

A Comparative Study of Prospective Scanner-Reported and Retrospective Radiation Dose Index Monitoring (RDIM) Software Size-Specific Dose Estimates (SSDE) for Abdomen-Pelvis CT

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ABSTRACT

Purpose: The AAPM TG Reports 204 and 220 size specific dose estimate (SSDE) provides a more useful CT dose approximation compared to CTDI_{vol}. Size-Specific Dose Estimate (SSDE) corrects for patient size and is commonly used in radiation dose index monitoring (RDIM) applications to assess the appropriateness of CT exam doses. New CT software has emerged with prospective console displays of series-level SSDE, calculated using the patient scout image(s). This study compares SSDE values from CT scanner displays and the RDIM application (Imalogix) to determine their consistency for both prospective dose assessment by the technologist and retrospective data review.

Methods: SSDE data was extracted from 384 abdomen/pelvis patient exams on two CT platforms (Siemens X.Cite, Canon Aquilion One) by accessing the RDSR and Imalogix reports. Exam data was sorted by size and evaluated collectively and within patient-size categories. SSDE data was evaluated using the Wilcoxon Signed Rank Test and visualized for agreement with Bland-Altman plots.

Results: Wilcoxon Signed Rank Test determined that SSDE datasets were statistically different from each other (p<0.05), with a median difference of 3.9% and the most dramatic deviations (<22%) observed for larger patient sizes. Bland-Altman plots demonstrate reasonable agreement for all groups of SSDE (average differences <2mGy), with agreement degrading with increasing patient size. Across all groups, scanner reported SSDE is generally lower than the RDIM reported SSDE.

Conclusion: Although differences in patient size, the scanner reported SSDE is typically lower than the RDIM reported SSDE, making it feasible to use the scanner reported SSDE prospectively by technologists to assess the appropriateness of an exam's dose. Future work may include comparing reported SSDE with additional scanners or exam types, and utilizing phantom images to evaluate scanner and RDIM reported SSDE against image-based SSDE calculations.

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INTRODUCTION

Size Specific Dose Estimate (SSDE) was introduced by AAPM TG Reports 204 and 220 as a more useful CT Dose index compared to CTDI_{vol} as it corrects for a particular effective diameter (ED) or water-equivalent diameter (WED). SSDE as a CT dose metric has become widely adopted by Radiation Dose Information Management (RDIM) systems, such as Imalogix, for monitoring patient dose and setting CT dose thresholds. Additionally, some CT scanners recently added to the market have begun to add the capability to display SSDE in addition to CTDI_{vol} prior to patient scans. As SSDE continues to proliferate and become more widely adopted, opportunities arise to educate technologists on using scanner displayed SSDE prospectively to determine the appropriateness of the current scan's dose. As medical physicists and lead technologists will continue to utilize RDIM systems to monitor CT dose, a first step requires confirming that scanner displayed SSDE agrees with the RDIM reported SSDE. While RDIM systems compile data (e.g. scanner reported CTDI_{vol}) from every exam's RDSR (Radiation Dose Structured Report), the RDIM independently calculates SSDE using a predefined algorithm. This study seeks to compare scanner reported and RDIM reported SSDE values and determine whether they can be used interchangeably as medical physicists, lead technologists, and front-line technologists collaborate to optimize and monitor CT dose.

METHODS AND MATERIALS

SSDE values for 384 Abdomen/Pelvis exams were extracted from two CT scanners (Siemens X.Cite, Canon Aquilion One) by accessing RDSR and Imalogix Reports. Exam data was sorted by patient size and evaluated collectively and within patient-size categories. Patient size categories are based on RDIM classification. SSDE data was evaluated using the Wilcoxon Signed Rank Test and Visualized for agreement with Bland-Altman plots.

Patient Size	Siemens X.Cite	Toshiba Aquilion One
XXS	1	1
XS	7	5
S	34	12
M	67	25
L	87	20
XL	58	6
XXL	45	16
Total	299	85

Table 1. Number of exams (n) extracted for each scanner and categorized by Imalogix-define patient size (based on effective diameter)

RESULTS

While Wilcoxon Signed Rank Test determined that the scanner vs RDIM reported SSDE values were statistically different from each other (p<0.05), the median difference was 3.9%, with the most dramatic deviations (~22%) occurring at very large patient sizes. The data was in closest agreement for small ("S") patients, with differences increasing with patient size.

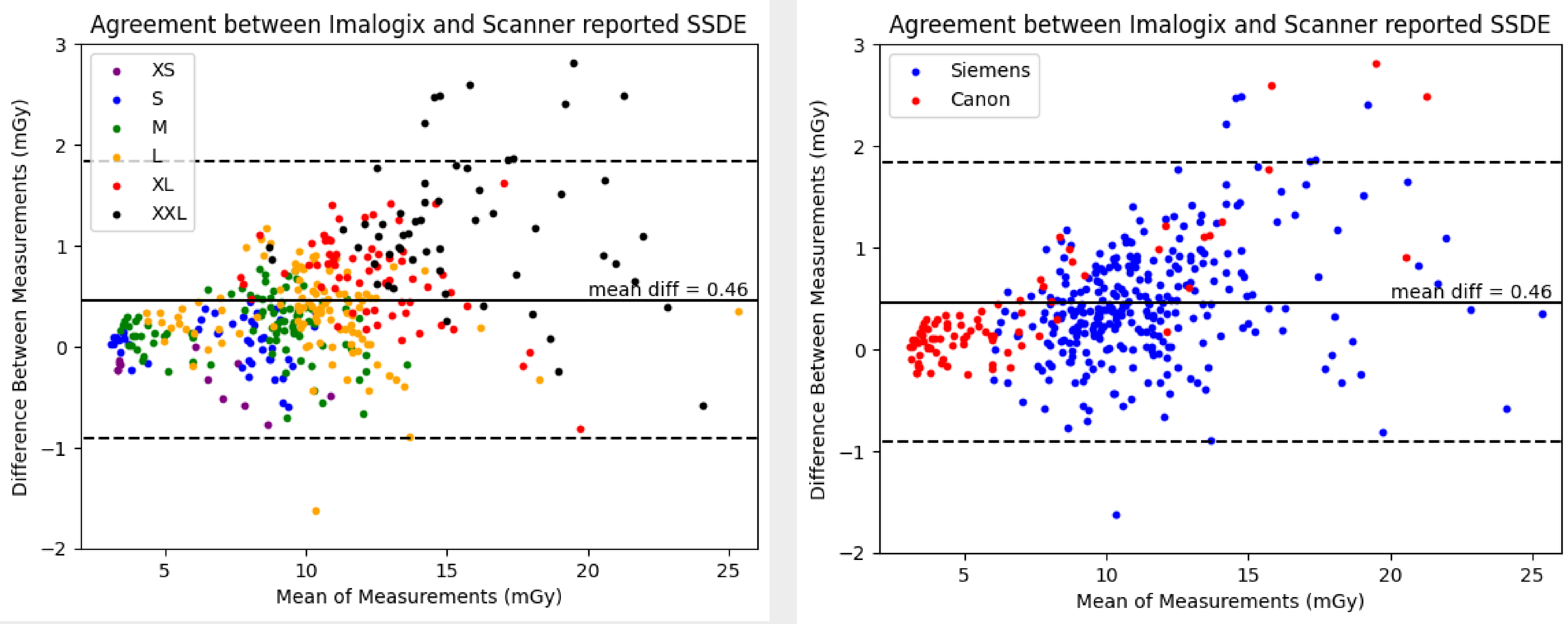


Fig 1. Bland-Altman plot visualizing agreement between scanner and RDIM reported SSDE values. The X-axis represents the average of the reported SSDE values for a single exam, and the Y-axis represents the difference between the two values being compared. Data points are color-coded according to patient size.

CONCLUSIONS AND FUTURE WORK

This comparative study demonstrates that scanner and RDIM reported SSDE values are reasonably similar for all but the largest patient sizes. As modern CT scanners continue to enter the market with SSDE reporting capability, there will be opportunity to educate technologists on utilizing SSDE as a metric for dose appropriateness specific to a patient's size. Where CTDI_{vol} fails to relay a useful dose metric for body scans due to patient size, SSDE thresholds and targets can be used to determine whether a particular scan will under- or over-expose a patient in real time. Future work will include validation of scanner and RDIM reported SSDE via phantom scanning, continuous CT protocol optimization to determine appropriate SSDE targets and thresholds for different protocols at different patient sizes, as well as educating technologists on the definition and utility of SSDE towards implementing a dose conscious practice of reviewing patient SSDE prior to scanning.

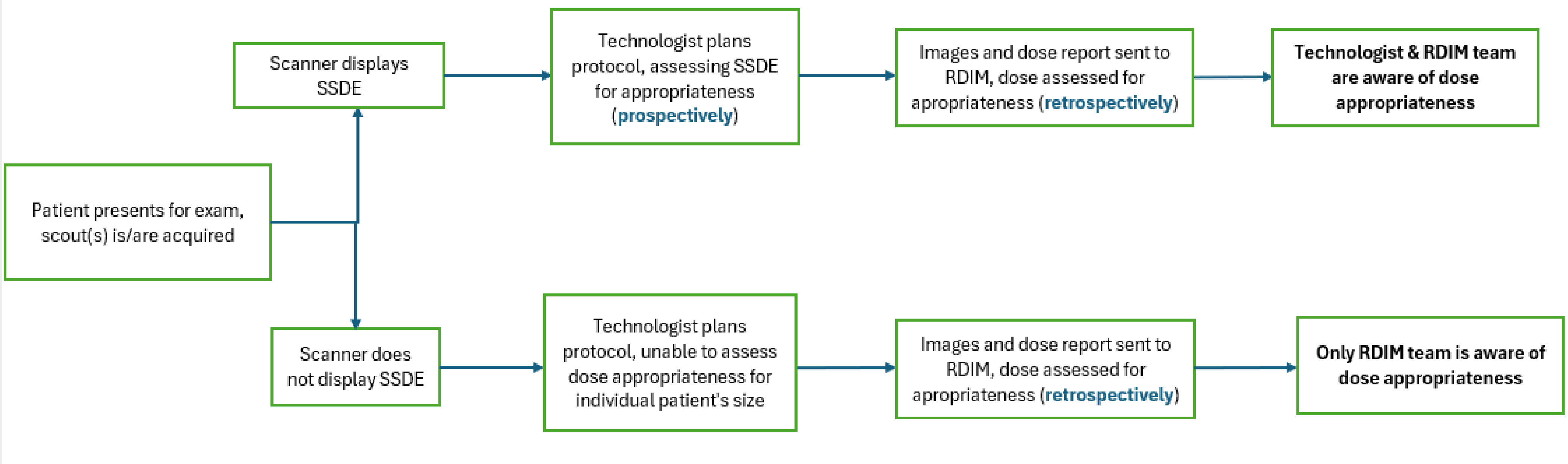


Fig 2. Flow-chart visualizing dose monitoring workflow for CT scanners that do vs don't display SSDE prior to scans.

REFERENCES

- AAPM. (2011). *Size-Specific Dose Estimates (SSDE) in Pediatric and Adult Body CT Examinations*. AAPM Report No. 204.
- AAPM. (2014). *Use of water equivalent diameter for calculating patient size in CT*. Report of AAPM Task Group 220.