquamation edema/ulceration</td>
<td>Erythema, epilation</td>
<td></td>
<td>Late skin breakdown</td>
</tr>
</tbody>
</table>

A. Dry desquamation (Poikiloderma) at one month in a patient receiving ~11 Gy calculated peak skin dose.

B. Skin Necrosis at 6 months in a patient who received ~18 Gy calculated peak skin dose.
A little can equal a lot.

There are two very important facts about radiation-induced effects:

No sensation of temperature rise at the time of irradiation

A long delay almost always occurs between irradiation and manifestation.
How are Staff and Physicians affected?
There are documented cases of Interventionalist injuries from fluoroscopic/x-ray usage. One of these cases was of a physician’s hands that lead to premature death at age 40.

Legs of an interventional cardiologist in Yerevan, Armenia as collected by Dr. Madan Rehani, IAEA through Dr. Vahan Mkhitarian, showing hair loss primarily in right leg.
The cataract has so far been considered to be a deterministic effect with threshold. Doses received by interventionalist and some paramedical staff may exceed these currently accepted international standards unless specific measures are taken.”
<table>
<thead>
<tr>
<th>Tissue</th>
<th>Risk</th>
<th>NCRP</th>
<th>ICRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupational</td>
<td>Stochastic</td>
<td>50 mSv yr(^{-1})</td>
<td>100 mSv (5 yr(^{-1}))</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 mSv × Age (yr)</td>
<td></td>
</tr>
<tr>
<td>Lens of eye</td>
<td>Cataract</td>
<td>150 mSv yr(^{-1})</td>
<td></td>
</tr>
<tr>
<td>Extremities</td>
<td>Stochastic</td>
<td>500 mSv yr(^{-1})</td>
<td></td>
</tr>
<tr>
<td>Embryo-fetus(^a)</td>
<td>Stochastic</td>
<td>0.5 mSv month(^{-1})</td>
<td>1 mSv per term</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 mSv per term(^b)</td>
<td></td>
</tr>
<tr>
<td>General public</td>
<td>Stochastic</td>
<td>1 mSv yr(^{-1})</td>
<td></td>
</tr>
</tbody>
</table>

10 mSv = 1 rem; Sources NCRP 116; ICRP 103.

\(^a\)After declaration of pregnancy
\(^b\)NRC recommendation.
Dose Factors and Reduction
Factors that Affect Dose

- X-ray tube (under table) distance to patient (table as far from tube as practical)
- Receptor (above table) distance to the patient (as close to patient as possible)
- Collimation
- Operator height
Factors that Affect Dose

- Patient size
- Steep Imaging Angles
- Magnification
  - Electronic magnification
  - Geometric magnification
Figure 5. Effect of electronic magnification on entrance skin dose.

Entrance skin dose (arb. units)

- Normal (23 cm)
- Mag 1 (15 cm)
- Mag 2 (11 cm)

4.4 x dose @ 23 cm
2.4 x dose @ 23 cm
Figure 4. Effect of geometric magnification on entrance skin dose.

Position 1:
SEE = 1.0 dose units
Magnification = 1.25

Position 2:
SEE = 1.8 dose units
Magnification = 1.67

Position 3:
SEE = 4.0 dose units
Magnification = 2.50

Mahesh M Radiographics 2001;21:1033–1045
Factors that Affect Dose

- Protocol Settings
  - Fluoroscopic pulse
  - Detail setting
  - Dose setting
  - Dose management

Effect of pulsed fluoroscopy on entrance skin dose. For example, by switching from continuous fluoroscopy (Cont Fluoro) mode to 15 pulses per second, dose savings of nearly 22% are achieved.
Factors that Affect Dose

Strategies to Reduce Radiation Exposure to Patient and Operator

Precautions to minimize exposure to patient and operator:

- Utilize radiation only when imaging is necessary to support clinical care
- Minimize use of cine
- Minimize use of steep angles of X-ray beam
- Minimize use of magnification modes
- Minimize frame rate of fluoroscopy and cine
- Keep image receptor close to the patient
- Utilize collimation to the fullest extent possible
- Monitor radiation close in real time to access patient risk/benefit during the procedure

Precautions to specifically minimize exposure to operator:

- Use appropriate protective barriers (apron, thyroid, glasses, built ins)
- Maximize distance of operator from X-ray source and patient
- Keep above and below table in optimal position at all times
- Keep all body parts out of the field of view at all times

Precautions to specifically minimize exposure to patient:

- Keep table height as high as comfortably possible for the operator vary the imaging beam angle to minimize exposure to any one skin area
- Keep patient’s eyes as well as extremities out of the beam
Factors that Affect Dose

- Time on pedal
  The Golden Rule “Keep beam on time to a minimum”
  Incremental verbal notifications can increase awareness and decrease dose.
  - Over-use of cine as a substitute for fluoroscopy results in excessive dose management.

<table>
<thead>
<tr>
<th>Dose Metric</th>
<th>First Notification</th>
<th>Subsequent Notifications (increments)</th>
<th>SRDL</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D_{\text{min, max}}$</td>
<td>2 Gy</td>
<td>0.5 Gy</td>
<td>3 Gy</td>
</tr>
<tr>
<td>$K_{\text{vJ}}$</td>
<td>3 Gy</td>
<td>1 Gy</td>
<td>5 Gy</td>
</tr>
<tr>
<td>$P_{\text{EA}}$</td>
<td>300 Gy cm$^2$</td>
<td>100 Gy cm$^2$</td>
<td>500 Gy cm$^2$</td>
</tr>
<tr>
<td>Fluoroscopy time</td>
<td>30 min</td>
<td>15 min</td>
<td>60 min</td>
</tr>
</tbody>
</table>

NCRP report #168 appendix M and table 4.7
How do we protect and educate our patients and what history is pertinent to an increased sensitivity to radiation?
Radiation dose management
Previous Exam Radiation data
Patient Information brochure
Radiation risk statement on consent
Discharge Instructions (What to look for statement)
Dose documentation
Pre-procedure issues that may make a patient’s skin more sensitive to radiation exposure.

- History of skin rashes
- Lupus or Scheroderma
- Diabetes mellitus
- Obesity
- Polymyositis
- Dermatomyositis
- Consider other procedures during the last 12 months
Patient Dose Management Processes

• Procedure Issues
  • Is there multi-vessel involvement
  • Are there any stents or other pertinent equipment not available
  • Can the tube angle be varied (RAO vs.

• Post-procedure issues
  • Does the patient need to return for additional interventions
  • Was this an SRDL procedure requiring patient notification and monitoring
Patient Dose Management Processes

- Begin with assessment of risk/benefit ratio of procedure
- Informed consent should include risk information
  - Procedure performed using ionizing radiation in form of x-rays
  - X-rays delivered to guide equipment and store images
  - Physician will deliver dose required to perform procedure
  - Short and long-term risk exists
    - significant injury is rare
    - if injury occurs, additional follow-up and treatment may be required
Post-Procedural Radiation Dose Management

- All patient radiation should be part of the medical record.
- If an SRDL (5 Gy total procedure, 3 Gy to any one site, or 60 minutes of fluoro if no other method is available) was exceeded during the procedure the interventionalist should note the patient record immediately following the procedure with a reason.
- Patients or caregivers should be notified of an SRDL being exceeded prior to discharge.
- All reports should have the radiation dose included.
- Communication with the primary care provider should occur when certain dose limits are exceeded.
Post–Procedure Radiation Dose Management

- Post–procedure patient follow–up for a minimum of 1 year is suggested when an SRDL limit is exceeded.
- Adverse tissue effect is best assessed by physical examination (in the area of the procedure) and referral to a specialist who is aware of potential etiology as needed.
- Biopsy is to be avoided unless required.
## Suggested values for first and subsequent notifications and the SRDL.

<table>
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<tr>
<th>Dose Metric</th>
<th>First Notification</th>
<th>Subsequent Notification (increments)</th>
<th>SRDL</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D_{\text{skin,max}}$ (single site)</td>
<td>2 Gy</td>
<td>0.5 Gy</td>
<td>3 Gy</td>
</tr>
<tr>
<td>$K_{a,r}$ (air kerma)</td>
<td>3 Gy</td>
<td>1 Gy</td>
<td>5 Gy</td>
</tr>
<tr>
<td>$PKA$ (DAP)</td>
<td>300 Gy cm² b</td>
<td>100 Gy cm²</td>
<td>500 Gy cm²</td>
</tr>
<tr>
<td>Fluoroscopy time</td>
<td>30 min</td>
<td>15 min</td>
<td>60 min</td>
</tr>
</tbody>
</table>
Protecting the Physician and Staff
Personal Protective Devices

- Lead apron
- Thyroid shield
- Leaded glasses
- Protective eye wear
- Leaded sterile gloves
- Movable or mobile leaded shields
- The whole body shield

NCRP No. 168 section 5.5
Protect Yourself....

- Always use appropriate radiation protection barriers

  - Lead Shield
  - Lead Goggles
  - Thyroid Shield
  - Lead Apron
There are time-tested principles to radiation safety that are foundational to any program and should be used to help maximize personal safety.

These time-tested principles will lower dose and increase personnel safety.
Personal Safety

- Protective garments protect gonads and 80% of the active bone marrow
- Standard 0.5mm lead apron stops 95% of scatter radiation
- Thyroid shielding
- Eye protection
- Fixed barriers below table
- Transparent ceiling–mounted shielding
- Movable barriers
Pregnant Personnel

- **Pregnancy**
  - May require special fitting lead aprons (may also double aprons if coverage is appropriate)
  - Avoidance of procedures should be based on facility policy as advised by the RSO, medical physicist, physician participants and additional members of the Radiation Safety Committee. Dosimetry history of the participant should also be considered.
Pregnant Personnel

- Pregnant employees
  - Should declare pregnancy in writing for additional considerations (appropriate state or NRC regulations should be consulted for detailed information regarding requirements)
  - Unlawful to prevent an un-declared worker, who may have exceeded the recommended conceptus threshold, from working with ionizing radiation.
  - Specific dosimeter (additional badge under lead apron at the waist level)
  - Specific exposure limits if pregnancy is declared in writing by worker.
Education of Physicians and Staff Involved

- Annual Radiation Safety Training
- Equipment competencies
- Coordinate with radiation safety officer
- Didactic training or verification of prior training
- Periodic updates
- Hands-on training for new personnel or equipment
- Documentation of training
Dosimetry Education for Physicians and Staff

- **Personal Dose Monitors**
  - Individual’s responsibility, Institution should enforce
  - Reviews should be made of unusually high exposures and exposures exceeding established level 1 or 2 thresholds, as well as exceptionally low or unused exposure records.
  - Two dosimeters are recommended for participants using **lead aprons** (under protective garment at waist, over protective garment at collar)
  - Reports reviewed by Radiation Safety Officer and reported to committee and participant as required
  - Lifetime personal exposure records
  - Metered Exposure report combines multiple institutions (using same dosimetry provider)
Education for Physicians and Staff Involved

- **Physician Credentialing Opportunities**
  - **FDA** “That all facilities assure appropriate credentials and training for physicians performing fluoroscopy” (1), (4)
  - **ACCF/AHA/HRS/SCAI FLUOROSCOPY CLINICAL COMPTENCE STATEMENT** “…employ a credentialing process to authorize physicians” (3)
  - **NCRP** (National Council on Radiation Protection) “credentialing and privileging physicians to use fluoroscopic equipment” (4)
  - “Every person who operates fluoroscopically guided equipment or supervises the use of fluoroscopically guided equipment shall have current training in the safe use of that specific equipment”. (4)
  - **ACR** (American College of Radiology) “Each facility should have a policy for credentialing all physicians who perform fluoroscopy” (4)
Administrative Regulatory Considerations
Review of Regulatory Considerations

- National Council on Radiation Protection and Measurement (NRCP)
- Food and Drug Administration (FDA)
- Manufacturer Requirements (currently employ audible signals at intervals indicating dose accumulation)
- Joint Commission (issue 47 August 24th 2011)
- ACCF/AHA/HRS/SCAI
Review of Professional Organizational Standards

- American College of Radiology (ACR)
- American College of Cardiology (ACC)
- American Heart Association (AHA)
- American Association of Physicists in Medicine (AAPM)
- National Council on Radiation Protection and Measurements (NCRP)
- International Commission on Radiological Protection (ICRP)
- The Alliance for Radiation Safety in Pediatric Imaging
- Society for Cardiac Angiography Interventions (SCAI)
What’s Next

It is paramount that we follow the **ALARA** principle and apply the safest practice of delivering radiation on behalf of the well-being of our patients.
What’s Next

New regulatory considerations, recommendations, equipment, and best practices should be monitored. This program should be reviewed annually and updated as appropriate.
Ten Safety Rules for Minimizing Risks from Fluoroscopic X-Rays

#1. Remember dose rates are greater and dose accumulates more rapidly as patient size and tissue penetration thickness increases.

#2. Set the dose and the dose rate controls for the best compromise in image quality and in radiation dose accumulation.

#3. Keep the beam-on time and the dose accumulation in a single area of the skin to the lowest level commensurate with the benefits of the procedure- The Golden Rule!

#4. Keep the patient at maximum practicable distance from the x-ray tube.

#5. Keep the image receptor as close to the patient as practicable.

#6. Don’t overuse geometric or electronic magnification. Collimate to the area of interest.

#7. If image quality is not compromised; remove the grid during procedures on small patients or when the image receptor cannot be placed close to the patient.

#8. Remain at least 6 feet from fluoroscopic area (when possible)

#9. Monitor radiation utilization and maintain a quality control program to assure radiation is managed properly.

#10. Commensurate with their duties, be sure personnel have mastered radiation safety and management.