Radiation Safety for the Spine Interventionalist
The Right Image at the Right Dose

Dose makes headlines
What is radiation?

**Radiation** is invisible energy that travels in the form of waves or high speed particles.

Also known as **ionizing radiation**, this has enough energy to break chemical bonds in molecules or remove tightly bound electrons from Atoms, thus creating charged molecules OR ATOMS (IONS).
Sources of Radiation Exposure

- Radon: 55%
- Cosmic: 8%
- Terrestrial: 8%
- Medical X-Rays: 11%
- Internal: 11%
- Other: <1%
- Consumer Products: 3%
- Nuclear Medicine: 4%
Delivering the proper amount of radiation is critical to producing superb image quality.
Why should we care about dose?

Physicians need fluoroscopy to perform Minimally Invasive Surgery (MIS)

They want the best I.Q. at lowest possible dose

Radiation dose is cumulative

High doses of radiation can be harmful to the body

Physicians and techs are in a radiation environment every day
Imaging challenges in the OR or procedures room

- Equipment & instrument crowding
- Exposure to patient, surgeons and staff
- Patient draping
- Limited options for patient positioning
X-ray Tube

Surgeon and staff normally receive scatter radiation

Patient receives primary radiation

Image Receptor

Primary Beam

Scatter Radiation

Leakage Radiation

Main source: patient

The Right Image at the Right Dose
Positioning & Set-up for Pain

The Right Image at the Right Dose

AP

Lateral

Oblique
Air Kerma Scatter Rates

9 Inch Image Intensifier
12 Inch Image Intensifier

33 mR/hr
67 mR/hr

163 mR/hr
248 mR/hr

523 mR/hr
1030 mR/hr

34 mR/hr
58 mR/hr

Inverse Square Principle – Distance reduces dose

Technique: Fluoroscopic 73kVp @ 2.4 ma
Phantom: ANSI Abdomen Phantom
Scatter radiation

Scatter radiation with X-ray tube on top

Scatter radiation with I.I. on top

Good radiation protection practices
Dose = Exposure Rate \times \text{Time}

What impacts dose?  
Exposure time  
Exposure amount

How can we reduce it?  
Minimize exposure time  
Minimize exposure amount

Take precautions!
Maximum dosimeter readings

MONTHLY 420 mrems
QUARTERLY 1250 mrems
YEARLY 5000 mrems
LIFETIME 5 rems x (n-18) where “n” is your age

These levels are the standards set by the federal government for radiation exposure to occupational personnel.

Dose = Amount of radiation received - mrem
Dose Rate = How fast you receive the dose - mrem/hr.
### Annual radiation exposure limits

<table>
<thead>
<tr>
<th>Area</th>
<th>Exposure Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole body (organs &amp; gonads)</td>
<td>5,000 mrem/yr</td>
</tr>
<tr>
<td>Lens of eyes</td>
<td>15,000 mrem/yr</td>
</tr>
<tr>
<td>Extremities &amp; skin</td>
<td>50,000 mrem/yr</td>
</tr>
<tr>
<td>Fetal</td>
<td>500 mrem/gestation period</td>
</tr>
</tbody>
</table>
Minimize exposure time.
Minimize exposure time

Better image quality means less exposure time

Lumbar
Cervical
Biacuplasty
Power efficiency is a balancing act

Providing a superb image with each exposure can reduce exposure time.

If you can’t see, you tend to fluoro longer.
Choose power so you have it when you need it

15 kW high frequency, generator delivers constant peak power

High Penetrating Power to Image Large Patients and do more applications
Rotating anode drives high I.Q.

Allows for a higher peak power capacity

Offers smaller focal spot for better resolution

Anode target rotates 3,560 RPM

Larger target area gives higher heat dissipation making it capable of high power pulse mode

- 300,000 H.U. Heat Storage
- 85,000 H.U./min. Heat Dissipation rate
- Small Focal spots – 0.3mm/0.6mm
Auto features make dose optimization easy

Automatic brightness & contrast features optimize imaging

Point & shoot capability reduces errors and unnecessary dose

Auto features can optimize technique factors for anatomical density:
- KVP
- mA
- Camera gain

Auto metal detection features prevent blooming or burnout and prevent retakes

Minimize exposure time
Fewer shots required with laser aimer

Removable targeting device pinpoints anatomy of interest

Crosshairs on the image help ensure alignment

Fewer shots, less dose
Minimize exposure amount.
Reduce dose by up to 90%

Low Dose Mode
One half the milliamperage
Up to 50% dose reduction

Pulse Fluoro Mode
1, 2, 4, 8 PPS
75-90% reduction in dose vs. standard fluoro
Minimize exposure amount

Image quality versus dose reduction

Low dose example on average size patient

Pulse fluoro example on average size patient
On-screen collimation limits exposure

Limit radiation with iris, dual leaf, and curved collimator

Collimators shield exposure using lead and tungsten shutters

Collimate & rotate from last image for fewer shots

Improved I.Q. through smaller focus area
Beam filtration reduces patient skin dose

Beam filters absorb low-energy photons that would be absorbed by the patient

Filtering the X-ray removes harmful and unnecessary radiation at lower energy and lower frequency levels

Hardens the beam for better I.Q.
Know your field of view
Size counts when it comes to dose

Larger field of view, more scatter radiation, but lower primary dose

Each magnification increases technique by 50% — higher technique, higher dose

Magnification is a trade-off between image quality and dose levels

**Normal**
- Largest Coverage
- Lowest Dose

**Mag.1**
- Zoomed image
- Higher-res.
- Higher dose

**Mag.2**
- Largest display
- Highest Res.
- Highest Dose

Minimize exposure amount
Magnification means higher dose

Minimize exposure amount
Protecting personnel

**Distance**: Stand as far from the radiation source as possible and use leaded shielding

**Shielding**: Lead aprons, screens, thyroid shields minimize exposure

0.5 mm of lead or its equivalent

**Monitoring**: Should be worn by all personnel who are in the room anytime fluoroscopy is taking place.
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