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

"Radiation Protection"

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Content

ALARA (As Low As Reasonably Achievable) Principle

Radiation Protection for Pregnancy


Radiation Protection for Pregnant Technologist


Radiation protection for the Public


Design for radiation protection


Patient Protection


Personal Monitoring Devices

Radiation Protection

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

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

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*

Time

time, ↓ dose

Distance

↑ distance, ↓ dose

Shielding

dose 95 % in male and 50 % in female

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

Radiation Protection for Pregnancy

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Radiation Protection for Pregnancy

Apply 10-day rule for a female of reproductive age for high dose phenomenon

highest risk → early fetal period

low risk → 2nd trimester

least risk → 3rd trimester

"ICRP" states that 10-day rule as:

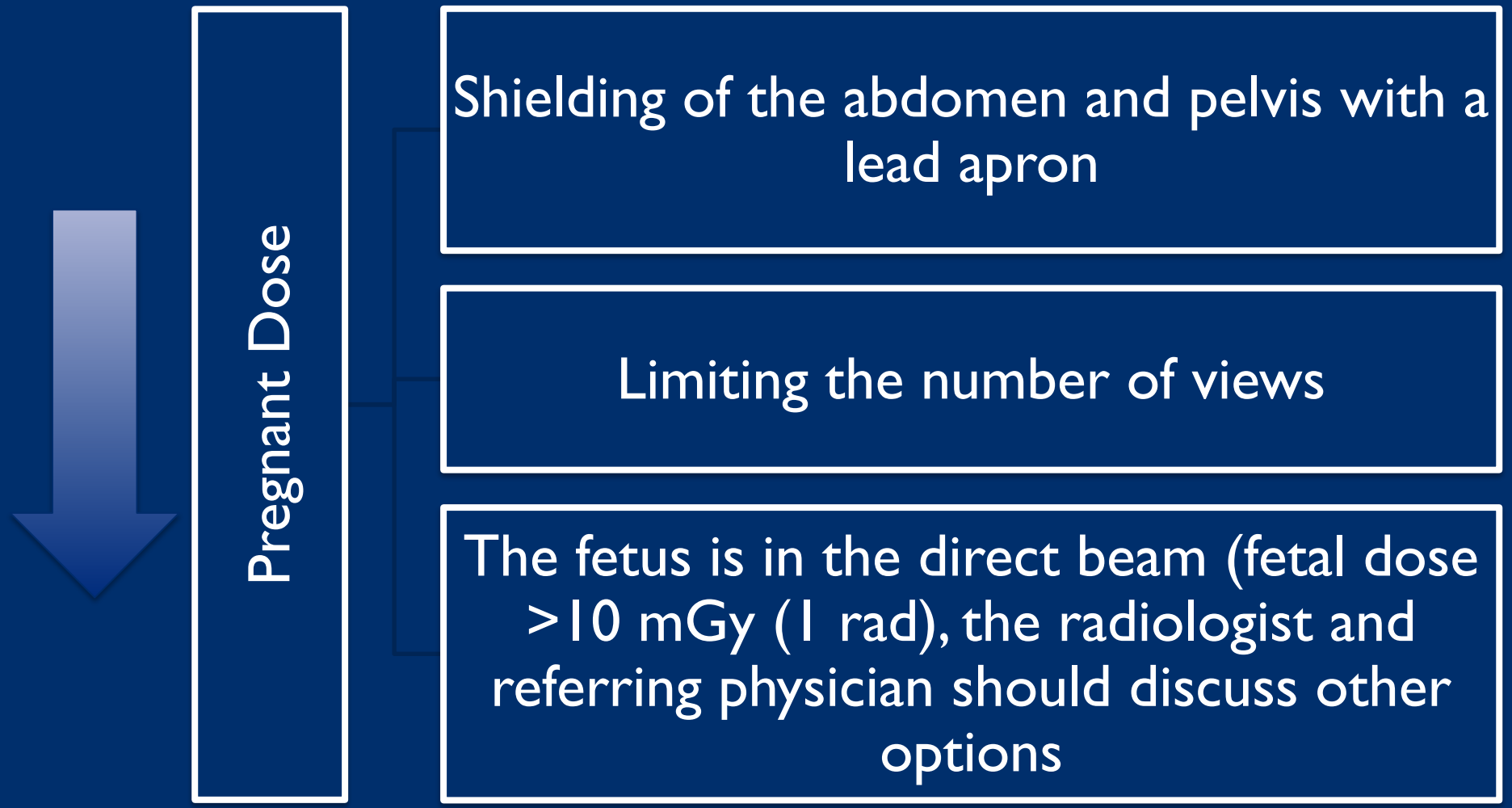
"whenever possible, one should confine the radiological examination of the lower abdomen and pelvis in the TEN-day interval following the onset of menstruation"

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.

Radiation Protection for Pregnancy – Cont.



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

Radiation Protection for Pregnancy – Cont.

Examination	Typical fetal dose (mGy)	Risk of childhood cancer per examination
Chest	0.001 – 0.1	<1 in 1,000,000

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.

Radiation Protection for Pregnant Technologists:

- 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

Reference: The Textbook of Radiographic Positioning & Related Anatomy, 8th Edition (ISBN 978-0-323-08388-1). Authors Kenneth L. Bontrager and John P. Lampignano.

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

Design for Radiation Protection

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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

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

Reference: The Textbook of Radiographic Positioning & Related Anatomy, 8th Edition (ISBN 978-0-323-08388-1). Authors Kenneth L. Bontrager and John P. Lampignano.

Patient Protection – Cont.

1. 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

Reference: The Textbook of Radiographic Positioning & Related Anatomy, 8th Edition (ISBN 978-0-323-08388-1). Authors Kenneth L. Bontrager and John P. Lampignano.

Patient Protection – Cont.

1) inherent or built-in filtration (0.5 mm aluminium equivalent)
2) added filtration, metal filter (aluminium or copper or combination of these)

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

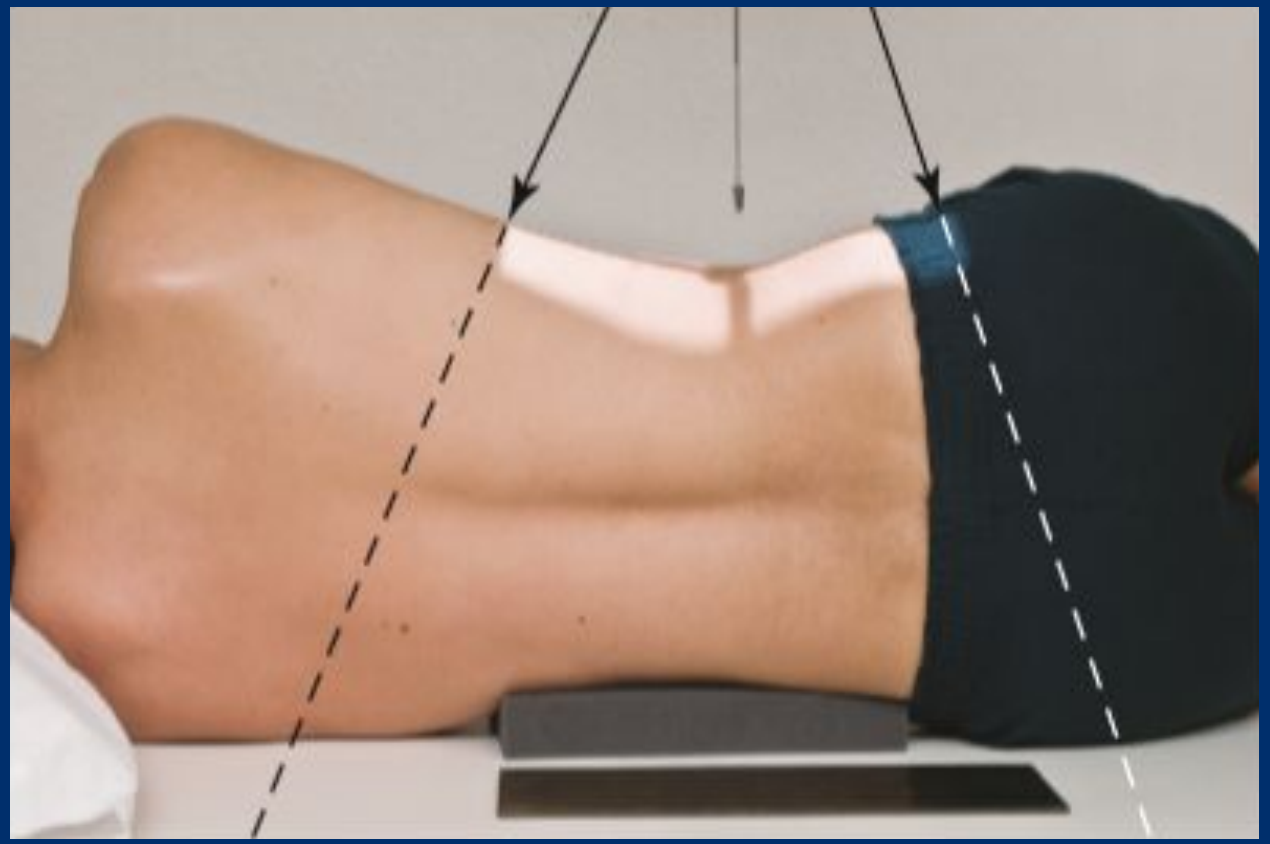
Reference: The Textbook of Radiographic Positioning & Related Anatomy, 8th Edition (ISBN 978-0-323-08388-1). Authors Kenneth L. Bontrager and John P. Lampignano.

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

Reference: The Textbook of Radiographic Positioning & Related Anatomy, 8th Edition (ISBN 978-0-323-08388-1). Authors Kenneth L. Bontrager and John P. Lampignano.



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

Reference: The Textbook of Radiographic Positioning & Related Anatomy, 8th Edition (ISBN 978-0-323-08388-1). Authors Kenneth L. Bontrager and John P. Lampignano.

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.

Reference: The Textbook of Radiographic Positioning & Related Anatomy, 8th Edition (ISBN 978-0-323-08388-1). Authors Kenneth L. Bontrager and John P. Lampignano.

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).

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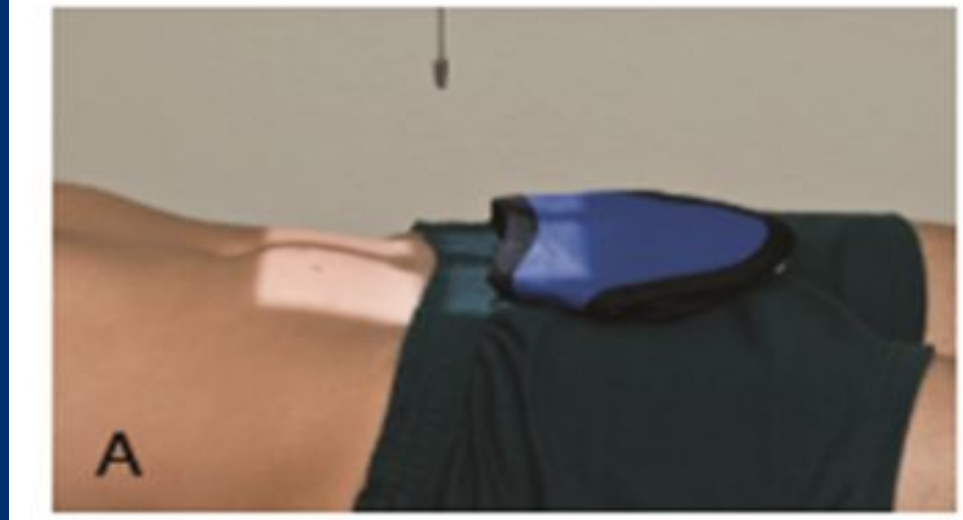
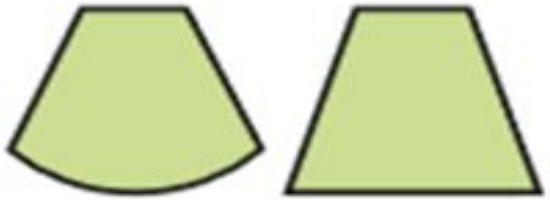


–Male gonadal shield



B Possible shapes

–Female ovarian shield

B Possible shapes

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

Reference: The Textbook of Radiographic Positioning & Related Anatomy, 8th Edition (ISBN 978-0-323-08388-1). Authors Kenneth L. Bontrager and John P. Lampignano.

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)

Reference: The Textbook of Radiographic Positioning & Related Anatomy, 8th Edition (ISBN 978-0-323-08388-1). Authors Kenneth L. Bontrager and John P. Lampignano.

Personal Monitoring Devices

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

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

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Personal Monitoring Devices – Cont.

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

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

Reference: The Textbook of Radiographic Positioning & Related Anatomy, 8th Edition (ISBN 978-0-323-08388-1). Authors Kenneth L. Bontrager and John P. Lampignano.

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 **RADIOLOGIC 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:

No	Advantages	Disadvantages
1	High sensitivity	Sensitivity to light
2	High precession	
3	Readout flexibility	
4	Convenience	

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Personal Monitoring Devices – Cont.

Pocket Dosimeter

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

No	Advantages	Disadvantages
1	Immediate reading	Limited range
2	Reusable	No permanent record
3	Readout flexibility	Sensitive to mechanical problems
4	Convenience	

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

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
Access for free at https://commons.wikimedia.org/wiki/File:Pocket_dosimeter_RKGB-01_Gorin.jpg

Personal Monitoring Devices – Cont.

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.

No	Advantages	Disadvantages
1	Very sensitive	High initial cost
2	Good for measuring pregnancy doses	

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

THANK YOU !