Fluoroscopy Review

Cohort 3

Definitions

- Absorbed dose
  - Energy imparted by ionizing radiation per unit mass of irradiated material
  - rad and Gray (Gy)
- ALARA
  - As Low As Reasonably Achievable
- Aluminum
  - Provides x-ray beam filtration: designed to absorb less penetrating x-ray photons

Definitions

- ADC
  - Analog to Digital Converter
- Anode
  - Positive electrode of the x-ray tube
- AERC
  - Automatic Exposure Rate Control

Definitions

- Barriers
  - Primary: designed to absorb useful or primary beam
  - Secondary: designed to absorb scatter or leakage radiation
  - Structural: 1/16” primary, 1/32 secondary
  - Image Intensifier housing is the primary barrier in fluoroscopy

Definitions

- Collimation
  - Restricting/confining/limiting a beam of radiation
    - **Most important method of reducing patient dose in fluoroscopy**
- Controlled area
  - Access as to which can be controlled by the licensee

Definitions

- Dead man’s switch
  - Radiation emission stops when pressure on fluoroscopy switch is released
- Dosimeter
  - Instrument used to detect and measure accumulated radiation exposure
    - Personnel: designed to be worn by an occupational worker

Definitions

- Effective Dose Limit ("E" or EfD)
  - Established limits for personnel
  - 5 rem whole body, 15 lens of the eye, 50 for skin/extremities
- Equivalent Dose
  - In rem for amount actually received

Definitions

- Field of view (FOV)
  - Area which can create a usable image
- Filtration
  - Aluminum or equivalent: absorbs lower energy photons
- Frame rate
  - Number of sequential images per unit of time (normal in seconds)

Definitions

- Gonadal shielding
  - Designed to protect the human gonads from radiation
- Image Intensifier
  - An x-ray image receptor that increases the brightness of the fluoroscopic image by electronic amplification and image minification
- Input phosphor (input screen)
  - CsI: converts x-ray into light
  - Full diameter is "normal mode"

Definitions

- Integration time
  - Time required by the eye for recognition of an image on the monitor
- Interrogation time
  - Time required for the x-ray tube to be switched on and reach selected levels of kVp and mA
  - Time required for the x-ray tube to be switched off is the extinction time

Definitions

- Magnification
  - Ratio of object size to image size
  - Magnification mode: occurs when useful area of the input phosphor is decreased
- Matrix
  - An array of circuit elements
    - Rows and columns
- Non-stochastic (deterministic)
  - Severity of health effects which vary with dose and a threshold is believed to exist

Definitions

- Panel
  - Tabletop of the imaging unit
  - TPD, STTD
- Pixel
  - Picture element: smallest unit of a matrix
    - DEL: detector element of an image receptor (contains a storage capacitor and a TFT, which is a switch

Definitions

- Protective apron
  - For operator and others during fluoroscopy (reduces radiation exposure)
- rad
  - Unit of absorbed dose
  - Gray (Gy)
  - Equal to a dose of 100 ergs/gram (or 0.01 joule/kg (0.01 Gy)

Definitions

- rem
  - Dose equivalent (rad x W_R)
  - Sievert (Sv)
- Source-to-Image Distance (SID)
  - Distance from the focal spot on the anode to the surface of the image detector
- Source-to-Skin Distance (SSD)
  - Distance from focal spot on the anode to the surface of the irradiated object or patient

Definitions

- Supervision
  - Responsibility for, and control of, quality, radiation safety, and technical aspects of all x-ray examinations and procedures
- Target
  - Same as focal spot on anode
- Visual acuity
  - Ability of the eye to resolve the angular separation of two objects

Math Equations for Fluoroscopy

Minification Gain

- In the image intensifier
- Represents the increase in output image brightness (at the output phosphor) as a result of reduction in image size
- Unless the size of the output phosphor is given, assume it is 1" (2.5 cm)

$$\frac{\text{Input phosphor size}^2}{\text{Output phosphor size}^2}$$

Total Brightness Gain

- In the image intensifier
- Need flux gain from the manufacturer
  - Increase in output image brightness expressed as a ratio of the number of light photons at the output phosphor to the number of light photons produced at the input phosphor

Total Brightness gain

TBG = Flux gain x Minification Gain

Dose Change with Magnification

- Anytime the unit is switched from normal mode to magnification mode, there is an increase in patient dose
- Normal mode is ALWAYS represented by the largest number given as it is the size of the input phosphor

Dose Change with Magnification

- If switching from magnification mode to normal mode, the dose will decrease
- In either case, the formula stays the same
- The number represented is the degree of change – there are no qualifiers

$$\frac{\text{Normal Mode}^2}{\text{Mag Mode}^2}$$

Inverse Square Law

- Any time distance from an x-ray source is changed, there is an effect on patient dose
- Changing distance will have the most profound impact on dose

$$\frac{Intensity_1}{Intensity_2} = \frac{Distance_2^2}{Distance_1^2}$$

Pixel Size

- Pixel size has an impact on resolution and detail
- Smaller pixel in a given field size (in mm) will increase resolution

$$\frac{Field\ size}{Matrix}$$

Conversions

- Inches to cm: multiply by 2.54
- cm to mm: multiply by 10
- rem to Sievert: multiply by 100
- rad to Gray: multiply by 100
- Gray to rad (Sv to rem): divide by 100
- 1 (unit) = 1000 milli (units)
  - 1 rem = 1000 millirems

The Numbers

- Gonadal shielding: 0.5 mm Pb minimum
- Protective aprons: ***shall*** be 0.25 mm Pb and **should** be 0.5 mm Pb
- Bucky slot cover, lead gloves, thyroid shield, lead glasses, protective drapes: all 0.25 mm Pb minimum
- Image intensifier is primary barrier: 2 mm Pb for units operating at 125 kVp and above

The Numbers

- Table attenuation: no more than 1 mm Al at 100 kVp
- X-ray tube: shielded so that it does not exceed 100 mR/hr at 1 meter
- Filtration: 2.5 mm Al at 80 kVp
- Exposure rates: 2.2 R per mA at 80 kVp; no more than 5 R/min (with AERC no more than 10 R/min); no more than 10 R/min with boost (with AERC no more than 20 R/min)

The Numbers

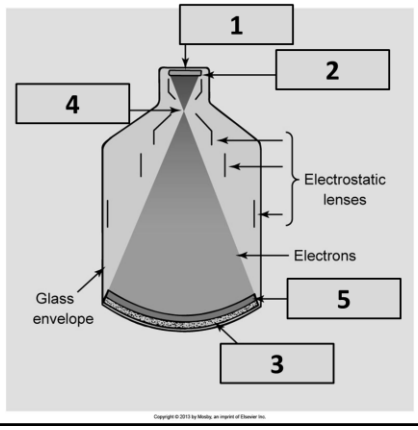
- Physicist survey of equipment: every 3 year *without AEC*; every year *with AEC*; AND anytime with modification or transfer
- STTD, TPD: ***shall*** be no less than 12”; ***should*** be at least 18”
- Monitoring required when using mobile equipment OR if expected to receive 1/10 of EfD limit (DL)

The Numbers

- Dose Limits
  - Occupational: 5 rem (50 mSv) whole body, 15 rem (150 mSv) lens of the eye, 50 rem (500 mSv) skin/extemities
    - Pregnant worker: 0.5 rem (5 mSv) for gestational period, 0.05 rem (0.5 mSv) per month
  - Non-occupational: 0.5 rem whole body, 1.5 rem eyes, 5 rem skin/extremities

The Numbers

- Radiation area: 0.005 rem (0.05 Sv) in 1 hour at 30 cm from the source
- High radiation area: 0.1 Rem (1 mSv) in 1 hour at 30 cm from the source
- Very high radiation area: 500 rads (5 Gy) in 1 hour at 1 meter from the source
- Controlled area: barrier reducing exposure to less than 100 mrem/wk
- Uncontrolled area: barrier reducing exposure to less than 2 mR/wk



Now What?

- Met recently with the liaison for the sponsor
- Time frame you need to be aware of:
  - You have about six months from the start of the course to complete the didactic and clinical training
  - You will have about a year to apply to the state to take the exam

Now What? (cont)

- If you have not complied with either time frame, you and your manager will receive a letter reminding you of the time frame and asking you to complete the task(s)
- Further actions are being developed
- Once you complete this course (have certificate in hand), you are NOT allowed to perform fluoroscopy until you have passed the state fluoroscopy test