2013 Scientific Sessions
Saturday, October 12, 2013
1:00 – 5:00 p.m.

Presenter: Douglas Larson, MD

Title of Abstract: **CT Dose Variability For Patients Undergoing Repeat Identical CT Scans: A Retrospective Analysis Of 2606 Patients Undergoing 12,632 CT scans.**

Institution: Duke University Medical Center

Authors: Douglas G. Larson MD, Daniel T. Boll MD, Tracy Jaffe MD, Olav Christianson PhD, Rendon C. Nelson MD

Modality: CT

Organ System: Multi

Intro: This analysis of the CT dose for 2606 patients who underwent multiple identical CT examinations at our institution included 12,632 unique scans. We evaluated the dose variability on a per-patient basis, which provides information about the clinical dose performance of the CT scanners, independent of patient factors.

Purpose: To evaluate the variability in radiation dose delivery of CT scanners in clinical use, independent of patient-specific factors.

Methods Used: We identified colon cancer, lung cancer, and renal stone patients who underwent the same CT protocol at least twice between 1/2007 and 2/2013. Patient and dose data was taken from DICOM headers and dose sheets in PACS. We performed multivariate analysis to characterize the dose variation for each patient, and to identify any significant cofactors in this variability. We used the "total exam Dose Length Product" (DLP) in our analyses. Included CT protocols were: (a) Abdomen/Pelvis with IV contrast (A/P), (b) Chest/Abdomen/Pelvis with IV contrast (C/A/P), (c) Renal Stone, and (d) Chest without IV contrast.

Results of Abstract: 2606 patients underwent 12,632 repeat CT scans (mean 4.8, range 2-33 repeat scans/patient). There were 875 A/P, 4620 C/A/P, 1053 Renal Stone, and 6084 Chest CT scans. The per-patient dose variation was identified, then normalized using coefficients of variation and ratios of maximum dose to minimum dose. In both cases, a higher value indicates higher dose variability. There was statistically significant variation across all patients and protocols ($p<0.0001$). For the four protocols, the coefficients of variability were 0.22, 0.23, 0.32, and 0.25 and maximum/minimum ratios were 1.6, 1.8, 2.0, and 2.0 (i.e. on average, the maximum dose was 60-100% higher than the minimum dose), respectively. ANOVA identified CT table height, patient size, scanner manufacturer, and scanner model as statistically significant covariates/factors ($p<0.0001$). No effect was seen for patient gender or age. For all protocols, there was a trend toward decreasing dose over time.

Discussion: As part of our effort to reduce ionizing radiation from medical sources, we should understand the characteristics of the dose-delivery mechanism, and work toward more consistent patient care. Phantom studies can provide an intrinsic measure of CT equipment variability, but omit the many contributors to dose variability present in clinical practice. By evaluating patients undergoing multiple scans with identical protocols, we were able to characterize the dose variability of CT scans in clinical use, while controlling for patient- and protocol-specific factors which could affect CT dose.

Scientific and/or Clinical Significance? Evaluation and scrutiny of CT dose delivery in clinical practice allows for determination of the intrinsic and controllable variability in an attempt to achieve more consistent patient care.

Relationship to existing work There have been previous phantom studies and retrospective clinical studies. To our knowledge, this is the largest work which controls for patient and protocol factors in analyzing clinical CT dose delivery.