Radiation Safety Institute of Canada
Institut de radioprotection du Canada

Lunch, Learn, & Dance Wellness Webinars

March 4, 2021

Radiation Protection in the Operating Room

Followed by STEPs Dance

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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.

Outline

- Sources of radiation
- Health effects of radiation
- Regulators
- Radiation protection principles
- Radiation Safety in the OR
- Dosimetry

Occupational Exposures to Ionizing Radiation

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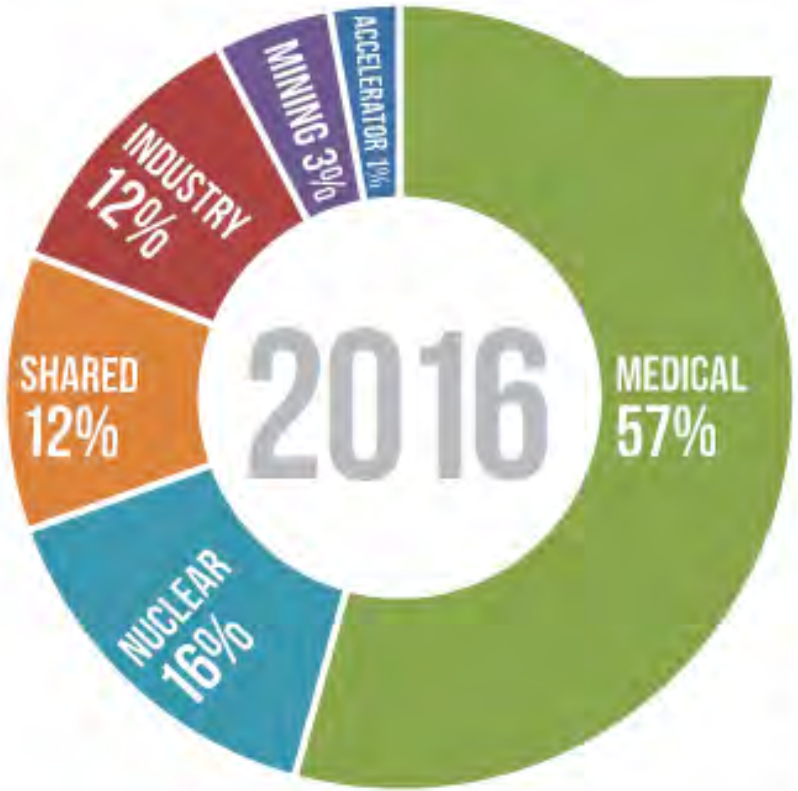
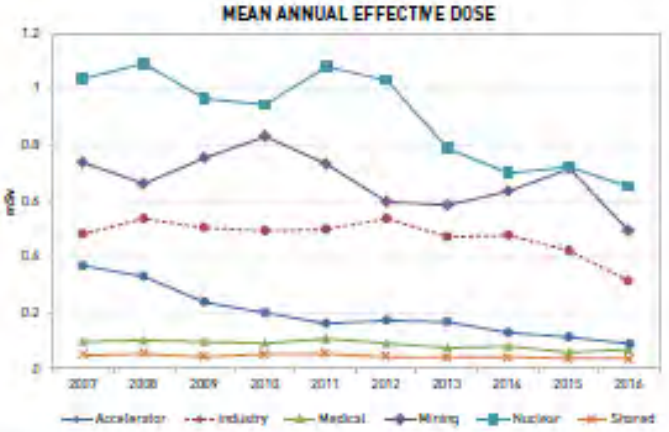


The number of workers has increased in **2016** (compared with 2015) for the following sectors: **Particle accelerator**, **Medical** and **Nuclear**. It has decreased for these sectors: **Industry**, **Mining** and **Shared**.



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**.

You can find the full Report on Occupational Radiation Exposures in Canada at: http://publications.gc.ca/collections/collection_2018/sc-hc/H126-1-2017-eng.pdf

Health Canada Santé Canada

Canada

In the Operating Room…

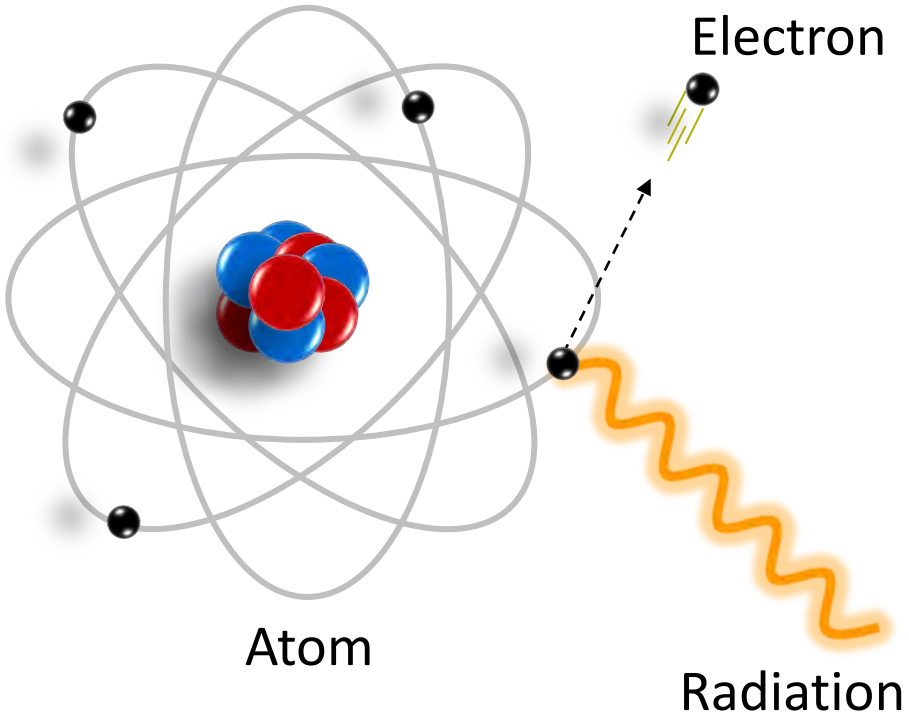
Sentinel Node Biopsy

- 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

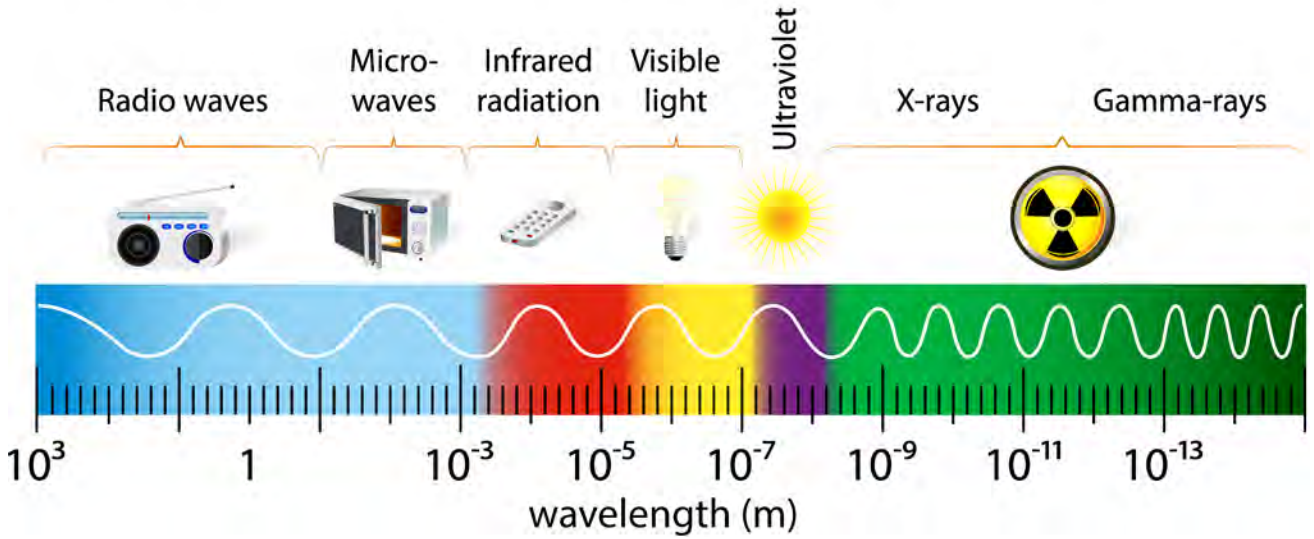
Ionizing vs. Non-Ionizing



- Any type can be categorized at 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/X-Ray Radiation

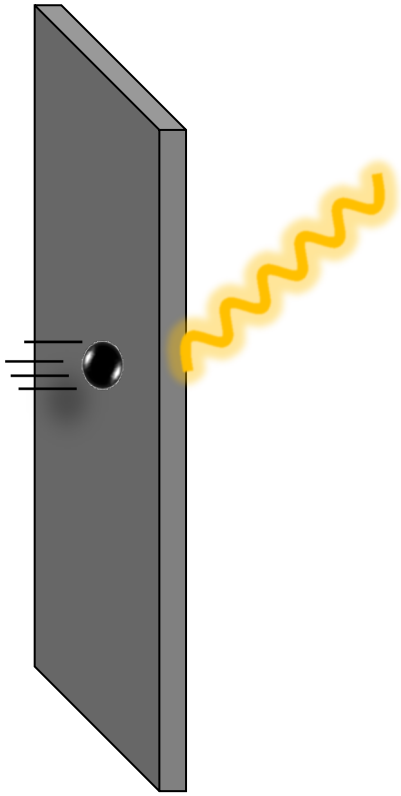
THE ELECTROMAGNETIC SPECTRUM



Gamma rays and x-rays are electromagnetic radiation just like **visible light**.

Gamma & X-Ray

X-Ray Production



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

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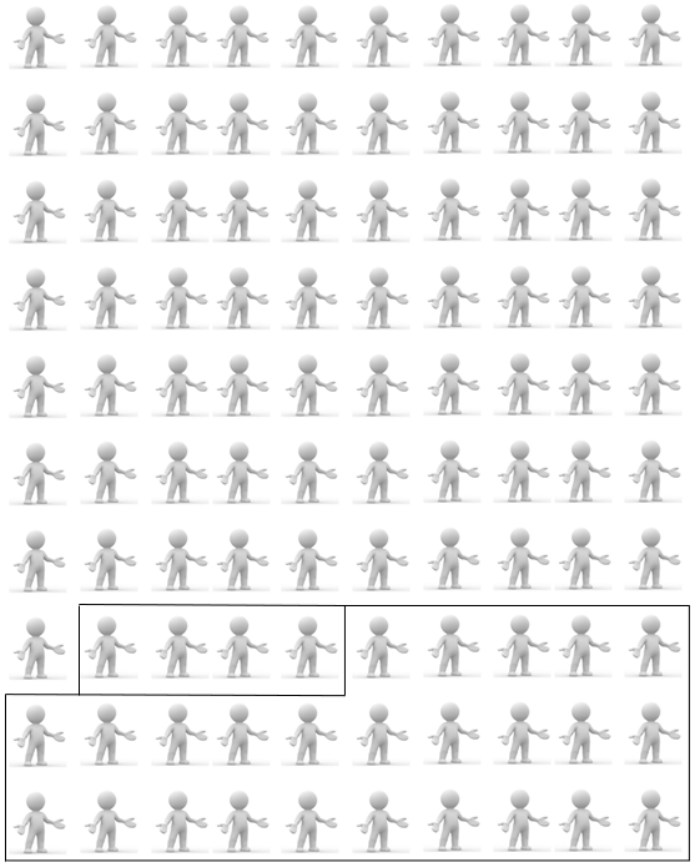
Cancer Risk from Radiation



- 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.

Regulator

- 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

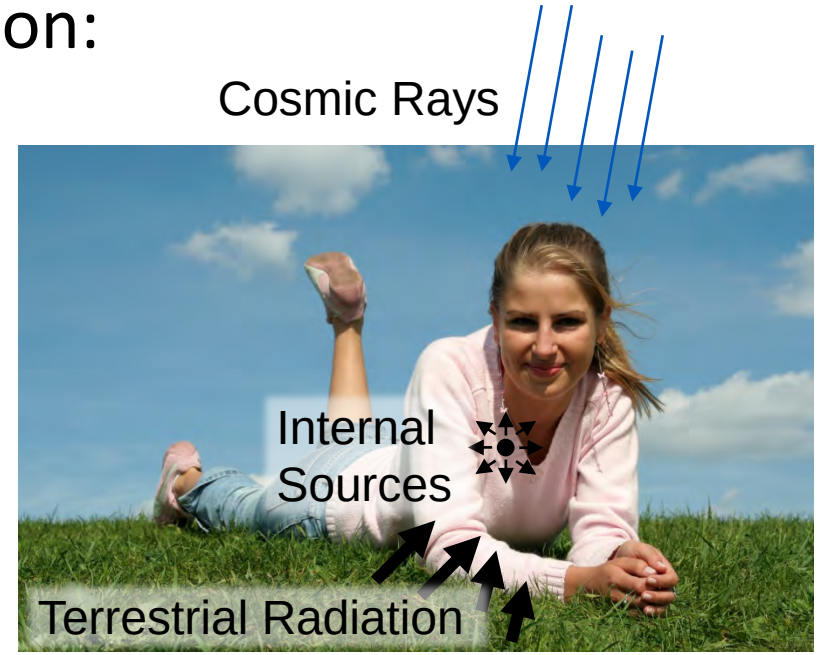
Effective Dose Limits

Person	Period	CNSC Effective Dose Limit	Ontario Effective Dose Limit
Nuclear Energy Worker / X-Ray Worker	1-yr dosimetry period	50 mSv	50 mSv
	5-yr dosimetry period	100 mSv	n/a
Pregnant NEW / X-Ray Worker	Balance of the pregnancy	4 mSv	5 mSv
A person who is not a designated worker	1 calendar year	1 mSv	5 mSv

ALARA: As Low As Reasonably Achievable

Radiation Exposure

- 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:

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

Medical Exposures:

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

Deterministic Effects: Acute Exposure

- Exposure to a high dose delivered within seconds, minutes or days
- Possible deterministic effects
  - Cataracts
  - Blood changes
  - Nausea
  - Diarrhea
  - Hair-loss
  - Skin damage
  - Death

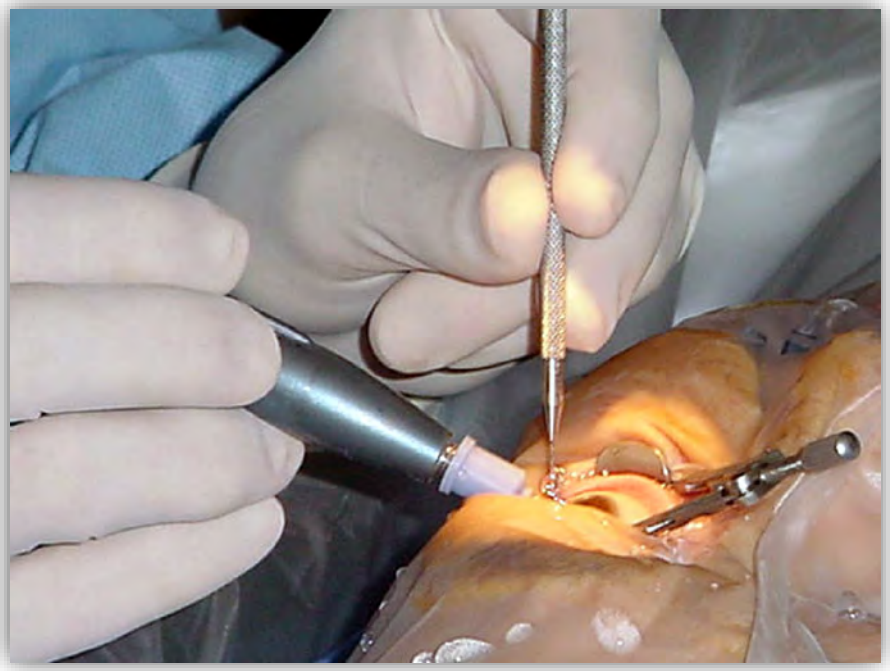
Image by LK Wagner, PhD; Vlietstra et a, CC BY-SA 3.0

Acute Exposure

Acute Dose (mGy)	Effect
< 250	No detectable effects
> 3,500	Chance of death 50% and above
> 6,000	Death an almost certainty, time between exposure and death depends on amount of dose

Cataracts

- 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



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Radiation Protection Principles

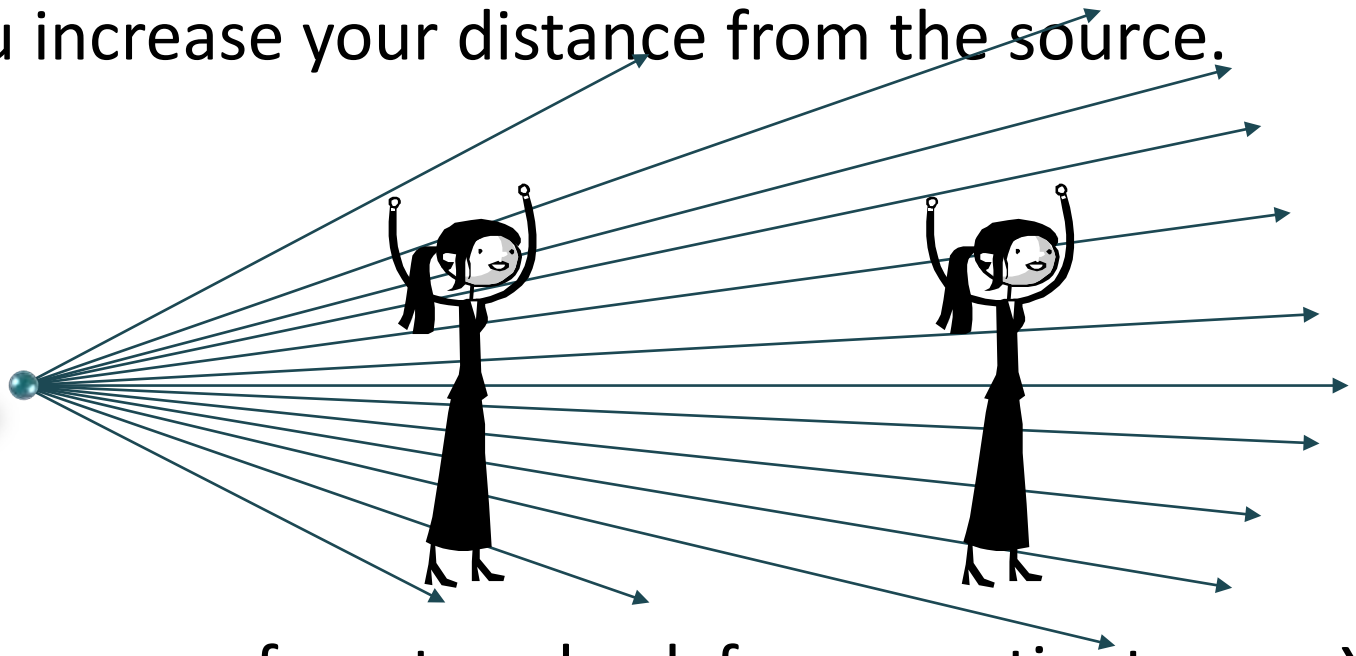
- Fundamentals of radiation protection
  - Avoid acute effects
  - Minimize risk of cancer
  - Keep exposures ALARA
- External radiation exposure can be decreased by:
  - Time
  - Distance
  - Shielding

Time

- 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

Distance

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

- 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.

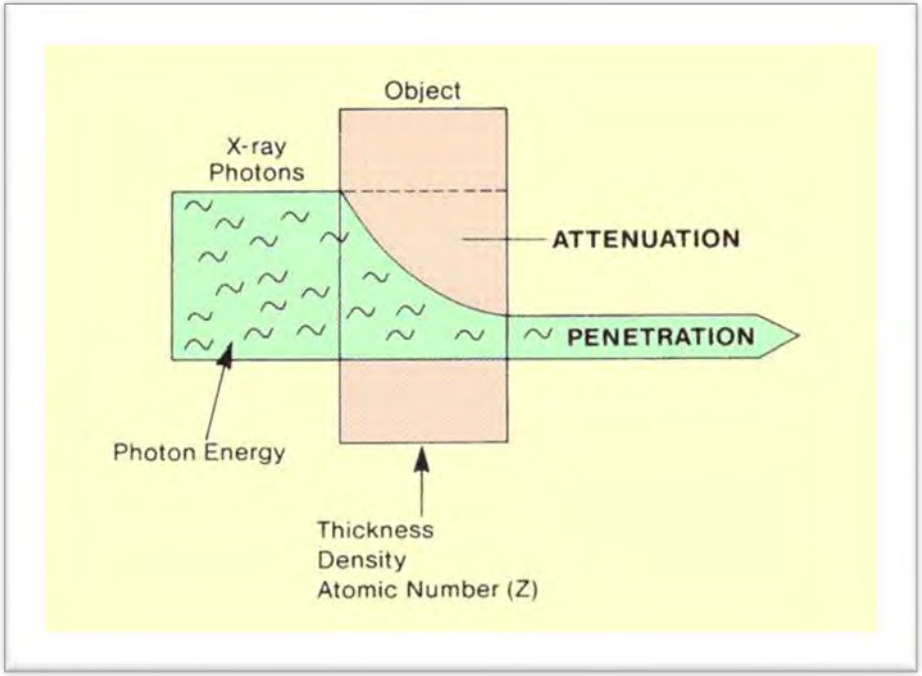


Image from http://www.sprawls.org/ppmi2/RADPEN/, open access.

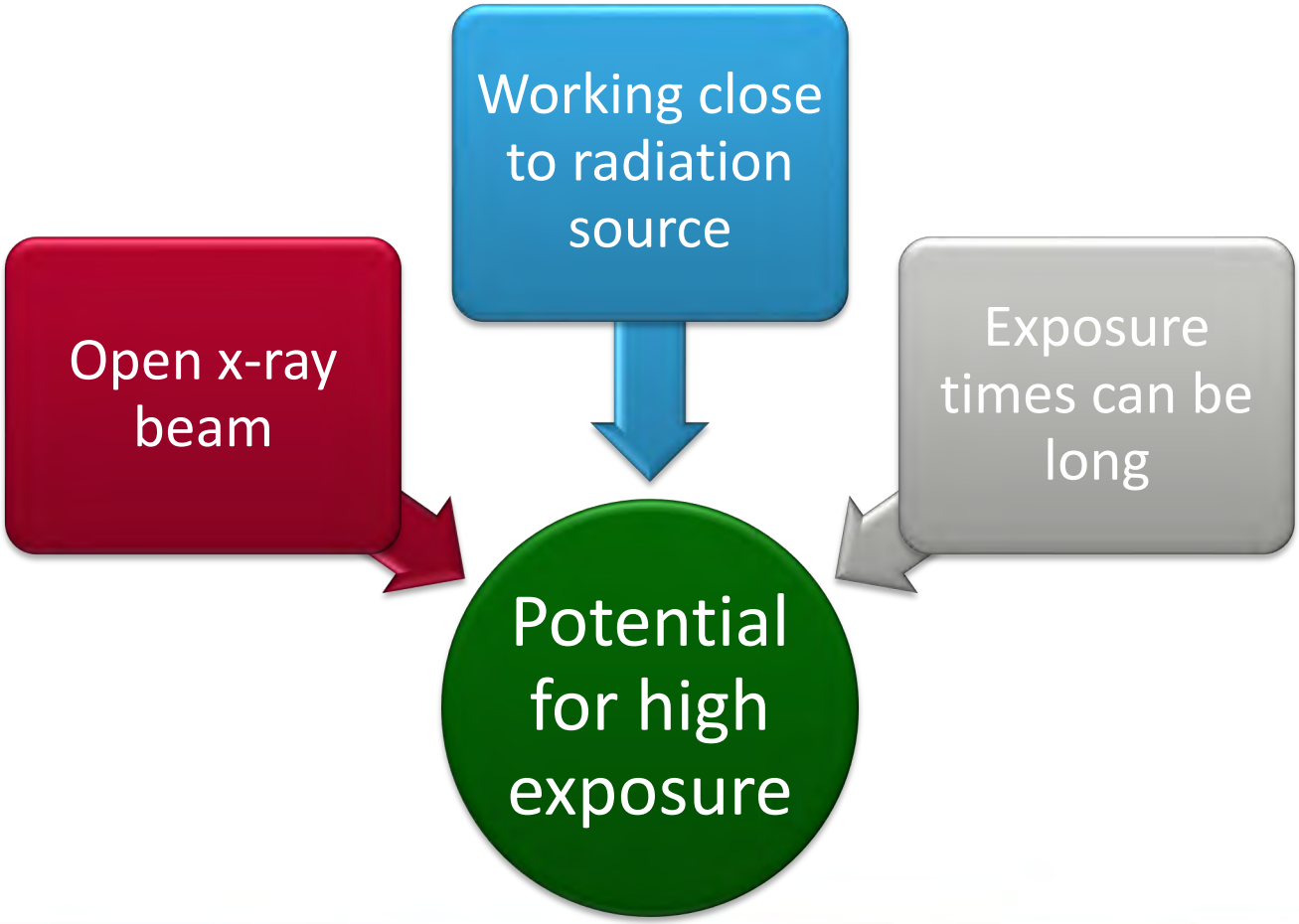
Sentinel Node Biopsy

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



More RP Tips for Fluoroscopy

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

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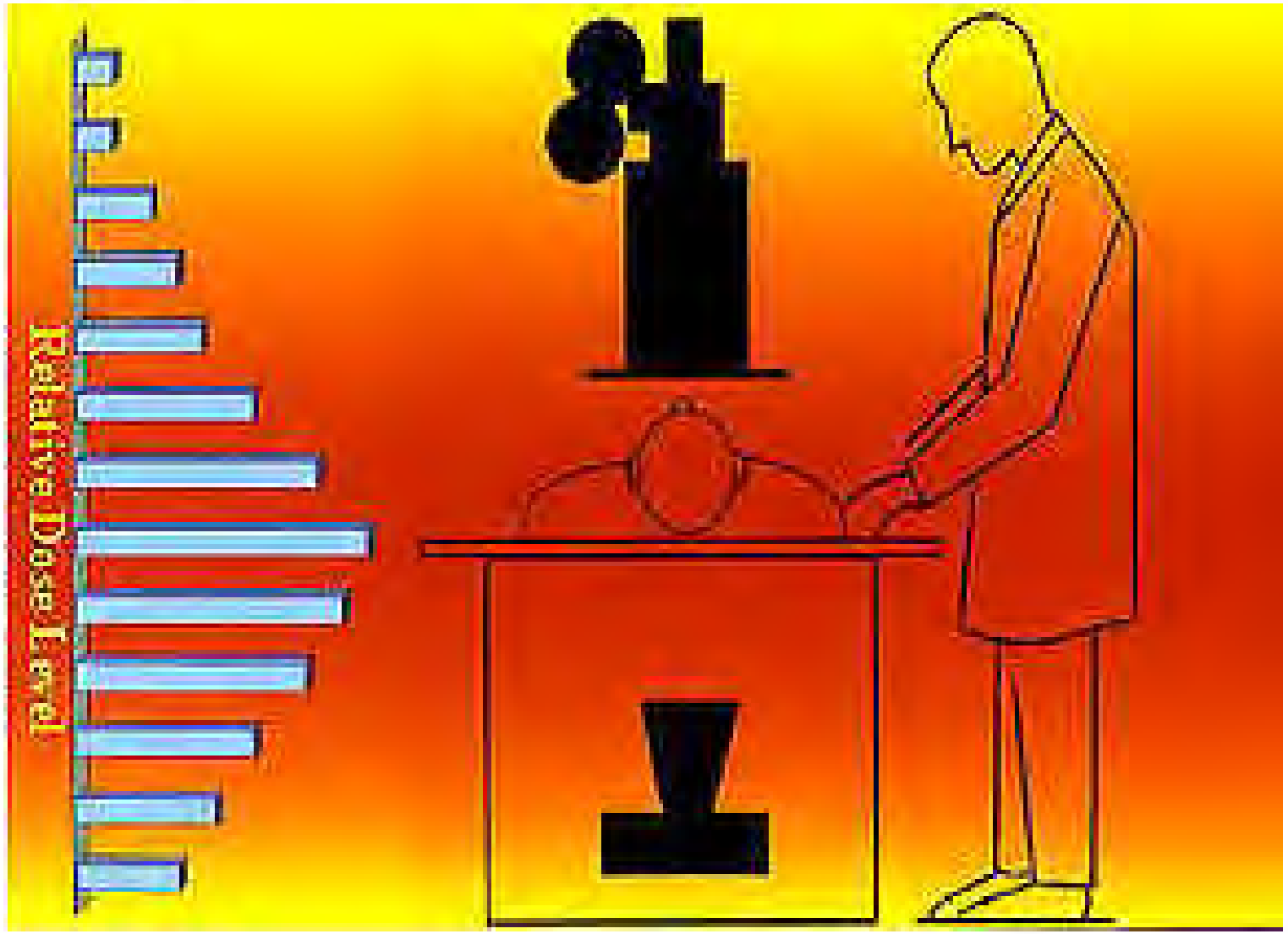
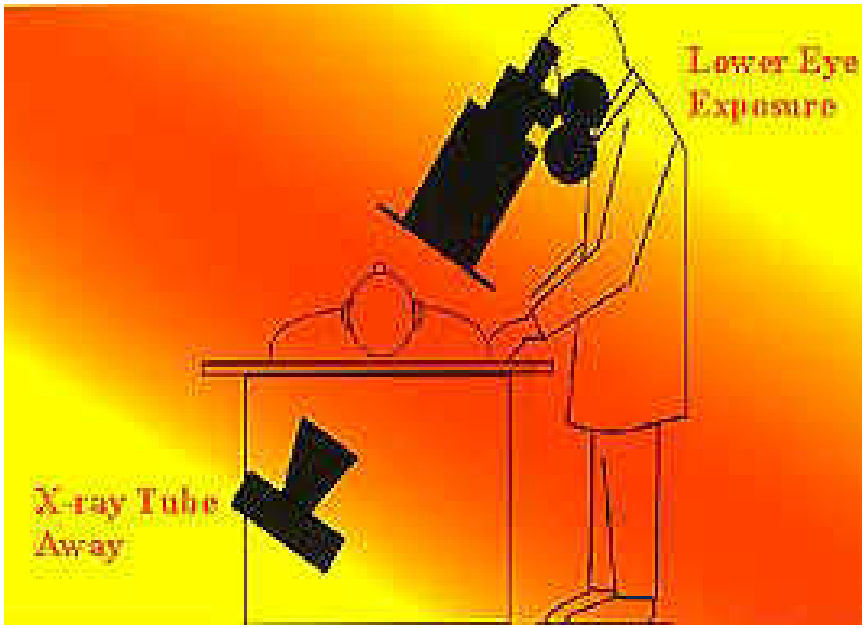


Scott Sorenson, 2000

More RP Tips for Fluoroscopy



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

More RP Tips for Fluoroscopy

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

Dosimetry

- 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.

Dosimetry

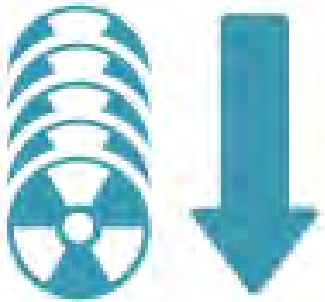
- The three CNSC licensed service providers report dose to the National Dose Registry (NDR)
  - National Dosimetry Services, Heath Canada
  - Landauer
  - Mirion Technologies
- The National Dose Registry keeps a record of individual cumulative dose over multiple licensed service providers and multiple employers

Dosimetry

MEAN RADIATION DOSE (2016): 0.2

MILLISIEVERTS (mSv)

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.



Data from https://www.canada.ca/en/health-canada/services/publications/health-risks-safety/occupational-radiation-exposures.html

More Information

- Research studies
- International Agencies
- Radiation Safety Officer
- X-ray Safety Officer
- RSIC

Radiation Safety Institute of Canada

- 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