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Improving the efficiency of $CTDI_w$ annual measurements with established 16 cm: 32 cm phantom ratios

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Abstract

Purpose: To validate the use of the 16 cm CTDI phantom to estimate the 32 cm phantom $CTDI_w$ with tabulated data from previous years.

Methods: A retrospective analysis of CTDI measurements was performed from the annual physics testing reports of four Siemens Symbia (Emotion) T6, one Siemens Symbia (Emotion) T16, one Siemens Sensation Open, one Siemens Sensation 16, one Siemens Sensation 32, two GE LightSpeed 16 and five GE VCT CT scanners. For each annual report, the ratio of the 16 cm: 32 cm CTDI phantom measurements was calculated from mAs-normalized $CTDI_{100}$. The ratios from a) the acceptance test, b) one year after the acceptance test or c) an average ratio of all of the previous years (range 4-8 years), were then used to estimate 32 cm CTDI phantom measurements based on active 16 cm CTDI measurements. The average percent difference between measured and calculated $CTDI_w$ was determined per scanner for all years.

Results: The most accurate results were obtained when using the average ratios of all the previous years, -2% to 3% difference across all scanner models. For the ratios of the year after the acceptance test, the difference ranged from -3% to 7%, while the data estimated from the acceptance testing results yielded the largest percent difference -4% to 8%. The 64-detector row system estimates displayed the greatest variation, followed by the 16-detector row scanners, while the 6-detector row system estimates were the most accurate.

Conclusion: Compared to the Siemens and GE specified CTDI limits of ± 15-30% , the variation in the estimated 32 cm phantom $CTDI_w$ values was 2-15 times lower, dependent on the scanner model and method of estimation. The variation was considerably less (2-3%) with ratios of all the previous years, perhaps indicative of year to year variations that can result in greater error.

CT dose measurements from annual testing reports of four 6-detector row (6a-d), five 16-detector row (16a-e), one 32-detector row (32a) and five 64-detector (64a-e) row scanners were used to derive correction factors in the form of ratios of $CTDI_{100}$ (normalized to mAs for the same kVp) of the 16 cm : 32 cm CTDI phantoms. The ratios were used to estimate the 32 cm phantom $CTDI_w$ for all of the subsequent years in three ways: using acceptance testing ratios, using the ratios from the year after acceptance testing, using the average ratios for the previous years (i.e., for 2012 data, the average ratios from 2007-2011 were used).

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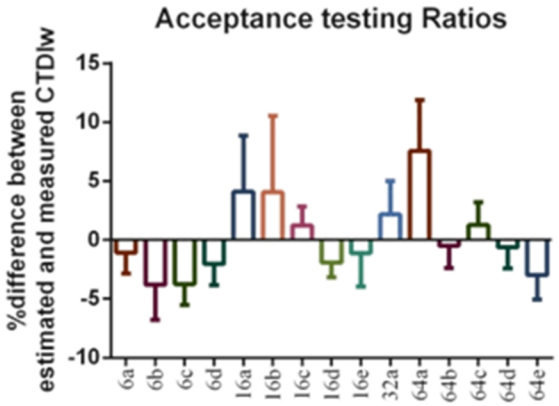
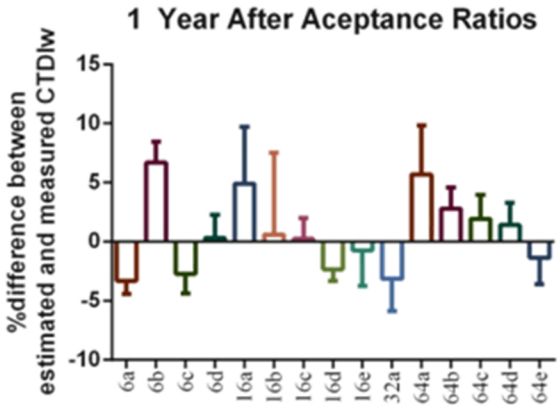
% difference between estimated and measured CTDIw

		Average	Min	Max	Count
Acceptance Testing Ratios	6a	-1.07	-4.01	2.38	8
	6b	-3.81	-9.50	-0.17	7
	6c	-3.74	-6.38	-0.99	8
	6d	-2.03	-4.07	1.12	7
	16a	4.10	-0.13	11.12	7
	16b	4.06	-4.24	19.62	9
	16c	1.21	-0.59	4.50	9
	16d	-1.93	-3.58	0.12	8
	16e	-1.11	-5.21	5.17	9
	32a	2.18	-3.09	4.91	7
	64a	7.54	2.82	15.09	6
	64b	-0.49	-2.94	2.49	8
	64c	1.27	-0.99	3.33	5
	64d	-0.61	-3.25	2.13	8
	64e	-2.99	-6.67	-1.64	5



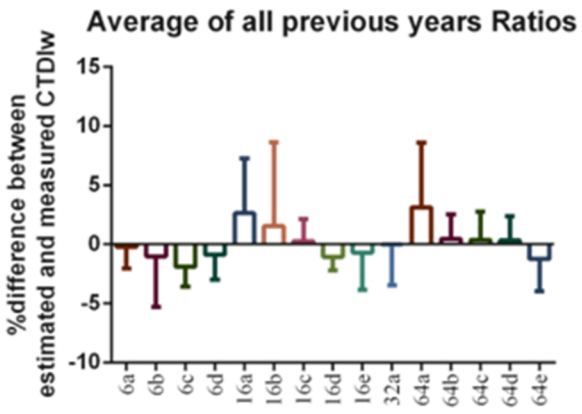
% difference between estimated and measured CTDIw

		Average	Min	Max	Years
Year after acceptance Ratios	6a	-3.33	-5.22	-2.06	7
	6b	6.71	4.21	9.41	6
	6c	-2.72	-5.03	0.44	7
	6d	0.32	-1.73	3.45	6
	16a	4.91	1.34	11.26	6
	16b	0.59	-7.78	16.13	8
	16c	0.25	-1.58	3.49	8
	16d	-2.33	-3.69	-0.80	7
	16e	-0.73	-4.70	5.62	8
	32a	-3.14	-7.84	0.11	6
	64a	5.69	1.80	12.29	5
	64b	2.79	0.02	5.54	7
	64c	1.94	-0.71	3.62	4
	64d	1.41	-1.36	3.92	7
	64e	-1.36	-4.67	0.23	4



% difference between estimated and measured CTDIw

		Average	Min	Max	Years
Average of all previous years Ratios	6a	-0.22	-4.11	2.38	8
	6b	-1.00	-9.50	4.47	7
	6c	-1.89	-5.70	-0.34	8
	6d	-0.88	-3.70	2.26	7
	16a	2.64	-1.10	10.30	7
	16b	1.55	-6.15	18.91	9
	16c	0.28	-1.78	3.81	9
	16d	-1.05	-2.55	0.32	8
	16e	-0.70	-5.98	5.90	9
	32a	-0.02	-6.07	4.88	7
	64a	3.15	-1.71	13.66	6
	64b	0.46	-2.80	3.23	8
	64c	0.38	-2.63	3.46	5
	64d	0.35	-1.99	3.76	8
	64e	-1.23	-5.71	0.99	5



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