

**READING HOSPITAL SCHOOL OF HEALTH SCIENCES
MEDICAL IMAGING PROGRAM
RADIATION PROTECTION—2020**

Limiting Patient Exposures

I. Holistic Patient Care

- a. Definition:

II. Effective Communication & Body Language

- a. Introduce yourself
- b. Address the patient properly
- c. Ease patient stress and anxiety
- d. Understanding and dignity
- e. Clear and concise instructions
- f. Increase their cooperation
- g. Give them time to ask questions
- h. Gain their trust (Tell them if there is discomfort or pain involved or strange sensations)
- i. Be professional, be present and watch body language
- j. Reduce repeat exposures

III. Patient Motion

- a. Involuntary motion

1. Definition:

2. Heart, digestive, chills, tremors, spasms, pain

3. Corrected by reducing exposure time and increasing screen speed

b. Voluntary motion

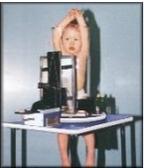
1. Definition:

2. Lack of control caused by: age, breathing, anxiety, discomfort, fear, mental instability

3. Corrected by:

IV. Immobilization

a. Piggostat



b. Papoose/ Octostop



c. Sponges and Sandbags



d. Mummy Wrap

e. Tape

f. Velcro straps

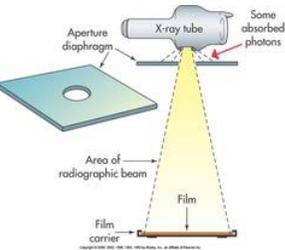
g. Radiolucent plexiglass

h. Non- radiology employee holds patient

V. Beam Limiting Device

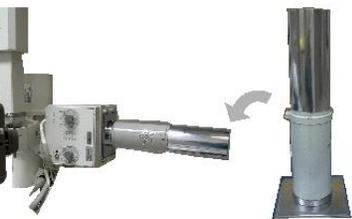
- Limits the primary beam to a smaller area
- Decreases exposure by reducing the amount of tissue that is exposed
- Reduces _____
- Types

1. Aperture diaphragm



- Flat lead with a hole cut in it and placed below the window
 - Most common: _____
 - Square
 - Round
- Reduces _____

2. Cones



- Circular metal cylinders that connect to front of the tube and limits the size of the beam
- Can be flared or straight
- Can be telescoped (10-12 inches) to make field size smaller- called extensive cylinder
- Have been replaced by _____
- Mostly used in _____ but can be used for heel, skull and spine images

3. Collimators

- Also called light localizing variable aperture rectangular collimator
- Most versatile
- Should not be opened larger than body part
 - Post shuttering is part of the ASRT Practice Standards
- Can reduce exposure by _____

e. Careful not to over collimate (make it too small) which causes repeat images

f. 2 sets of shutters 90 degrees from one another

- Near (upper)

- Located close to window

- Reduces exposure from

- Far (lower)

- Located close to light source

- Confines the beam to area of interest

g. Skin sparing

- Minimizes skin exposure by requiring a _____ cm distance from skin to collimator

- Can be achieved by spacer bars mounted on the tube

h. PBL- Positive Beam Limitation

- Electronic sensors in the bucky that sense the size of the IR that is used and opens the collimators appropriately

- Slits or pegs

- Reduces human error

- Also known as _____

- Regulated to be within 2% accuracy



VI. Filtration

a. Hardens the beam by cleaning up low energy (long wavelength)

b. Reduces patient exposure to skin and superficial surface

c. Reduces absorbed dose

d. Lower energy photons provide no detail to the image

- e. Total filtration in the housing is _____ mm Aluminum (Al) equivalent for units that operate above 70kVp

1.2 types of filtration

- Inherent
 - _____ mm Al equivalent
 - Made up of glass envelope, insulating oil, and glass window
 - Added
 - _____ mm Al equivalent
 - Made up of sheets of Al added outside the glass window above the collimator
 - Can be accessed by service person
 - Can be changed as tube ages
- b. Mobile and fluoroscopy require _____ mm Al filtration
- c. NCRP Report # _____ lists minimum requirements for filtration
- d. Radiation Control for Health and Safety Act of 1981 states that x-ray tube must have adequate filtration
- Verified by half value layer (HVL)
 - Measures beam quality or effective energy of the beam
 - Measured at least once a year by a physicist or if the tube is replaced or repairs are made

VII. Shielding

- a. Needed to reduce exposures to radiosensitive organs (eye, breast, reproductive)
- b. 2 types

1. Gonadal

- a. Should be used if the gonadal area is within _____ cm of the collimation field

- b. Unless covering area of interest
- c. First step to gonadal protection is proper _____
- d. Due to location of gonads females receive _____ more exposure
- e. Appropriate shield placement can reduce exposure
 - Female _____ %
 - Male _____ %
- f. Placement of contact of shadow shields
 - Female- place shield at the level of ASIS and should extend to 1/2 inch above the superior rim of the pubic bone.
 - Male- place shield just below the pubic bone.
- g. Types of gonad shield

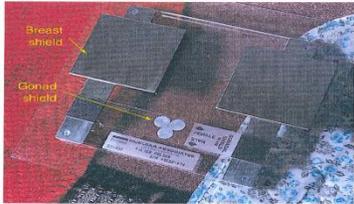


FIGURE 12-8 Lead filter with a breast and gonad shielding device. This shield functions as a shadow shield.



FIGURE 12-9 Shaped contact shields (cuplike in shape) may be held in place with a suitable carrier.

- Flat contact/ figleaf
 - Most effective in AP or PA view (on the front side or backside of patient)
- Shadow
 - Needs to be carefully placed
 - Not useful in fluoro
- Shaped
 - Contoured to male anatomy
 - Placed by patient
 - Not useful with PA projection
- Clear lead- transparent lead
- Half shield
 - Used for gonadal protection of patient
 - Covers front or back of patient and is



attached by velcro strap or on wheels

h. Guidelines for Shielding According to the Center for Devices of Radiological Health

- If the gonads lie within or close to (about 5cm from) the primary x-ray field despite proper beam limitation
- If the clinical objective of the examination is not compromised
- If the patient has a reasonable reproductive potential

2. Specific

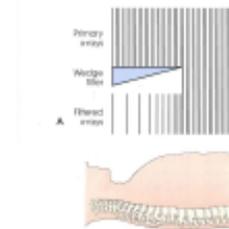
- a. Eye
- b. Breast
- c. Thyroid
- d. Glove

VIII. Compensating Filters

- a. Used when x-raying a part that has varying thickness to reduce dose and provide a uniform density across the image
- b. Decreases the entrance skin exposure
- c. Constructed of aluminum or lead-acrylic that is attached to the bottom of the collimator
- d. Types

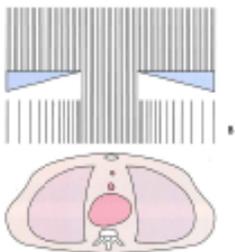
1. Wedge

- a. Used for foot or spine



2. Trough

- a. Used for chest



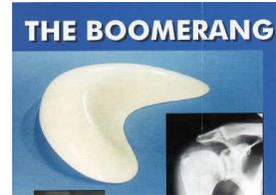
3. Ferlic

- a. Used for hips



4. Boomerang

- a. Used for shoulders



IX. X-ray Terminology

- a. kVp/ kilovoltage peak

1. Maximum possible energy of a photon that exits the x-ray tube
2. This is a unit selected on the operating console
3. _____ proportional to patient exposure

- b. mA/ milliamperage

1. Measurement of x-ray tube current or the number of electrons crossing the tube from cathode
2. This is a unit selected on the operating console
3. _____ proportional to patient exposure

- c. mAs/ milliamperere seconds

1. Controls the amount of radiation produced by the x-ray tube
2. $\text{mA} \times \text{seconds} = \text{mAs}$
3. _____ proportional to patient exposure

- d. AEC/ Automatic exposure control

1. The cells that are selected on the operating console that will automatically select the _____ according to cell selection and body part

X. Exposure Index (EI)

- a. The number that is found on the image after processing to identify if the image was exposed properly

Use Proper Exposure Factors

- b. Makes an optimal image with minimum dose



- c. Sufficient penetration
- d. Increase _____, decrease _____
- e. When setting manual technique, measure the patient for accuracy
- f. Technique charts
- g. AEC
- h. AEC/ Automatic Exposure Control

1. Sets the appropriate _____ for the body part being x-rayed by selecting cells

XI. Proper Film Screen Combination

- a. Increase in film screen speed _____ patient exposure but decreases sharpness
- b. Computed Radiography acts as a 200 speed image receptor
- c. Digital Radiography acts as a 200 or 400 speed image receptor

XII. Correct Processing

- a. Inadequate processing results in _____
- b. Careful loading and unloading of film is important
- c. Strict quality control standards need to be maintained

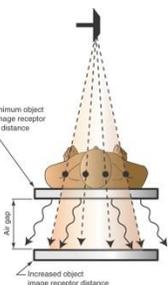
XIII. Radiographic Grids

- a. Rule of thumb is to use a grid when part thickness is over _____ cm
- b. Removes scatter that comes from the patient before they reach the image receptor
- c. Improves the contrast and detail of the image
- d. Grids _____ patient dose but improves the quality of the image which provides a better diagnosis

1. Use _____ grid ratio appropriate for the body part

XIV. Air Gap Technique

- a. Alternative to using a grid to clean up _____
- b. Patient is placed _____ inches away from the image receptor with a 10-12 feet SID
- c. Negative side is the increase in magnification and not useful in kVp higher than 90



XV. Eliminate Repeats

- a. _____ is any image that must be done more than once due to human or mechanical errors
- b. Patient receives a _____ dose
- c. Repeats are unacceptable if done due to carelessness or poor judgment
 - 1.Positioning
 - 2.Technique
- d. Repeat analysis
 - 1.Problems with positioning
 - 2.Incorrect centering
 - 3.Inappropriate technical factors
 - 4.Improper collimation
 - 5.Foreign bodies
 - 6.Processing artifacts
 - 7.Patient motion

XVI. Unnecessary Exposures

- a. Chest x-rays
 - 1.Pre admission
 - 2.Pre employment
 - 3.Routine health check ups
 - 4.Screening for TB
- b. Lumbar x-rays
 - 1.Pre employment
- c. CT whole body scans
 - 1.Check for disease

XVII. Mobile X-rays

- a. Minimal source to skin distance on a mobile fluoroscopy unit is _____ inches or _____ cm
- b. The smaller the source to skin distance the larger the entrance exposure
- c. Only perform portable x-ray on patients that cannot be transported to the department

XVIII. Digital Radiography & Computed Radiography

- a. Just because the image is able to be manipulated, does not excuse over exposing the patient
- b. Utilization of technique charts
- c. Grids

XIX. Fluoroscopy

- a. Largest exposure to patients in diagnostic radiology
- b. Limit Exposures
 - 1. Image Intensification
 - a. Increases brightness on screen
 - 2. Intermittent or pulse fluoro
 - 3. Limit magnification mode
 - 4. Limiting field size
 - 5. Techniques
 - 6. Filtration- Reduces skin dose
 - 7. Shielding- Underneath patient if tube is under table
 - 8. Source to skin distance
 - a. NCRP states _____ inches or _____ cm for fixed units and _____ inches or _____ cm for mobile units
 - 9. Cumulative timing device
 - a. Audible alarm at _____ minutes
 - b. Who is responsible to record fluoro time? _____

10. Exposure rate limit- Federal regulations for table top exposures is _____

mGy per minute

11. Primary protective barrier

a. 2 mm lead equivalent for II that is built into to equipment

*Automatic Brightness Control/ Stabilization -ABC/ ABS: no matter what kVp or mA, the brightness of the image will remain the same

*Automatic Exposure Rate Control- AERC- adjusts exposure factors automatically to adjust fluoroiing over varying thicknesses

12. Fluoro exposure switch

a. Called a dead man switch

- Foot pedal requires _____ pressure to continue with fluoro
- So if the user would “fall over dead” the exposure will stop

13. Fluoroscopically guided positioning (FGP)

a. Using fluoro to

b. ASRT stand is that this practice is unethical and should never be used

XX. Digital Fluoroscopy

a. Beam turns off while image is scanned and then turns back on

1.Pulsed

b. Dose Area Product- DAP: newer fluoro systems provide the sum of the air kerma (energy) over the exposed are of the patient

c. Last image hold

1.When the foot comes off the pedal, it holds the last iamge and displays it on the screen until the foot pedal is activated again

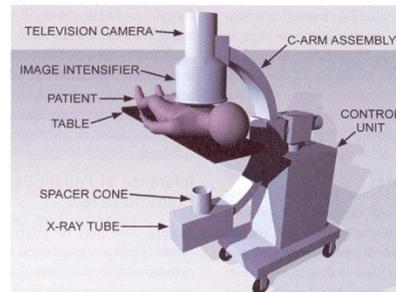
XXI. Fluoroscopy Guided Positioning (FGP)

- a. Using fluoro to determine the patient is positioned correctly before taking an x-ray
- b. ASRT stand- unethical and should not be used

XXII. C-arm Fluoroscopy

- a. Used in the

- 1. _____
- 2. _____
- 3. _____



- b. Lengthy cases have the potential for high doses
- c. Properly trained personnel to work the equipment
- d. _____ inches or _____ cm minimal distance to the patient

1. Spacers are usually placed to maintain a safe distance

- e. C-arm should be positioned with the _____ on top

1. Reduces scatter and patient dose

XXIII. Cinefluoroscopy

- a. Used in

- 1. _____
- 2. _____

- b. Works like a movie
- c. Reduce patient exposure
 - 1. Limit time without losing information
 - 2. Collimate
 - 3. Last frame hold

XXIV. Interventional Radiology

- a. Invasive sterile procedures performed by a physician under fluoro
- b. FDA requires documentation in the patient chart if skin dose is _____ Gy

- c. Federal regulations for table top exposures of high level control fluoro are _____mGy per minute
- d. Should be performed by an educated and trained physician
 - 1.Keeps patient doses and occupational doses down

XXV. Radiation Dose Measurements

- a. Entrance Skin Exposure (ESE)- includes skin and glandular
- b. Skin Dose- Absorbed dose to the most superficial layers
- c. Gonadal Dose
 - 1.Genetically significant dose (GSD)- assess the effects of gonadal dose
 - a. US dose is _____mSv
- d. Bone Marrow Dose/ Mean marrow dose- dose to entire active bone marrow

XXVI. Pregnant Patient

- a. Asking LMP (last menstrual period)
 - 1.Define

- b. 10 day rule
 - 1.ICRP recommendation from 1970
 - 2.X-rays should be done within 10 days of onset of period. Most females are probably not pregnant at this time; considered obsolete
- c. ACR’s position on pregnant patients
 - 1. “Abdominal radiological exams that have been requested after full consideration of the clinical status of a patient, including the possibility of pregnancy, need not be postponed or selectively scheduled.”
- d. Elective exams should be scheduled according to the 10 day rule
- e. 10-25 rad rule



1.<10- ok

2.10-25- consider options

3.>25- not good

f. Radiology departments are responsible to post pregnancy signs

g. If a pregnant patient must be x-rayed

1.Minimize the dose

a. Smallest exposure that will produce optimal images

2.Collimate

3.Lead apron should be provided if not in area of interest

4.RH patient must sign a consent form if the pelvic/ abdomen area is being x-rayed

XXVII. Mammography

a. Utilizes low _____

b. Limit number of projections

c. Adequate compression

d. Avoid axillary exposure unless ordered by radiologist



XXVIII. CT

a. Doses are _____ than diagnostic radiology

b. Shielding is not utilized because of the nature of the exposure

c. Collimators are very tight in CT, exposure is caused by internal scatter



XXIX. Pediatric Patients

a. More sensitive to exposure due to rapidly dividing cells

b. Longer life span can increase chances of developing a radiation induced leukemia or a radiogenic malignancy such as _____ or _____

c. Decreasing exposure to pediatric patients

1.Communicate at their level

2. Minimize repeats
3. Minimize number of images taken
4. Use collimation
5. Use short exposure times
 - a. appropriate exposure factors
 - b. Less exposure is needed to obtain optimal images
6. Shield
7. Immobilization

XXX. Morbid Obesity

- a. Center patient to table because landmarks are hard to palpate
- b. Skeletal anatomy and organ size does not change except possibly:
 1. _____
 2. _____
 3. _____
- c. Increase _____ to increase penetration of the x-ray beam
- d. Use grids to clean up scatter
- e. Smaller collimation = decrease scatter

XXXI. Image Gently Campaigns

- a. CT- One Size Does Not Fit All
- b. Digital- Back to Basics
- c. NM- Go With the Guidelines
- d. Fluoro- Pause and Pulse
- e. AIR- Step Lightly
- f. Child focus is Image Gently
- g. Adult focus is Image Wisely



XXXII. Equipment Safety

- a. On and off switches
- b. Interlocks
 - 1. Detents
 - 2. Fluoro locks
- c. Visual/ audio monitors
 - 1. Control panel
 - 2. Laser light
 - 3. Tape measures
- d. Emergency controls