The Effect of Technical Parameters in Practice on Abdominal Computed Tomography (CT) Dose
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SUMMARY
- Radiation doses for CT are highly variable both within and across institutions.
- As part of a PCORI and NIH funded study, we created a CT radiation dose registry, using Bayer Radimetrics software, from 151 institutions across seven countries.
- Lowering patients’ exposure to radiation, a known carcinogen, requires understanding factors contributing to this variation.
- Understanding reasons for variation in CT doses can guide future optimization strategies.

BACKGROUND
- Approximately 80 million CT scans are performed annually in the US, averaging one per four individuals per year.
- Despite the large number of CT scans that are performed, there are few standards for the conduct of these studies.
- We have found radiation dose from CT exams can vary dramatically both within and across institutions suggesting opportunities in quality improvement.
- Much of the variation comes from differences in the use of technical parameters when conducting each scan.

METHODS
- Using Bayer Radimetrics software, we created an aggregated CT radiation dose registry on a single server at UCSF, including 1.85 million adult (>=15 years) CT examinations conducted between January 1, 2017 and December 31, 2017.
- We excluded scans done for invasive procedures and research purposes.
- Radimetrics calculated the average effective dose (ED) in mSv by summing organ doses using ICRP103 weighting factors.
- We estimated the relative contributions of technical parameters to mean dose length product (DLP) and proportions of high-dose examinations for abdomen CT, after adjusting for patient & institutional characteristics, and scanner model, using hierarchical and logistic regression, respectively.

RESULTS
- A summary of our findings are presented in the accompanying tables and figures.
- Mean DLP and proportion of high-dose examinations varied modestly (10–50%) by institutional characteristics and scanner model after adjusting for patient characteristics (age, sex and size).
- In multivariable models, dose variation was primarily attributable to institutional differences in the use of technical parameters. When accounting for technical parameters, the differences between institutions were attenuated or eliminated.
- In our data, mAs accounted for the largest difference in dose between countries, and was twice as important as the other factors. For each standard deviation change in the log-transformed mAs, the average DLP increased by 60%.
- Variation in the use of multiphase scanning was the next most important factor explaining variation in DLP. With each standard deviation change in the log-transformed phase count, the average DLP increased by 51%.
- A typical change in mAs and phase count had twice the effect on dose as typical changes in other parameters.
- For every increase in log transformed standard deviation change in technical parameters, there was a 2% increase in DLP for scan length, a 21% decrease for pitch, an 18% increase for kvp, and a 4% decrease for slice thickness.
- In order of magnitude, the technical parameters most influential on abdominal dose were: mAs, phase count, scan length, pitch, kvp, and slice thickness.

CONCLUSION
- Differences between abdomen doses across institutions were largely attenuated when controlling for dose technical parameters, to a degree not seen when controlling for patient, institutional characteristics, and scanner model.
- These results demonstrate that CT scanner make and model play a relatively modest role, in comparison to technical parameters, as predictors of radiation dose.
- Optimum standardized protocols for computed tomography (CT) should be developed to ensure patient safety.

NEXT STEPS
- Expanding the CT Dose registry to include more countries, manufacturers, machine models, and other factors potentially affecting radiation dose.