Linear Regression for Modeling Common Fluoroscopy Dose Metrics in Cardiac Catheterization Procedures

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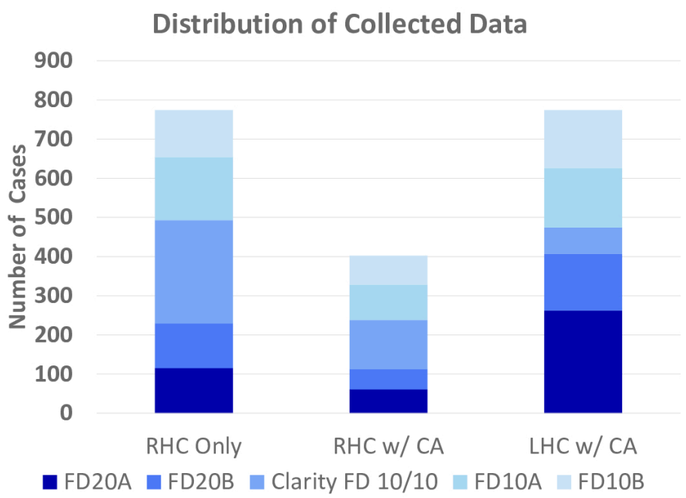
INTRODUCTION

- Fluoroscopy is an integral part of invasive cardiac catheterization procedures.
- However, potential variation exists in fluoroscopy utilization driven by operator tendencies, patient characteristics, and available technology.
- Moreover, the compounding impact of these variables may disguise the overall benefit of new technology on reducing patient radiation dose.
- This study aims to use linear regression models to estimate the impact of attending and assisting physician, patient habitus, and technology on common fluoroscopy dose metrics within a single institution.

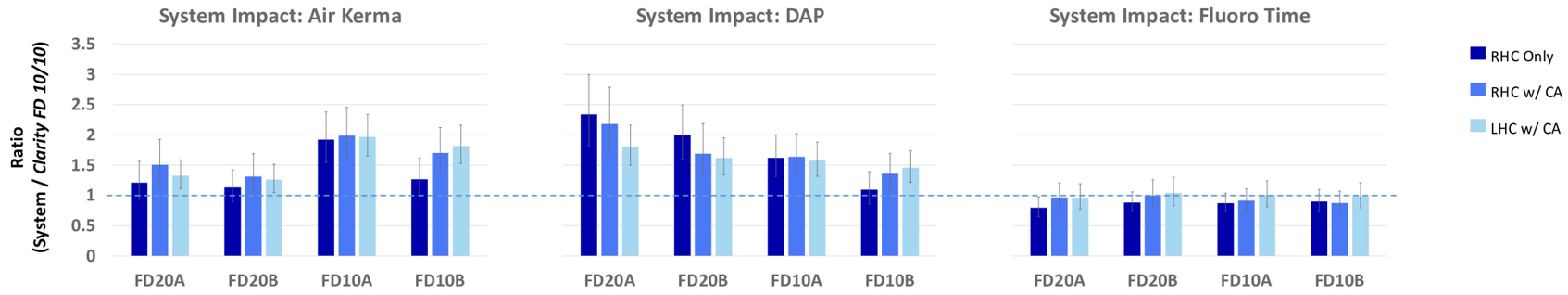
METHODS

- Diagnostic left and right heart catheterization data over a 9 month period were retrospectively collected from 5 Philips Allura fluoroscopy systems.
- Systems differed in detector size (10" and 20"), configuration (4 single-plane units, 1 bi-plane unit) and image processing technology (1 Clarity vs 4 non-Clarity).
- Collected procedure data included attending (23) and assisting (32) physicians, patient BMI, and procedure type.
- Utilization metrics were obtained from the RDSR including air kerma (AK), dose area product (DAP), and fluoroscopy time (FT).



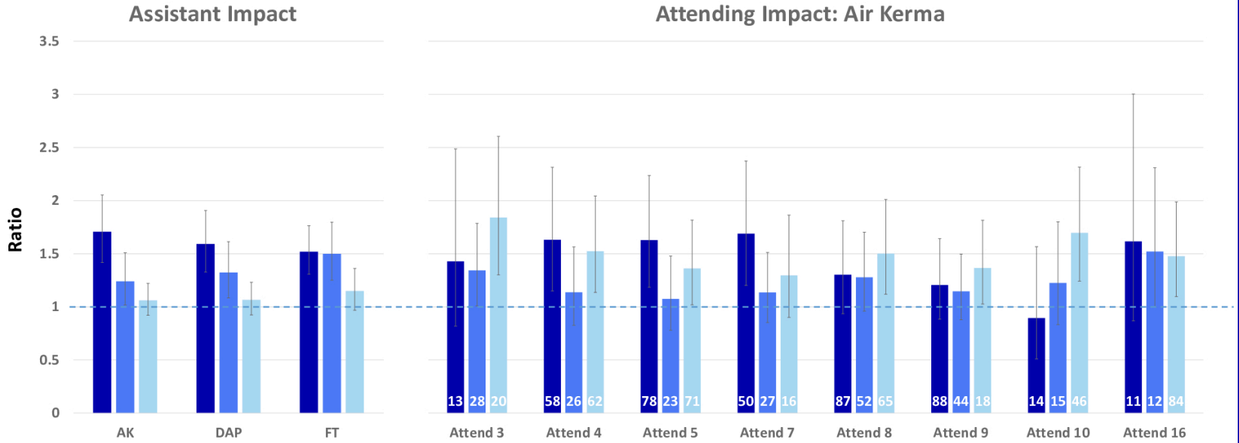
- Data were modeled using linear regression with reference values based on the Clarity FD 10/10 and physician with lowest average AK. Assistant physician presence was modeled as binary variable.

RESULTS



Graphs demonstrate the ratio & 95% CI of mean Air Kerma, DAP, and Fluoro Time of each system compared to the Clarity FD 10/10 system, after accounting for other model variables. Values with mean and CI above the dashed line were found to be significantly different from the reference system.

- Results demonstrate that system technology has a significant impact on dose metrics, with the newer Clarity system outperforming the older technology in AK & DAP for several procedures. FT is largely unaffected.
- AK and DAP results are mixed across systems. As expected, larger detector systems demonstrate larger DAP values. Higher AK values are seen for smaller detectors, which may be due to scatter differences.
- Large variability is observed across physicians with >50% higher average AK observed for some operators.
- The presence of assisting physicians (fellows) is shown to have a significant impact for RHC procedures, with an average expected increase of 25-70% in AK, DAP, and FT.
- As expected, BMI was found to be significant in AK and DAP, but not FT. Each increasing point of BMI contributed an additional ~1% to the expected AK and DAP.



(LEFT) Ratio & 95% CI of the mean AK, DAP, and FT with the presence of an assisting physician (fellow) versus no assistant.
(RIGHT) Ratio & 95% CI of mean AK compared to a reference physician (Attend 1), limited to show physicians that performed at least 10 cases of each procedure. Each bar is labeled with the number of cases performed by that physician.

CONCLUSIONS

- Modern technology is significant in reducing radiation dose in cardiac cath lab procedures, reducing radiation utilization as much as 58% in diagnostic right and left-heart catheterization procedures.
- Significant variability exists among physicians, which if unaccounted for may disguise overall benefit of new technology. Physician differences are exacerbated by the natural variation in case complexity, which necessitates evaluation of physician performance over large numbers of cases.
- The presence of fellows enrolled in training programs can have a significant impact on the overall dose burden for patients, with increases as much as 70%. It is likely this overall magnitude of the difference is heavily dependent on the experience level of the assistant physician.

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