Radiation Protection in the Operating Room

Followed by STEPs Dance
Webinar Functionality

- Audio and video
  - Will be from the presenters only
  - Use computer or telephone (call in)
  - Computer seems to give the best sound quality
- Use the “Chat” feature to enter comments
- Use the “Questions” feature to ask questions
- Posted on webinar page
  - Video, Q&A answers, copy of the slides
- Follow up email will be sent
  - Topics covered, time of attendance
- It may be possible to change your Zoom view if the controls are hiding the closed captioning.
• Sources of radiation
• Health effects of radiation
• Regulators
• Radiation protection principles
• Radiation Safety in the OR
• Dosimetry
Occupational Exposures to Ionizing Radiation

The number of workers has increased in 2016 (compared with 2015) for the following sectors: Particle accelerator, Medical and Nuclear. It has decreased for these sectors: Industry, Mining and Shared.

The mean annual effective dose for each sector tends to decrease over time, with few exceptions. For 2016, the Medical and Shared sectors had small increases (less than 0.01 mSv each), while the other sectors had decreases.

Sentinel Node Biopsy

- Patient injected with radioactive material which emits gamma rays
- Use a hand-held meter to measure the radiation coming out of the patient

Fluoroscopy

- An X-ray machine is used to image the patient
- An image intensifier records the radiation that goes through the patient
Ionizing vs. Non-Ionizing

• Any type can be categorized as ionizing or non-ionizing

• Ionizing
  – Enough energy to remove electrons from atoms
  – Can cause damage to large molecules, such as DNA molecules

• Non-ionizing
  – Not enough energy to remove electrons from atoms
  – Damage mainly due to heating or photochemical effects
Gamma rays and x-rays are electromagnetic radiation just like visible light.
Interaction with the Body

When radiation strikes living tissue, there are a number of possible outcomes:

- No damage caused
- Damage to cells that is repaired
- Damage to cells that leads to cell death
- Damage to cell chromosomes that is incorrectly repaired ("mutated")

No harm | Deterministic/tissue effects | Risk of cancer
Stochastic Effect: Cancer

- Radiation exposure increases the **likelihood** of developing cancer.
- The greater the exposure, the greater is the chance.
- Effect is similar to the fact that smoking increases the risk of lung cancer.
The risk of developing a fatal cancer as a result of exposure to radiation is approximately 4% per 1000 mSv.

- Consider a person who worked for 50 years and received 20 mSv per year.
- This person’s total lifetime radiation dose is 1000 mSv.
- This person will have an extra 4% chance of developing a fatal cancer.
The Canadian Nuclear Safety Commission (CNSC) regulates the possession and use of all radioactive substances and radiation devices in Canada.

- Owners of radiation sources and devices must have a license from the CNSC.

Equipment which produces non-ionizing radiation are generally under provincial jurisdiction, if they are regulated.

- Most x-ray equipment is provincially regulated.
- Very high energy x-ray units are regulated by the CNSC.
<table>
<thead>
<tr>
<th>Person</th>
<th>Period</th>
<th>CNSC Effective Dose Limit</th>
<th>Ontario Effective Dose Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear Energy Worker / X-Ray Worker</td>
<td>1-yr dosimetry period</td>
<td>50 mSv</td>
<td>50 mSv</td>
</tr>
<tr>
<td></td>
<td>5-yr dosimetry period</td>
<td>100 mSv</td>
<td>n/a</td>
</tr>
<tr>
<td>Pregnant NEW / X-Ray Worker</td>
<td>Balance of the pregnancy</td>
<td>4 mSv</td>
<td>5 mSv</td>
</tr>
<tr>
<td>A person who is not a designated worker</td>
<td>1 calendar year</td>
<td>1 mSv</td>
<td>5 mSv</td>
</tr>
</tbody>
</table>

ALARA: As Low As Reasonably Achievable
We are all exposed to radiation:

- Cosmic radiation
  - sun, space
- Terrestrial radiation
  - soil, rocks
- Internally
  - Food, air (radon gas)
- Medical treatment

On average, we receive about 2 – 4 mSv per year from background radiation.
### Summary of Exposures

#### Public exposures and threshold effects:

<table>
<thead>
<tr>
<th>Source or Effect</th>
<th>Effective Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Dose limit</td>
<td>20 mSv (NEW)</td>
</tr>
<tr>
<td></td>
<td>1 mSv (public)</td>
</tr>
<tr>
<td>Background Radiation</td>
<td>2-4 mSv/year</td>
</tr>
<tr>
<td></td>
<td>0.01 mSv/day</td>
</tr>
<tr>
<td>Acute dose which affects the blood</td>
<td>&gt; 250 mSv</td>
</tr>
<tr>
<td>4% increased risk of fatal cancer</td>
<td>1000 mSv</td>
</tr>
<tr>
<td>Cross country plane ride</td>
<td>0.03 mSv</td>
</tr>
</tbody>
</table>

#### Medical Exposures:

<table>
<thead>
<tr>
<th>Source</th>
<th>Effective Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest X-ray</td>
<td>0.1 mSv</td>
</tr>
<tr>
<td>Chest CT</td>
<td>6 mSv</td>
</tr>
<tr>
<td>PET/CT scan</td>
<td>23 mSv</td>
</tr>
<tr>
<td>SPECT w/ Tc-99m</td>
<td>10 mSv</td>
</tr>
<tr>
<td>Mammography</td>
<td>0.2-0.3 mSv</td>
</tr>
<tr>
<td>Dental X-rays</td>
<td>0.005 mSv</td>
</tr>
<tr>
<td>Radiation Therapy</td>
<td>Up to 60 Gy (equivalent dose)</td>
</tr>
</tbody>
</table>

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*Good Science in Plain Language®
www.radiationsafety.ca*
• Exposure to a high dose delivered within seconds, minutes or days
• Possible deterministic effects
  – Cataracts
  – Blood changes
  – Nausea
  – Diarrhea
  – Hair-loss
  – Skin damage
  – Death
## Acute Exposure

### Acute Dose (mGy) vs. Effect

<table>
<thead>
<tr>
<th>Acute Dose (mGy)</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 250</td>
<td>No detectable effects</td>
</tr>
<tr>
<td>&gt; 3,500</td>
<td>Chance of death 50% and above</td>
</tr>
<tr>
<td>&gt; 6,000</td>
<td>Death an almost certainty, time between exposure and death depends on amount of dose</td>
</tr>
</tbody>
</table>
• Threshold: 0.5 Gy (500 mGy)
• New ICRP recommendation:
  – 20 mSv per year on average
• CNSC annual dose limit for the lens of the eye for designated workers:
  – 50 mSv per year
• Provinces each have dose limits for x-rays
  – Ontario: 150 mSv/hear; 50 mSv/year
Radiation Protection Principles

- Fundamentals of radiation protection
  - Avoid acute effects
  - Minimize risk of cancer
  - Keep exposures ALARA

- External radiation exposure can be decreased by:
  - Time
  - Distance
  - Shielding
• Limit the time a person spends near a source
  – Efficient work practices should be used
• Limit the amount of time the source is generating x-rays
  – Take as few fluoroscopic images as possible
  – Use different pulse modes
The intensity of x-ray and gamma ray fields decreases as you increase your distance from the source.

Taking even a few steps back from a patient or an X-ray tube will quickly reduce your dose.
• Shielding is the main source of protection from exposure to x-rays and gamma rays.
• X-rays and gamma rays cannot be 100% stopped.
• Shielding reduces exposure by attenuating radiation.

Image from http://www.sprawls.org/ppmi2/RADPEN/, open access.
Sentinel Node Biopsy

**Time:** Efficient work practices will reduce the time spent around the patient

**Distance:** When you are not taking a measurement, take a few steps back from the patient

**Shielding:** Lead aprons, thyroid collars, etc can be worn to shield your body from the radiation
Occupational Risk: Fluoroscopy

- Working close to radiation source
- Open x-ray beam
- Exposure times can be long

Potential for high exposure
Fluoroscopy machines use an X-ray tube

- The patient is exposed to the primary beam
- Most of the radiation others receive in the OR is from scattered radiation
- Collimation

Radiation exposure to everyone in the room is directly proportional to the ON-time of the unit

- Keep tube current as low as possible
- Keep tube potential fairly high
More RP Tips for Fluoroscopy

Scott Sorenson, 2000
More RP Tips for Fluoroscopy

Higher Eye Exposure

X-ray Tube Away

Lower Eye Exposure

II Away

Scott Sorenson, 2000
More RP Tips for Fluoroscopy

• Shielding and dosimetry are critical in fluoroscopy
• Shielding:
  – Lead curtains can be installed on the patient table
  – Lead aprons should always be worn and should cover the thyroid, core, and reproductive area
  – A lead glass screen will absorb scattered radiation
  – Goggles can be used to protect the eyes

www.ultraray.com
Dosimeters

• One dosimeter should be worn underneath the apron
• Ring or bracelet dosimeters can keep track of dose to the hands
• One dosimeter should be worn on the collar, above the apron, to measure radiation to the eyes
• It is strongly recommended that those working at multiple locations have a different dosimeter for each location
  – In case of an unusual exposure, this will make it easier to determine where the exposure was received
• Dose recorded from each dosimeter must be communicated to the employee.
• The three CNSC licensed service providers report dose to the National Dose Registry (NDR)
  – National Dosimetry Services, Health Canada
  – Landauer
  – Mirion Technologies
• The National Dose Registry keeps a record of individual cumulative dose over multiple licensed service providers and multiple employers
The mean dose of ionizing radiation received by Canadian workers has been decreasing for the past 5 years and is at its lowest level since the first report was published in 1978.

• Research studies
• International Agencies
• Radiation Safety Officer
• X-ray Safety Officer
• RSIC
• The Radiation Safety Institute of Canada is an independent, not-for-profit organization specializing in radiation safety.

• For further information on all types of radiation contact us at:
  1-800-263-5803
  info@radiationsafety.ca
  www.radiationsafety.ca