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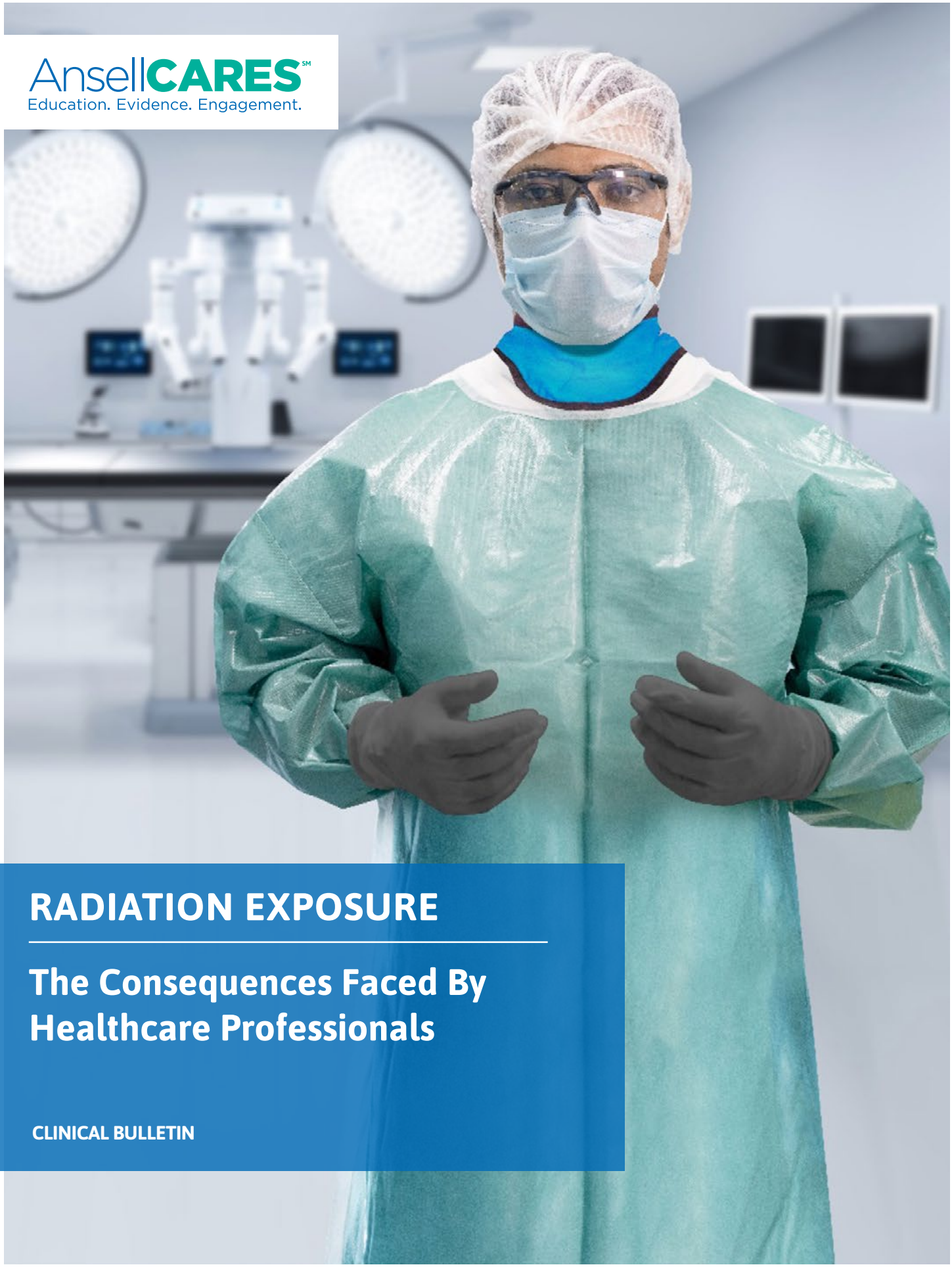


# RADIATION EXPOSURE

## The Consequences Faced By Healthcare Professionals

CLINICAL BULLETIN

## WHAT IS RADIATION?

Radiation is the emission of energy in the form of energy waves or particles that travels through space or a material medium.

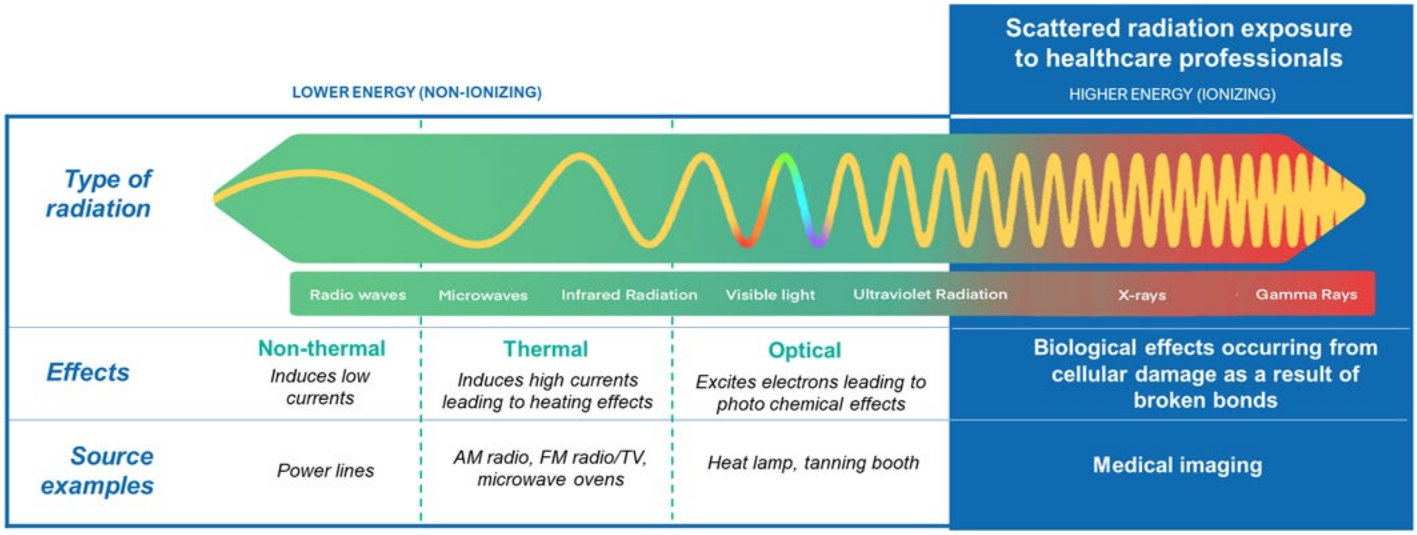
- Radiation is categorized as being either **ionizing** or **non-ionizing**
- **Ionizing radiation is short wavelength/high frequency energy capable of damaging DNA**
  - Medical imaging generates ionizing radiation
  - Healthcare professionals contact with ionizing radiation may come from a direct source or from scattered radiation
- Non-ionizing radiation **DOES NOT** factor in medical imaging

## WHAT IS IONIZING RADIATION?

When the electron has enough energy to break away from the atom, the energy that comes out of a radioactive atom is what is known as ionizing radiation. It has more energy than non-ionizing radiation and can cause more biological damage.

- Radiation damage occurs at the cellular level
  - Either changes the nature of the cell or kills the cell as a result of broken bonds[1]
  - May cause immediate VISIBLE effects or not become apparent for a long time[1]
- Impact of exposure to scattered radiation may be cumulative over the long term[2, 3]

***An overview of type, effect and source of ionizing radiation compared to non-ionizing radiation[4]***



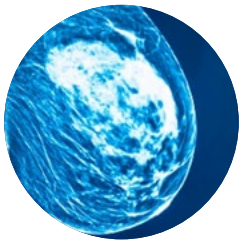
# A CLOSE LOOK AT HOW THE C-ARM FLUROSCOPY GENERATES RADIATION

Healthcare workers are exposed to greater amounts of ionizing radiation due to caring for patients during their treatments. Exposure may come from Radiology, mammography, computed tomography (CT), and fluoroscopy.

Radiology

Computerized Tomography (CT)

Fluoroscopy



Mammography


- **A** **X-ray tube:** X-ray tube, the beam source, emits X-rays that penetrate the patient.
- **B** **Primary radiation beam:** emitted from the beam source, X-ray tube.
- **C** **Scattered radiation field:** secondary ionizing radiation spreads out in different directions when the radiation beam is intercepted by objects, such as a patient.
- **D** **Image detector:** Captures X-ray and converts to an image displayed on a monitor.

- Primary radiation is a major source of dose to patients
- Scattered radiation is a major source of exposure to healthcare professionals
  - Reduction of scattered radiation is the main aim of RAGs

***Biological Effects of Exposure to Ionizing Radiation to Both Patients and Healthcare Professionals***

## Deterministic Effects[5]

- Occur only **after a threshold dose** has been surpassed before a biological response is seen
- Severity is dose dependent above the threshold

**VISIBLE**

*Cataracts*

*Skin reddening (erythema)*

*Skin decay (necrosis)*

**NON-VISIBLE**

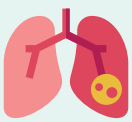
*Temporary or permanent sterility*

## Stochastic Effects[6]

- Occur by statistical chance and **not dependent on threshold dose:**
- No radiation dose is considered to be 'safe' for radiation protection purposes*

**VISIBLE**

*Skin cancer*



*Lung cancer*

**NON-VISIBLE**

*Genetic effects such as mutations that can be transmitted to offspring*

**In accordance with the principle of ALARA*

### *Risks of Exposure to Radiation are Cumulative, Long Term and Not Immediately Visible*

A retrospective study revealed a

**29% incidence of cancer among ortho surgeons exposed to medical radiation**

compared to 4% among their unexposed peers[7]

- Typical lag period between radiation exposure and cancer diagnosis is at least 5 years. In most cases, **may be 1 or 2 decades** or longer[2]
- Latent period for radiogenic skin cancer ranges from **2 to 65 years** after exposure, with an estimated median latency of 20 to 45 years[3]

### *General Principles of Radiation Protection and What It Means to Healthcare Professionals*

**ALARA is the Most Referenced Standard of Practice**

**ALARA**

The principle of **As Low As Reasonably Achievable (ALARA)**[8] is used by key safety and occupational agencies to minimize radiation does by employing all reasonable methods.

- Central to many radiation safety programs

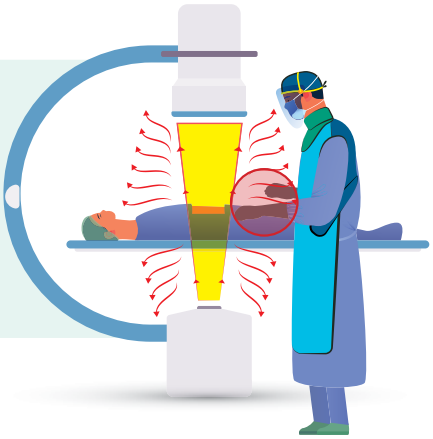
1. **Less TIME:** The shorter the time spent near a radiation source, the lower the amount of radiation exposure received.
2. **More DISTANCE:** The closer to the radiation source, the greater the chances of damaging the body: When the working distance from a radiation source is increased by a factor of 2, the dose received from the source is reduced by a factor of 4.
3. **More SHIELDING:** Increasing the shielding around a radiation source decreases the exposure.

## WHERE ARE HANDS IN SCATTERED RADIATION FIELD?

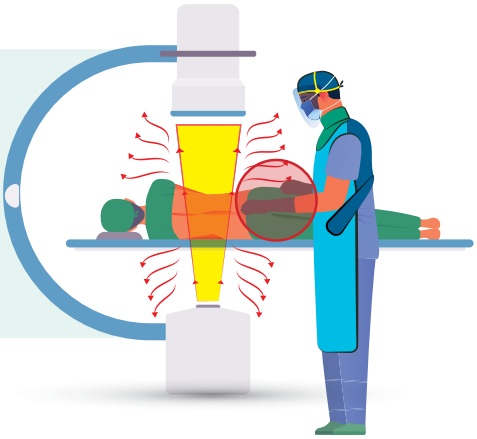
**SPOT THE PROXIMITY OF THE HANDS!**

**Hands are often close to the scattered radiation field in image guided interventional procedures due to the need to position patients.**

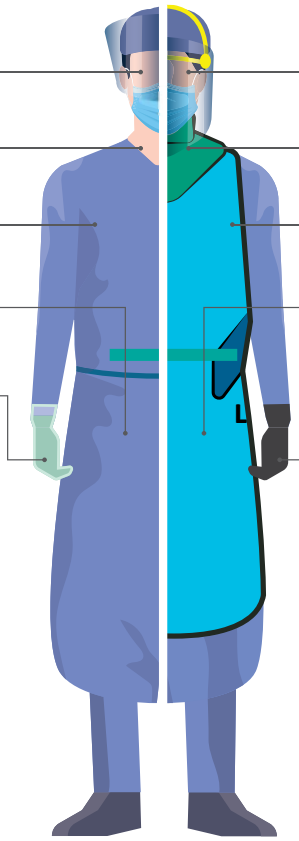
**O.R. PROCEDURES**
Examples: Spinal surgery and Orthopedic surgery



**CATH LAB/ INTERVENTIONAL RADIOLOGY**
Examples: Angiograms, Catheter insertion, Placement of devices and Barium X-rays



*Hands are often the most exposed, yet least protected to scattered radiation[9]*



| | |
|---|---|
| 4.1 µSv to eye | Reduced by approx. 65% |
| 1.6 µSv to thyroid | Reduced by approx. 25% |
| 2.0 µSv to chest | Reduced by approx. 35% |
| 1.9 µSv to groin | Reduced by 32% |
| 31.0 µSv to hand | Reduced by 69.4% |

**COMPARING HAND EXPOSURE:**

**19.4x** GREATER EXPOSURE COMPARED TO THYROID

**15.5x** GREATER EXPOSURE COMPARED TO CHEST

HANDS HAVE UP TO **13x GREATER** EXPOSURE TO THE SUM TOTAL OF OTHER BODY PARTS

Results are based on a study[4] using a distal radial fracture surgery model to examine radiation exposure to the eyes, thyroid, chest, groin and hands of a surgeon mannequin, with and without shielding equipment. The C-Arm fluoroscope was vertically positioned.

**DOUBLE GLOVING WITH STANDARD SURGICAL GLOVES**

**ATTUENUATES UNDER 1%[10]**

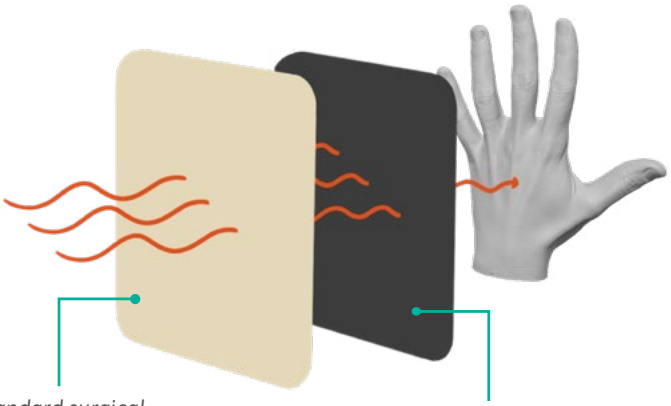
**OF SCATTERED RADIATION**

## IONIZING RADIATION ATTENUATION

### Radiation Attenuation

- Attenuation is always relative to the radiation detected with no material between the source and the detector
- It is a measure how much the radiation interacts (is lost) as it goes through a material
- Radiation can be "lost" between source and detector:
  - » When it is absorbed (energy deposited in the material)
  - » When it is scatted in a different direction, so it does not reach the detector

*Ionizing radiation protective shields are often lead-based or made of lead-free bismuth oxide or tungsten*



*Standard surgical glove material*

*Materials using attenuating agents to protect from scattered radiation: Lead, bismuth oxide and/or tungsten*

**Attenuation** → **Scatter** + **Absorption**

## KEY TAKEAWAYS

**Hands are the most exposed, yet least protected:** often closest to the primary radiation beam and scattered radiation field.

- **Hands have 13 times greater exposure** than the sum total of all other protected body parts[9]
- Body parts (chest, thyroid), with much less exposure, are protected with protective shields but not hands

Even though healthcare professionals may not exceed the annual permissible rate (as guided by International Commission of Radiation Protection) for hand dose, **the long term, cumulative impact of hand exposure should not be dismissed.**

- **Even the smallest doses could put a user at risk** of cancer and genetic mutations
- Dose limits **DO NOT** and **CANNOT** define a demarcation between 'safe' and 'unsafe'

**Radiation attenuation gloves are not widely used:** consistent and constant education and awareness of the level of hand dose exposure compared to other body parts and the ensuing stochastic risks are needed to **shift behavior from 'rarely or never use' to 'use regularly'.**

There are no laws mandating the use of protective shields but **ALARA is the principle of best practice** most referred to by protective agencies and healthcare occupational bodies.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