

**FLUOROSCOPIC SAFETY AND PATIENT AND
OPERATOR RADIATION DOSE REDUCTION:
CREATING A FOCUSED FLUOROSCOPIC
CURRICULUM FOR RADIOLOGY RESIDENTS**



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- DISCLOSURES: NONE

Background/Purpose

- 1) Radiology residents often lack a strong knowledge of the basics of fluoroscopy, including ways to reduce patient and operator radiation dose.
- 2) We created a focused curriculum to review the basics of fluoroscopy, image production, as well as occupational dose monitoring and effects of radiation, including deterministic and stochastic effects. Additional methods to reduce radiation dose to the patient and operator are included.
- 3) During the summer of 2016, a series of 4 teaching conferences were created by two second year radiology residents dedicated to fluoroscopic safety were presented to our radiology residents. A pre and post curriculum survey questionnaire was administered to assess radiology resident's improvement in their knowledge of this subject.

Basics of Fluoroscopy

- Fluoroscopy involves the use of x-ray imaging in real time for diagnostic and therapeutic purposes.
- Radiation dose that is delivered to the patient is dependent on the fluoroscopic procedure time, mA, kVp, collimation, magnification and additional factors.
- Fluoroscopy is performed at lower x-ray tube current (~ 3 mA) for continuous operation
- Radiography is static and has higher tube current (approximately 100 times higher).

Fluoroscopy Unit

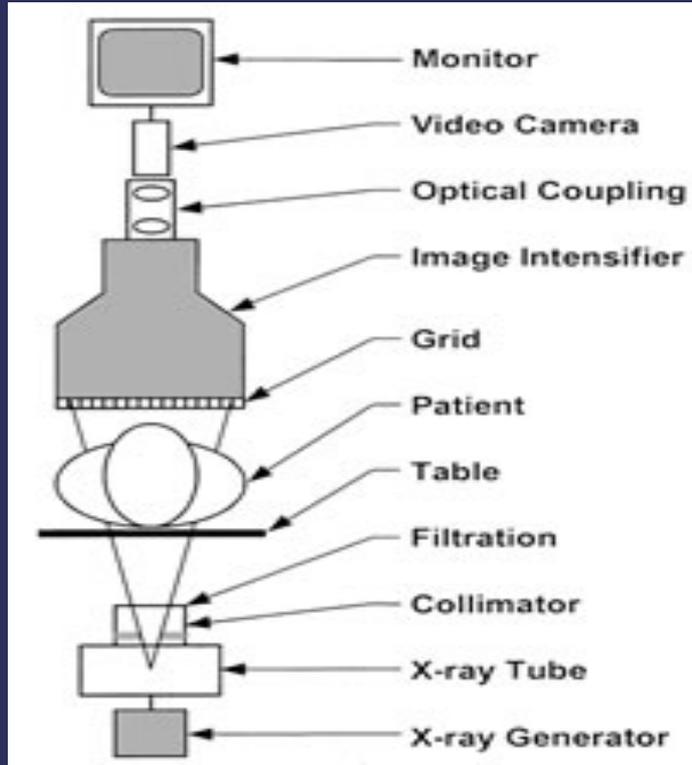


Figure 1. Schematic Diagram of a fluoroscopic system using an X-ray image intensifier (XRII) and video camera

Reprinted from RadioGraphics;20(4), Schueler BA, The AAPM/RSNA physics tutorial for residents general overview of fluoroscopic imaging – Fig 2, p1117, 2000, with permission from RSNA.

Occupational Dose Monitoring and Protective Equipment During Fluoroscopy

- Radiation dose badge (s) should be worn at all times when there is potential occupational exposure to radiation, so that dose to radiosensitive organs can accurately be measured and reported. Radiation dose badge does NOT provide protection from radiation.
 - If there is only a single badge, it should be worn at the collar level outside the lead.
 - If a 2nd badge is provided, such as in interventional radiology, the 2nd badge should be worn under the lead apron at the waist level.
- Appropriate Attire for Purpose of Dose Reduction
 - Lead apron of at least 0.5mm lead (Pb) or lead equivalent thickness to provide 90% exposure dose reduction to the operator and staff
 - Thyroid collars shield the radiosensitive thyroid .

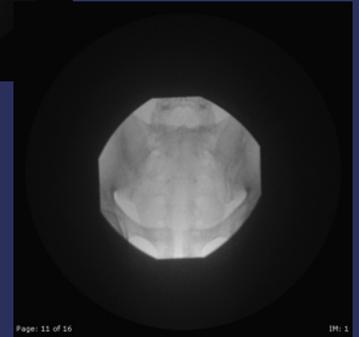
Dose Limit to the Lens

- Subcapsular posterior lens is the part of the lens that is most commonly affected by radiation, leading to cataracts
- Lead lined goggles/glasses are used to protect against radiation to the lens and provide 5 to 10 fold dose reduction to the lens
 - Goggles equipped with lateral eye shields provide additional protection from scatter radiation to eye from lateral/peripheral direction
- Radiation Dose Limit to the Lens:
- Per NRC (Nuclear Regulatory Committee) regulations, 15 rems or 150 mSv annually
- Per ICRP (International Commission on Radiological Protection) guidelines, 20 mSv per year averaged over 5 years with no annual exposure greater than 50 mSv



Ways to Reduce Radiation Dose

- Reducing fluoroscopy time
 - last image hold (LIH)
 - fluoroscopy store
- Dose reduction during fluoroscopy
 - magnification
 - collimation
 - grid
 - using continuous vs. pulse fluoroscopy
 - automated brightness control
 - x-ray tube current and voltage (kVp and mA)



Radiation Effects

- **Deterministic Effect:** Biologic effect that can occur above a certain threshold radiation dose during a single radiation exposure
 - Skin erythema: 2 Gy
 - Permanent Sterility: 5 Gy
 - Hematopoietic effect: 3-5 Gy
 - Gastrointestinal syndrome: 10 Gy
 - Neurovascular syndrome: 50 Gy
- **Stochastic Effect:** occur by chance and which may occur without a threshold level of dose, whose probability is proportional to the dose and whose severity is independent of the dose.
 - Risk of developing cancer
 - No specific dose threshold
 - Linear type relationship

Journal Clubs

- 2 Additional Journal Club Lectures were given reviewing the following articles that covered relevant topics in fluoroscopy:
 - Mahesh, M. (2001). Fluoroscopy: Patient Radiation Exposure Issues1. *RadioGraphics*, 21(4), 1033-1045. doi:10.1148/radiographics.21.4.g01jl271033
 - Hernanz-Schulman, Marta, Marilyn J. Goske, Ishtiaq H. Bercha, and Keith J. Strauss. “Pause and Pulse: Ten Steps That Help Manage Radiation Dose During Pediatric Fluoroscopy: American Journal of Roentgenology: Vol. 197, No. 2 (AJR).” *American Journal of Roentgenology*. N.p., Aug. 2011. Web. 08 July 2016.

Sample Survey Questions

- Q: Which of the following does NOT help reduce radiation dose to the operator?

A) Lead apron
B) Lead lined glasses
C) Radiation dose badge
D) Thyroid collars

- Q: What is the annual radiation dose limit to the lens?

A) 15 rems (0.15 Sv)
B) 20 rems (0.20 Sv)
C) 50 rems (0.50 Sv)
D) 5 rems (0.05 Sv)

- Q: What is the best measure of radiation dose in fluoroscopy?

A) Fluoroscopic Exposure Time
B) Sieverts
C) Air Kerma
D) Dose Length Product

Sample Survey Questions

Q: In fluoroscopy systems, which of the following can have an impact on reducing the patient radiation dose?

- A) Lower fluoroscopy pulse rates**
- B) Decreased x-ray beam filtration
- C) Smaller field-of-view (FOV)
- D) Decreased source to skin distance

Q: Pulsed fluoroscopy only reduces patient dose when acquiring frames at less than ____ frames/second?

- A) 30**
- B) 40
- C) 45
- D) 60

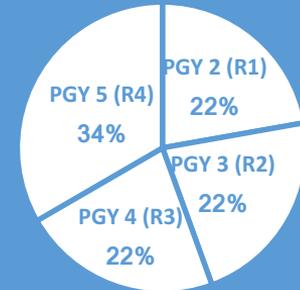
Q: How does collimation during fluoroscopy impact imaging results?

- A) Improves spatial resolution
- B) Improves temporal resolution
- C) Reduces fluoroscopic noise
- D) Improves image contrast**

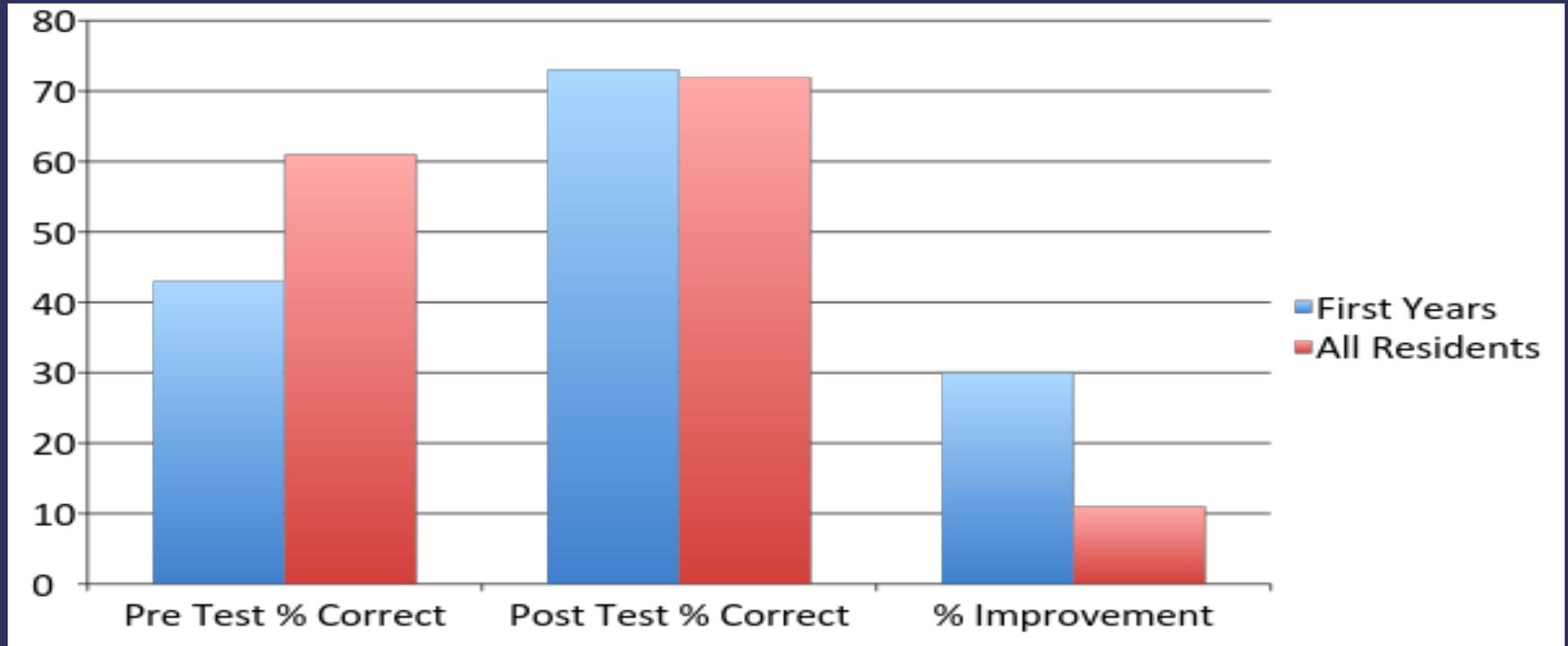
Survey Demographics & Results

- 18 Radiology Residents took the survey, 4 of whom were first year radiology residents.
- Overall the residents' scores improved by 11% from average pre-test score to post-test score upon completion of the dedicated fluoroscopy curriculum.
- First year residents showed the greatest improvement in average score from 43% average on the pre-test exam to 73% post-test, for a 30% improvement in score.

SURVEY PARTICIPANT
DEMOGRAPHICS



Schematic of Survey Results



Conclusions

- A dedicated fluoroscopic curriculum was helpful in improving our radiology residents' understanding of different aspects of fluoroscopy, including radiation safety as well as patient and operator dose reduction techniques
- This formal curriculum can serve as a blueprint for other radiology residencies to incorporate into their own training programs.
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