Chest X-ray Taking Procedures Training for X-ray Technicians/ Radiographer

“Radiation Protection”

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Patients should be protected from unnecessary radiation for all diagnostic radiographic examinations, especially for CXRs because these are the most common radiographic examinations.

**Aims:**
- to prevent deterministic effect
- to limit the probability of the certain level

Reference: 10e RADIOLOGIC SCIENCE FOR TECHNOLOGISTS; PHYS, BIOL PROTECTION By Bushong ScD FACR FACMP, Stewart.
ALARA Principle
ALARA (As Low As Reasonably Achievable) Principle

“All technologists should practice the ALARA principle so that patients and other health care professionals do not receive unnecessary radiation.”

Reference: 10e RADIOLOGIC SCIENCE FOR TECHNOLOGISTS: PHYS, BIOL PROTECTION By Bushong ScD FACR FACMP, Stewart
Four important ways that ALARA can be achieved:

1. Always wear a personnel monitoring device

2. Mechanical holding devices should be used.

3. Close collimation, filtration of the primary beam, optimum kV technique, high-speed IRs, and avoidance of repeat projections reduce the dose to the patient.

4. Practice the three cardinal principles of radiation protection: time, distance, and shielding

Reference: 10e RADIOLOGIC SCIENCE FOR TECHNOLOGISTS: PHYS, BIOL PROTECTION By Bushong ScD FACR FACMP, Stewart.
Radiation Protection for Pregnancy
Apply 10-day rule for a female of reproductive age for high dose phenomenon.

“ICRP” states that 10-day rule as:
“whenever possible, one should confine the radiological examination of the lower abdomen and pelvis in the TEN-day interval following the onset of menstruation”

10-day rule suggests that:
• Non-urgent x-ray during the first TEN days of Menstrual cycle
• During this period, x-ray of lower abdomen and pelvis could harm developing follicles and fertilized ovum.

Reference: 10e RADIOLOGIC SCIENCE FOR TECHNOLOGISTS: PHYS, BIOL PROTECTION By Bushong ScD FACR FACMP, Stewart.

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USAID Infectious Disease Detection and Surveillance (IDDS)
Pregnant Dose

- Shielding of the abdomen and pelvis with a lead apron
- Limiting the number of views
- The fetus is in the direct beam (fetal dose >10 mGy (1 rad), the radiologist and referring physician should discuss other options

Reference: 10e RADIOLOGIC SCIENCE FOR TECHNOLOGISTS: PHYS, BIOL PROTECTION By Bushong ScD FACR FACMP Stewart.
## Radiation Protection for Pregnancy – Cont.

<table>
<thead>
<tr>
<th>Examination</th>
<th>Typical fetal dose (mGy)</th>
<th>Risk of childhood cancer per examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest</td>
<td>0.001 – 0.1</td>
<td>&lt;1 in 1,000,000</td>
</tr>
</tbody>
</table>

Reference: 10e **RADIOLOGIC SCIENCE FOR TECHNOLOGISTS: PHYS, BIOL PROTECTION** By Bushong ScD FACR FACMP, Stewart.
Radiation Protection for Pregnant Technologists

Reference: 10e RADIOLOGIC SCIENCE FOR TECHNOLOGISTS: PHYS, BIOL PROTECTION By Bushong ScD FACR FACMP, Stewart.
When an employee first discovers she is pregnant, it is desirable to conduct, on an individual basis, a review of her exposure history and work assignments. Not receive more than 5 mSv (500 mrem) during the period of gestation.
Radiation Protection for the Public

Reference: 10e RADIOLOGIC SCIENCE FOR TECHNOLOGISTS: PHYS, BIOL PROTECTION By Bushong ScD FACR FACMP. Stewart.
Radiation Protection for the Public

Can be reduced by

3 cardinal principles
(time, distance and shielding)

ALARA principle should be applied

Can be controlled by

Conventional gypsum board,
glass or lead acrylic

Wearing radiation monitoring devices
(photographic emulsion, film badge,
gas-filled radiation detector, scintillation
detector, TLD and OSLD)

Reference: 10e RADILOGIC SCIENCE FOR TECHNOLOGISTS: PHYS, BIOL PROTECTION By Bushong ScD FACR FACMP, Stewart.
Design for Radiation Protection

Reference: 10e RADIOLOGIC SCIENCE FOR TECHNOLOGISTS: PHYS, BIOL PROTECTION By Bushong ScD FACR FACMP, Stewart.
Design for Radiation Protection

• Protective x-ray tube housing:
  • Reduces leakage radiation (less than 1 mGy/hr at distance 1 m)
  • Doesn't contribute significantly to staff dose

• Collimation

Reference: 10e RADIOLOGIC SCIENCE FOR TECHNOLOGISTS: PHYS, BIOL PROTECTION By Bushong ScD FACR FACMP Stewart.
Design for Radiation Protection – Cont.

• A total filtration - at least 2.5 mm AL above 70 kvp
  • 1.5 mm AL between 50 and 70 kvp
  • 0.5 mm AL below 50 kvp
• For mobile x-ray system
  • Protective lead apron should be used
  • The operator is far, at least 2m from the x-ray tube during the exposure

In diagnostic radiology (excluding mammography) is 2.5 mm aluminium for equipment operating at 70 kV or higher

Reference: 10e RADIOLOGIC SCIENCE FOR TECHNOLOGISTS: PHYS, BIOL PROTECTION By Bushong ScD FACR FACMP Stewart.
Patient Protection

1. Minimum repeat radiographs
2. Correct filtration
3. Accurate collimation
4. Specific area shielding (gonadal and female breast shielding)
5. Select projections and technique factors appropriate for the examination

Patient Protection – Cont.

I. Minimum repeat radiographs

• Good communication between the technologist and the patient

• Simple and understandable breathing instructions

• Carefulness in positioning and selection of correct technique factors

2. Correct filtration

- Filtration of the primary x-ray beam reduces exposure to the patient by preferentially absorbing low-energy “unusable” x-rays, which mainly expose the patient’s skin and superficial tissue without contributing to image formation.
- There are 2 types of filtration:
  1) inherent or built-in filtration (0.5 mm aluminium equivalent)
  2) added filtration, metal filter (aluminium or copper or combination of these)

Patient Protection – Cont.

3. Accurate collimation

- Reduces patient exposure by limiting the size and shape of the x-ray field to the area of clinical interest
- **Collimation Rule:**
  - Collimation limit the x-ray field to only the area of interest, and collimation borders should be visible on the IR on all four sides

Close four-sided collimation
(The collimated light field may appear too small because of divergence of x-rays)

Patient Protection – Cont.

4. Specific area shielding (gonadal and female breast shielding)

• **Male Gonadal shielding:**
  - Should be placed *distally to the symphysis pubis*, covering the area of the teste and scrotum.
  - The *upper margin* of the shield should be *at the symphysis pubis*.

Patient Protection – Cont.

• **Female Gonadal shielding:**
  
  • Should be placed to cover the area of the ovaries, uterine tubes, and uterus.
  
  • The **lower border** of the shield should be at or slightly **above the symphysis pubis**.
  
  • The **upper border** extending just **above** the level of the anterior superior iliac spines (ASIS).

A. AP pelvis with flat contact shield (1 mm lead equivalent)
B. Male gonadal shield shapes

A. AP right hip with flat contact shield (1 mm lead equivalent)
B. Female ovarian shield shapes

Patient Protection – Cont.

5. Select projections and technique factors appropriate for the examination

• Use high kV and low mAs techniques
• Use PA rather than AP projections to reduce dose to anterior upper thoracic region (thyroid and female breasts)

Personal Monitoring Devices
Personal Monitoring Devices

Many instruments are used for individual monitoring of radiation exposure:

**Aims:**

- Monitor and control the individual dose
- Report and investigate over-exposure and recommend necessary remedial measures, if needed
- Maintain life-time cumulative dose record
**Film Badge**

- **A personal monitoring device**
- Measures individual doses from x-ray, beta particle and thermal neutrons
- Consists of a film pack loaded in film holder having suitable metallic filters
- Dose is measured in Sv

<table>
<thead>
<tr>
<th>Advantages:</th>
<th>Disadvantages:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Permanent record, cheap</td>
<td>- Complex darkroom procedure</td>
</tr>
<tr>
<td>- Can distinguish between different energies of photons</td>
<td>- Limited self life (one month)</td>
</tr>
<tr>
<td>- Can measure doses from different types of radiation</td>
<td>- Cannot be reused (film)</td>
</tr>
<tr>
<td></td>
<td>- Sensitive to temperature, humidity, chemicals and lights</td>
</tr>
</tbody>
</table>

Personal Monitoring Devices – Cont.

TLD (Thermo-Luminescence Dosimeter)

- Is a personal monitoring device
- Based on the principle of thermoluminescence
- Is used to measure individual dose from x-ray, beta and gamma ray

“The emission of Light by certain material when they are heated after radiation exposure”

Types of TLD
1) Chest batch - whole body
2) Wrist batch - extremity
3) Finger batch - finger

Reference: 10e RADIOLOGIC SCIENCE FOR TECHNOLOGISTS: PHYS, BIOL PROTECTION By Bushong ScD FACR FACMP Stewart.
Personal Monitoring Devices – Cont.

Advantages of TLD

- Can be made very small for finger/eye doses
- Can be reused (one TLD can be used 100 times, one card can be used for 300 months (25 years)
- Can be worn up to 3 months at most

Disadvantages of TLD

- Expensive but cost effective for reuse
- Cannot distinguish between different types of radiation
- Once read out, record is lost i.e., can't provide permanent record

Reference: 10e RADILOGIC SCIENCE FOR TECHNOLOGISTS: PHYS, BIOL PROTECTION By Bushong ScD FACR FACMP, Stewart.
Personal Monitoring Devices – Cont.

Optically stimulated luminescence Dosimeter (OSLD)

- To provide X, gamma, beta and neutron radiation monitoring using OSL technology that is a method that has established itself in the whole-body dosimetry:

<table>
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<tr>
<th>No</th>
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<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>High sensitivity</td>
<td>Sensitivity to light</td>
</tr>
<tr>
<td>2</td>
<td>High precession</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Readout flexibility</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Convenience</td>
<td></td>
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</tbody>
</table>

Personal Monitoring Devices – Cont.

Pocket Dosimeter

- Provides the wearer with an immediate reading of exposure
- Contains a small ionization chamber

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<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Immediate reading</td>
<td>Limited range</td>
</tr>
<tr>
<td>2</td>
<td>Reusable</td>
<td>No permanent record</td>
</tr>
<tr>
<td>3</td>
<td>Readout flexibility</td>
<td>Sensitive to mechanical problems</td>
</tr>
<tr>
<td>4</td>
<td>Convenience</td>
<td></td>
</tr>
</tbody>
</table>
Personal Monitoring Devices – Cont.

Direct-reading Pocket Dosimeter

Reference: Author- Prolineserver
Access for free at https://commons.wikimedia.org/wiki/File:Direct-reading_dosimeter.jpg
Personal Monitoring Devices – Cont.

Pocket Dosimeter

Reference: Author: Dozymetr
Electronic Dosimeters:

- Uses silicone diode detector
- Can provide a direct electronic readout and live/real time readouts
- Don't need the processing
- Require yearly battery replacement and checking.

<table>
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<tr>
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<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Very sensitive</td>
<td>High initial cost</td>
</tr>
<tr>
<td>2</td>
<td>Good for measuring pregnancy doses</td>
<td></td>
</tr>
</tbody>
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Reference: 10e RADIOLOGIC SCIENCE FOR TECHNOLOGISTS: PHYS, BIOL PROTECTION By Bushong ScD FACR, FACMP, Stewart.
THANK YOU!