Evaluating Discrepant Radiation Dose Documentation for Fluoroscopy Procedures: An Analysis of 30,000 Radiation Events

Ashima Kundu, BS[1], Sachin Govind, BS[2], Sara Siddiqui, BA[2], Judy James, PhD[3]

[1] *Loyola University Chicago Stritch School of Medicine, Chicago, IL*
[2] *Northwestern University Feinberg School of Medicine, Chicago, IL*
[3] *Loyola University Medical Center, Department of Radiology, Chicago, IL*

Introduction

- Diagnostic and treatment modalities utilizing radiation (such as fluoroscopy) are routine procedures in medicine.
- Fluoroscopic procedures use continuous or pulsed X-rays to provide real-time visualization of internal structures.
- Excessive radiation can be harmful and several radiation monitoring reports, including the Radiation Dose Structured Report (RDSR) and Dose Sheet, are used to track radiation exposure.
- **Problem**: RDSR and Dose Sheets have differing standards regarding which exposures are reported leading to the potential for certain reports to include incomplete data sets; this might mislead physicians about the radiation doses their patients are receiving.
- **Purpose**: This project explores some of the discrepancies between RDSR and Dose Sheet reports across different types of scanners in how events and exposures are listed.



Fig. 1. Fluoroscopy machine getting set up for use.

Methods

RDSR and Dose Sheet data were acquired from radiation dose monitoring software for randomly-selected accession numbers from all three fluoroscopy machines in the Interventional Radiology department at Loyola University Medical Center.



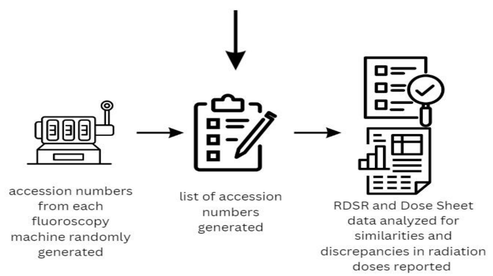


Fig. 2. Schematic showing project methods workflow.

Results

- There were significant discrepancies in the total radiation dose computed and in the number of events and exposures noted in the RDSR versus the Dose Sheet for all the machines.
- Across all equipment, 29.7% of the total radiation accounted for in the RDSR was reported in the Dose Sheet.
- The proportion of total radiation captured by the Dose Sheet varied by scanner: 54.8% for Device 1, 8.0% for Device 2, and 3.7% for Device 3.
- RDSR entries with lower radiation dose ($p < 0.0001$), lower DAP ($p < 0.0001$), higher collimated field area ($p < 0.0001$), or higher primary angle ($p = 0.0003$) were more likely to be excluded from the Dose Sheet.

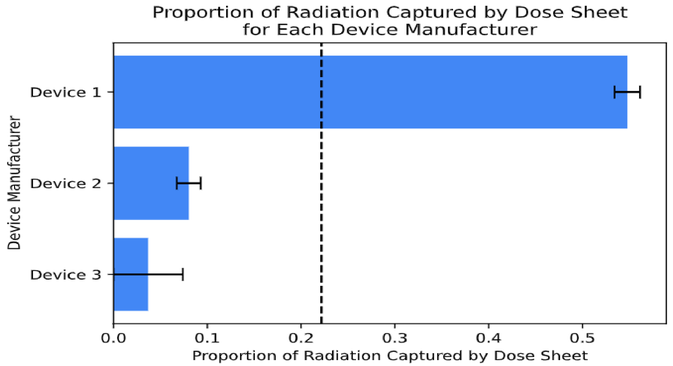


Fig. 3. Differences in proportion of total radiation captured by Dose Sheet by device.

- Dosages were more accurately accounted for in the Dose Sheet, as measured by percentage included, for peripheral angiograms (83.8%), left heart catheterizations (74.5%), and abdominal angiograms (64.7%), while they were less accurately accounted for in IVC filter placements (0.6%), biventricular device implantations (5.2%), and pacemaker implantations (6.6%).

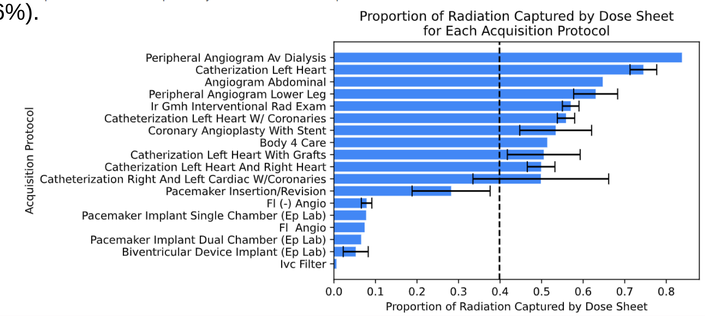


Fig. 4. Differences in proportion of total radiation captured by Dose Sheet broken down by acquisition protocol.

Conclusion

- This study discovered sizable discrepancies in the total radiation dose inferred from RDSR and Dose Sheet data from various fluoroscopy devices.
- Because physicians typically use Dose Sheets to monitor procedural radiation doses, these discrepancies should be further evaluated to discern differences in the accuracy of the reports and characterize the nature of the differences.
- This investigation identified RDSR as the preferred dose reporting scheme (required for Peak Skin Dose calculations) because it captures more dose information.

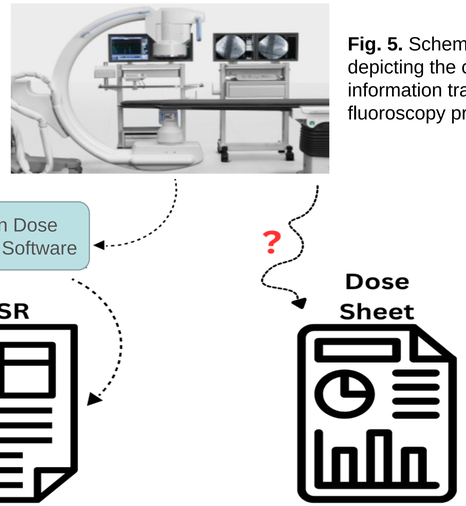


Fig. 5. Schematic depicting the current information transfer post fluoroscopy procedure.

- Limitations of the project included the limited number of patients analyzed in the study and confounding factors such as the varying amount of radiation that is included in different procedure protocols.
- Future research should include multi-institutional investigations.

References

1. Domínguez-Maldonado G, Munuera-Martinez PV, Castillo-López JM, Ramos-Ortega J, Albornoz-Cabello M. Normal values of metatarsal parabola arch in male and female feet. Scientific World Journal. 2014 Feb 6;2014:505736. doi: 10.1155/2014/505736. PMID: 24688397; PMCID: PMC3932714.
2. Malani K, Ravine M, Schneider HP. Nonoperative treatment of plantar plate tears. Clinics in Podiatric Medicine and Surgery. 2022; 39(3), 451-459. https://doi.org/10.1016/j.cpm.2022.02.006
3. Kinter CW, Hodgkins CW. Lesser Metatarsophalangeal Instability: Diagnosis and Conservative Management of a Common Cause of Metatarsalgia. Sports Health. 2020 Jul/Aug;12(4):390-394. doi: 10.1177/1941738120904944. Epub 2020 Mar 30. PMID: 32223694; PMCID: PMC7787564.
4. Nery C, Coughlin MJ, Baumfeld D, Mann TS. Lesser metatarsophalangeal joint instability: prospective evaluation and repair of plantar plate and capsular insufficiency. Foot Ankle Int. 2012 Apr;33(4):301-11. doi: 10.3113/FAI.2012.0301. PMID: 22735202.
5. Peck CN, Macleod A, Barrie J. Lesser metatarsophalangeal instability: presentation, management, and outcomes. Foot Ankle Int. 2012 Jul;33(7):565-70. doi: 10.3113/FAI.2012.0565. PMID: 22835394.
6. McCarthy CL, Thompson GV. Ultrasound findings of plantar plate tears of the lesser metatarsophalangeal joints. Skeletal Radiol. 2021 Aug;50(8):1513-1525. doi: 10.1007/s00256-020-03708-1. Epub 2021 Jan 10. PMID: 33423073.