2025

Radiation Dose Reduction Strategies in Interventional Radiology

Breanna Fluhr
Misericordia University

Radiation Dose Reduction Strategies in Interventional Radiology

MISERICORDIA UNIVERSITY

Student Researcher: Breanna Fluhr

Faculty Advisor: Dr. Elaine Halesey, Ed.D., R.T. (R)(QM)(ARRT)

Introduction

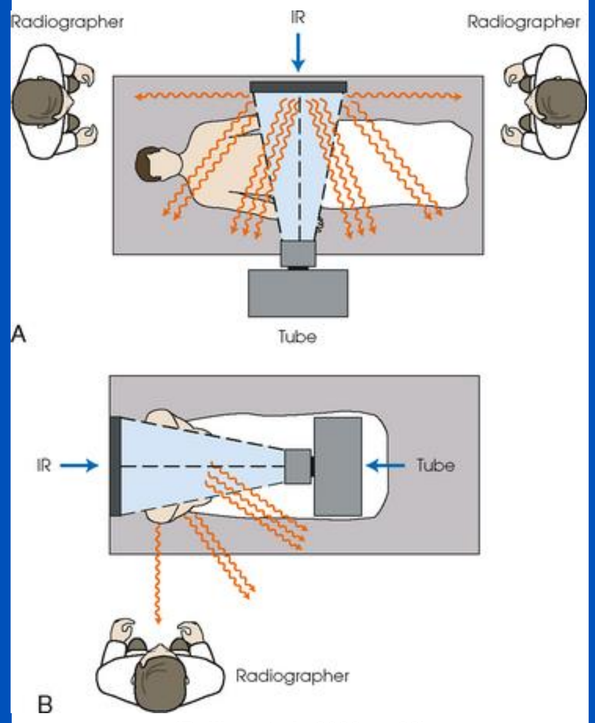
- Interventional Radiology (IR) combines diagnostic imaging and minimally invasive procedures guided by real time fluoroscopy.
- While this approach greatly reduces patient recovery time and procedural risks, it typically results in higher radiation exposure compared to conventional radiography or CT due to prolonged imaging time and complex procedures.
- Radiation safety in IR is a dual responsibility, protecting both patients and medical staff.
- Because IR procedures can be repeated and long in duration, understanding dose management, optimization, and protection strategies is essential for ensuring diagnostic accuracy without unnecessary exposure (Tsapaki, 2020).

Radiation Dose Challenges in IR

- Extended fluoroscopy times and complex anatomy often lead to higher cumulative dose levels.
- Scatter radiation affects operators, emphasizing the importance of distance, shielding, and beam angulation.
- Operator scatter exposure increases when the C-arm or patient positioning brings the x-ray tube closer to the physician (Garg & Shrigiriwar, 2022).
- Inadequate training and inconsistent use of protective devices further elevate occupational risk.
- Patient specific factors such as body habitus, age, and procedure type influence dose output.
- The use of multiple imaging modalities can increase cumulative exposure if not optimized.

Established Dose Reduction Strategies

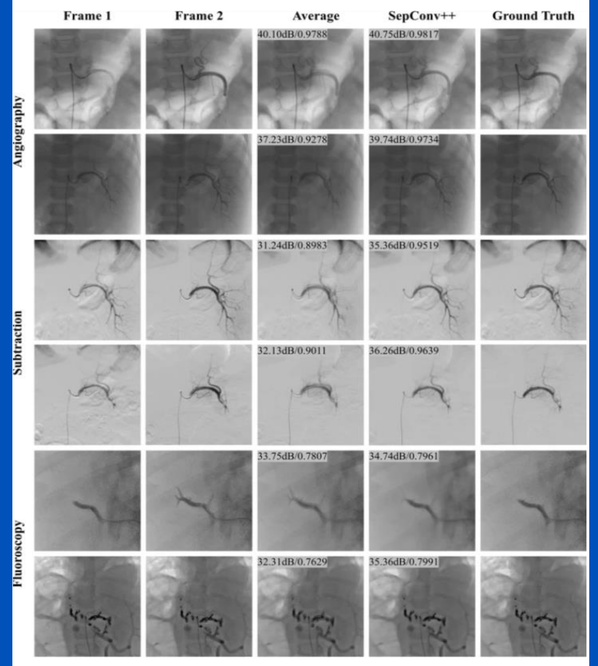
- Use pulsed fluoroscopy and adjust exposure settings with AEC to match patient size.
- Utilize last image hold and collimation to limit unnecessary exposure.
- Radiation exposure is influenced not only by procedure time but also by factors such as source-to-image distance (SID), procedure type, quality of lead apron, team communication, and adherence to the ALARA principle (Baron, 2024).
- Promote radiation safety education and conduct dose audits to reinforce ALARA principles and ensure continual optimization.
- The most effective radiation protection is maintaining a at least 6 feet of distance and standing at a 90-degree angle to the x-ray beam (Rollins et al., 2023).



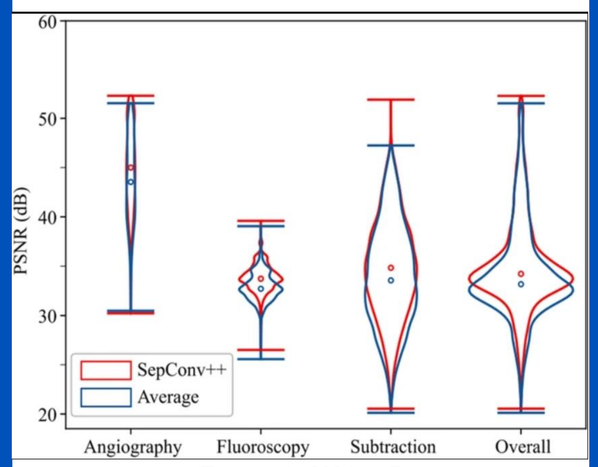
(Rollins et al., 2023, p. 28)

A Video Frame Interpolation Solution

- Tang et al. (2024) developed an AI model called SepConv++ to predict and recreate missing frames in IR imaging.
- By capturing images at a lower frame rate, radiation exposure was significantly reduced.
- The AI filled in the gaps between frames, creating smooth, realistic motion and maintaining image quality.
- The resulting images were nearly identical in quality to the originals, allowing radiologists to safely reduce radiation without losing diagnostic accuracy.
- This technique is especially valuable in pediatric IR, where minimizing radiation exposure is essential for patient safety.



(Tang et al., 2024, p. 6)



(Tang et al., 2024, p. 7)

• Results & Future Implications

- Combining AI techniques such as SepConv++ with standard radiation safety practices could transform how IR procedures are performed.
- Future advancements in radiation dose optimization will rely heavily on emerging technologies such as Radiation Dose Structured Reports (RDSR), patient dose management software (PDMS), and artificial intelligence (AI), which can enhance protocol customization, improve dose tracking, and assist clinicians in maintaining optimal image quality with minimal patient exposure (Tsapaki, 2020).
- Integration of machine-learning algorithms into fluoroscopy systems may enable real time adjustment of exposure parameters, automatically optimizing dose levels based on patient anatomy and procedural complexity.
- Automated dose monitoring platforms can provide continuous feedback to technologists and radiologists, identifying patterns of unnecessary exposure and guiding protocol improvements.

Conclusion

- Effective dose reduction in IR requires both traditional safety practices and emerging AI solutions.
- Established methods such as pulsed fluoroscopy, shielding, collimation, and staff education remain essential.
- AI assisted imaging, like SepConv++ interpolation, can reduce dose without compromising diagnostic clarity.
- Continued research, training, and technological innovation will drive safer, more efficient IR procedures
- Medical Imaging has revolutionized patient care, but ensuring safety requires continuous quality assurance, individualized dose optimization, collaboration among professionals, proper staff training, and active involvement of medical physicists to monitor equipment performance and guide safe imaging practices (Tsapaki, 2020).

Misericordia University Printing Services