

A multicentric study on patient dose in multislice CT

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Purpose

1. Estimate the radiation dose delivered to patients for the most common CT practices in terms of CTDI_{vol} and DLP for multislice CT scanners
2. Investigate the dose distribution of the same practice in different centers
3. Compare scanners in terms of radiation dose
4. Compare mean and third quartile values with the most recently published DRLs in NRPB W67¹.

Method

- 16 scanners (in 14 centers) were divided into 4 groups (single, dual, 4 and 8+ slices)
- Data was collected for head, abdomen, thorax and pelvis examinations for 1400 patients between September 2009 and April 2010.
- Mean and third quartile values of kV, pitch, slice and image thickness, scan length, CTDIvol and DLP were calculated for each exam and group and compared with the DRLs.

Results – Table 1:
Radiation dose delivered to patients for the most
common CT practices

Mean CTDIvol (mGy) \pm SD of all exams (1400 patients)						
Exam	<i>Head base (post fossa)</i>	<i>Head (cerebrum)</i>	<i>Abdomen</i>	<i>thorax (lungs)</i>	<i>thorax (HR)</i>	<i>Pelvis</i>
Number of patients	212		284	455	145	304
Mean CTDIvol (all exams)	71	68.8	20.4	13.1	9.9	21
SD (all exams)	34	18.8	7.2	8.5	8	9.2
% CV	47.9	27.3	35.2	65	80.8	43.8

Results - Table 2: CTDIvol, DLP and the respective NRPB DRL values for the most common CT practices

Scanner group	value	<i>Head base (post fossa)</i>		<i>Head (cerebrum)</i>		<i>Abdomen</i>	
		CTDIvol (mGy)	DLP (mGycm)	CTDIvol (mGy)	DLP (mGycm)	CTDIvol (mGy)	DLP (mGycm)
Single slice	<i>mean</i>	57,8 ± 12,9	310 ± 54	62,6 ± 4,8	614 ± 65	19,2 ± 7,2	734 ± 451
	<i>NRPB mean</i>	54	177	47	357	11	340
	<i>3rd quart</i>	64,585	341,3	64,3	637,0	21,4	919,6
	<i>NRPB 3rd quart</i>	64	228	56	476	13	455
Dual slice	<i>mean</i>	41,5 ± 22,1	618 ± 224	63,8 ± 11	381 ± 64	18,1 ± 7,4	619 ± 216
	<i>NRPB mean</i>	48	141	44	386	9,8	292
	<i>3rd quart</i>	53,85	746,9	67,7	404,5	21,8	705,9
	<i>NRPB 3rd quart</i>	53	162	50	450	10	405
4 slice	<i>mean</i>	85,1 ± 36,1	511 ± 114	79,7 ± 41,5	540 ± 160	20 ± 10,6	633 ± 296
	<i>NRPB mean</i>	88	277	54	408	13	407
	<i>3rd quart</i>	110	550,62	50,3	427,3	24,3	789,0
	<i>NRPB 3rd quart</i>	99	366	62	546	14	484
8+ slice	<i>mean</i>	81,1 ± 27,7	755 ± 708	56,4 ± 4,3	470 ± 73	18,6 ± 6,3	982 ± 468
	<i>NRPB mean</i>	97	307	57	383	13	312
	<i>3rd quart</i>	89,2	570,88	57,9	496,8	21,9	1242,0
	<i>NRPB 3rd quart</i>	124	428	66	529	15	399

Results – Table 3: CTDIvol, DLP and the respective NRPB DRL values for the most common CT practices

Scanner group	value	<i>Thorax (lungs)</i>		<i>Thorax (HR)</i>		<i>Pelvis</i>	
		CTDIvol (mGy)	DLP (mGycm)	CTDIvol (mGy)	DLP (mGycm)	CTDIvol (mGy)	DLP (mGycm)
Single slice	<i>mean</i>	10,7 ± 6,4	394 ± 255	2,9 ± 0,7	34 ± 43	13,9 ± 4,5	420 ± 187
	<i>NRPB mean</i>	8	187	2,2	64	11	321
	<i>3rd quart</i>	12,0	558,0	3,2	48,0	15,3	517,0
	<i>NRPB 3rd quart</i>	10	229	3	77	12	367
Dual slice	<i>mean</i>	14,3 ± 2,9	338 ± 88	15,8 ± 1,7	205 ± 184	21,3 ± 6	528 ± 234
	<i>NRPB mean</i>	7,9	198	1,8	39	11	397
	<i>3rd quart</i>	15,8	369,6	16,4	205,1	23,4	611,0
	<i>NRPB 3rd quart</i>	8,3	207	2,4	61	12	428
4 slice	<i>mean</i>	17 ± 11,1	586 ± 420	6 ± 5,2	192 ± 199	31,1 ± 8,7	723 ± 419
	<i>NRPB mean</i>	10	270	5,2	146	14	574
	<i>3rd quart</i>	24,7	871,2	7,8	192,0	34,2	871,9
	<i>NRPB 3rd quart</i>	12	309	7,1	178	14	669
8+ slice	<i>mean</i>	13,4 ± 11,1	477 ± 507	13,7 ± 10,6	460 ± 449	17,8 ± 7	490 ± 310
	<i>NRPB mean</i>	11	254	5,3	106	13	475
	<i>3rd quart</i>	13,2	395,1	19,8	682,9	18,6	581,8
	<i>NRPB 3rd quart</i>	10	251	6,1	128	13	467

Results - Table 4:
Dose distribution of the same practice in
different centers

<i>CT scanner</i>	<i>Scanner group</i>	Mean CTDIvol (mGy)					
		<i>Head base (post fossa)</i>	<i>Head (cerebrum)</i>	<i>Abdomen</i>	<i>thorax (lungs)</i>	<i>thorax (HR)</i>	<i>Pelvis</i>
CT No 1	Single slice	44,4	/	19,1	6,5	3,5	19,1
CT No 2		59,2	59,2	28,4	6,7	2,9	11,3
CT No 3		70,0	66,0	18,8	20,0	2,1	/
CT No 4		/	/	10,7	9,4	/	11,4
CT No 5	Dual slice	59,5	/	18,2	14,6	14,6	25,5
CT No 6		48,2	71,6	10,6	11,3	/	/
CT No 7		16,8	56,0	25,4	17,0	17,0	17,0
CT No 8	4 slice	63,8	109,0	12,0	8,6	/	37,3
CT No 9		46,8	/	12,5	6,8	2,3	/
CT No 10		125,0	50,3	34,7	29,7	9,6	/
CT No 11		105,0	/	20,9	23,0	/	25,0
CT No 12 (6-slice)	8+ slice	70,8	/	13,68	13,17	/	13,68
CT No 13 (16-slice)		67,1	/	14	10,48	1,69	14
CT No 14 (16-slice)		125,1	/	28,3	3,5	17,6	28,3
CT No 15 (64-slice)		53,3	53,3	15,4	7,7	/	15,4
CT No 16 (128-slice)		89,2	59,4	21,9	32,3	21,9	/

Conclusions

- Table 1 shows the radiation dose in terms of CTDIvol for all patients who underwent the same examination in all CT modalities.
- Tables 2 and 3 show patient radiation dose in terms of mean and 3rd quartile CTDIvol and DLP values and compare them with the recently published DRLs in NRPB W67 taking into account the scanner group.
- Table 4 shows the patient dose fluctuation for the same exam in different scanners.
- When mean CTDIvol values for the 24 cases (4 scanner groups x 6 exams) are compared with NRPB W67 DRLs, the dose delivered to patients is higher in 20 cases (83.3%), whereas 3rd quartile values are higher than the respective DRLs in 22 cases (91.6%). Mean DLP values are higher than DRLs in 22 cases (91.6%) whereas 3rd quartile values are higher than the respective DRLs in 19 cases (79.1%).

Conclusions

- There is a big fluctuation in dose delivered to patients who underwent the same examination. The highest dose distribution is observed in thorax HR exam (% CV is 80.8%) whereas the lowest is observed in head cerebrum exams (% CV is 27.3%).
- In cases where the dose is higher than DRLs, parameters such as pitch, slice thickness and scan length are also higher, indicating possible ways of dose reduction.

References

- P C Shrimpton, M C Hillier, M A Lewis, M Dunn, NRPB W-67, Doses from Computed Tomography (CT) Examinations in the UK-2003 Review