Public Health England

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Doses from Cervical Spine Computed Tomography (CT) examinations in the UK

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Why a new dose survey?

Number of enquires received concerning the current NDRL

Concern that could not meet the NDRL after optimisation work

Queried the size of CTDI phantom used in the NDRL dataset

Variation in the size of CTDI phantom quoted for this examination

PHE did not request CTDI phantom size information

16-cm phantom was assumed to be used for cervical spine examinations

Decided to conduct a small scale dose survey for CT cervical spine

Chance to review current CT equipment and practices since 2011

IR, wide beam scanners, etc

Method

Data collection form adapted from recent IPEM Hybrid Imaging survey

Distributed via CT users group and MEDICAL-PHYSICS-ENGINEERING mailing lists

Issued October 2016 – request for data by end of 2016

Extended to end of January 2017

Prospective or Retrospective data

Only patient dose data from previous 12 months

Protocol details

Standard Protocol Settings

Local protocol name*:	
CTDI phantom size (cm) (i.e. 16 cm or 32 cm)*:	
Is Automatic Exposure Control (AEC) used?	
AEC name (e.g. AutomA, ZDOM, CARE Dose 4D, SureExposure):	
AEC setting type (e.g. noise index, reference mAs, etc):	
AEC setting value:	
minimum mA for AEC (where applicable):	
maximum mA for AEC (where applicable):	
Is iterative reconstruction used?	
Iterative recon type (eg. ASIR, SAFIRE, iDose, AIDR):	
Iterative recon value (eg. ASIR 40%, SAFIRE 3, iDose level 4):	
Radiation beam collimation:- Beam width (mm):	
- Number of slices:	
- Detector size (mm) (eg. 0.625,0.6):	
Tube voltage (kV):	
Tube rotation time (s):	
Primary image slice thickness (mm):	
Scan field of view (SFOV) (mm):	
Axial or helical?	
Pitch (where applicable):	
Is IV contrast used?	
How many scan phases are performed?	

Calibration details

Calibration Data (only if available)

Last measured $CTDI_{vol}$ for this or a similar protocol (mGy):	
mAs used for the CTDI measurement above:	
Displayed $CTDI_{vol}$ for the CTDI measurement above (mGy):	

Patient details

Patient No	Age at time of scan (yrs)	Body Mass (kg)	Scan length (mm)	Complete If different from standard protocol				
				kVp	Tube rotation time (s)	Pitch	AEC setting value	CTDI phantom size
1								
2								

Tube current or tube current time		$CTDI_{vol}$ (mGy)*	DLP (mGy.cm)*	Comments
mA	mAs			

Results

Data received for:

42 Hospitals

73 Scanners

4299 Patients
(1512 for one scanner)
(>100 for 6 scanners)

Scanner summary

Manufacturer	Model	Number of detector rows	Number of scanners
GE	Discovery 750HD	64	6
	LightSpeed Pro 32	32	2
	LightSpeed VCT	64	11
	Optima CT660	64	6
	Revolution	256	1
Philips	Brilliance 64	64	1
	Brilliance ICT	128	1
	Ingenuity	64	1
	Ingenuity 128	64	2
Siemens	Somatom Definition (Dual Source)	64	1
	Somatom Definition AS	64	3
	Somatom Definition AS+	64	8
	Somatom Definition Edge	64	5
	Somatom Definition Flash	64	4
	Somatom Force	96	1
	Somatom Perspective	Unknown	1
	Somatom Sensation 64	64	3
Toshiba	Aquilion	Unknown	1
	Aquilion 64	64	3
	Aquilion CX	64	2
	Aquilion CXL	64	1
	Aquilion ONE	320	6
	Aquilion Prime	80	3

Scanner summary

Manufacturer	Number of Scanners
GE	26
Philips	5
Siemens	26
Toshiba	16

Number of detector rows	% of Scanners	2011 Survey
<64	***2.5***	***44.5***
64	78	45
>64 – ≤128	7	10
>128	10	0.5
Unknown	2.5	0

AEC and Iterative Reconstruction

Parameter	Used	Not Used	No response
Automatic Exposure Control (AEC)	62	2	9
Iterative Reconstruction (IR)	36	24	13

CTDI calibration

Number of scanners	27
Minimum error (%)	-13
Maximum error (%)	17
|Average error| (+/- %)	13

CTDI phantom selection

CTDI phantom	Number of scanners
16-cm head	4
32-cm body	69

Dose data criteria

Data for at least 15 patients per scanner

Excluded Toshiba Aquilion CX and 64 scanners from $CTDI_{vol}$ analysis

- 5 scanners
- Appeared to report max $CTDI_{vol}$
- Does not affect the proposed NDRLs

Manufacturer	Model	DLP/$CTDI_{vol}$
Toshiba	Aquilion 64	11
Toshiba	Aquilion 64	12
Toshiba	Aquilion CX	13
Toshiba	Aquilion	13
Toshiba	Aquilion 64	16
Next scanner		19

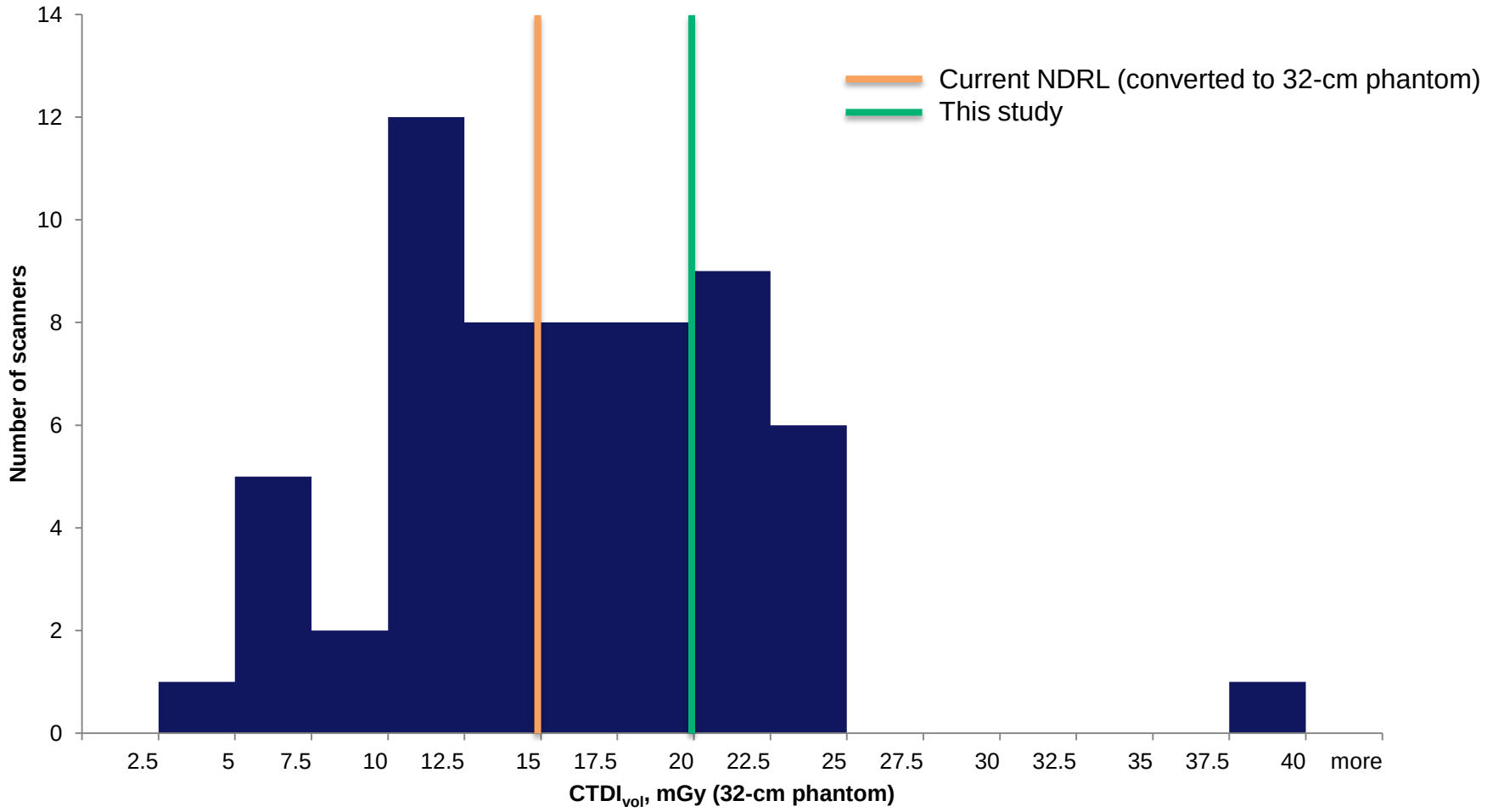
60 scanners included for $CTDI_{vol}$ and 67 scanners for DLP

95% of scanners reported doses based on the 32-cm body phantom

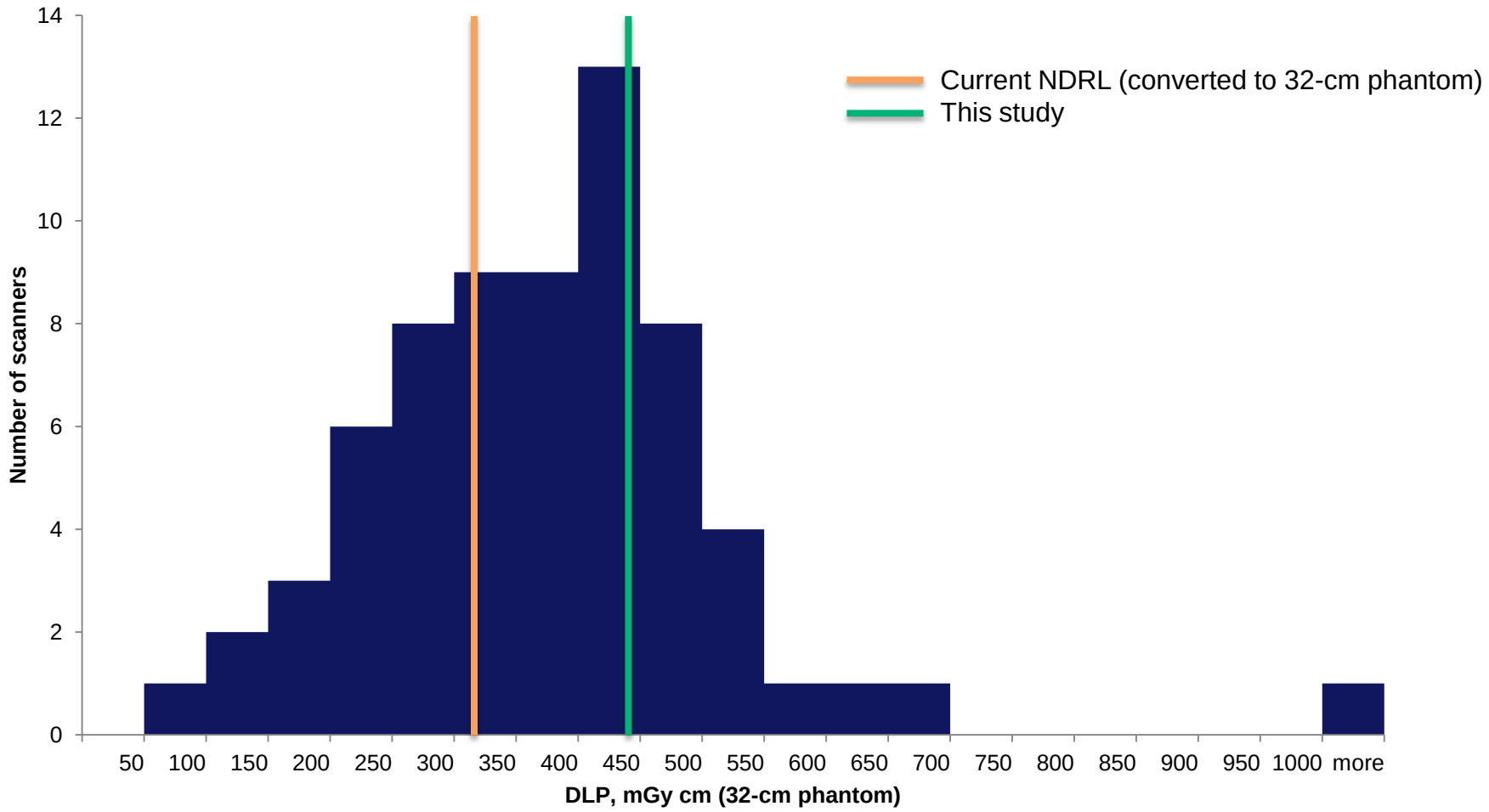
- 16-cm dose data converted to 32-cm value using the AAPM SSDE factor of 0.54[1]

[1]AAPM Report 204: Size-Specific Dose Estimates (SSDE) in Pediatric and Adult Body CT Examinations

$CTDI_{vol}$ Results



DLP Results


Current NDRL (converted to 32-cm phantom)
This study
Number of scanners
0
2
4
6
8
10
12
14
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
more
DLP, mGy cm (32-cm phantom)

Iterative Reconstruction vs. Filtered Back Projection

Reconstruction technique	Number of scanners		Third quartile values	
	$CTDI_{vol}$	DLP	$CTDI_{vol}$ (mGy)	DLP (mGy.cm)
FBP	22	24	21 (20)	471 (455)
IR	28	31	16 (16)	452 (421)

All doses based on 32-cm phantom
Values calculated from scanner median values in brackets

Choice of Iterative Reconstruction Setting

Manufacturer	IR name	Scanners	Mode	Min	Max
GE	ASIR	15	ASIR 40% (12)	ASIR 20%	ASIR 50%
Philips	iDOSE	3	Level 4 (3)	Level 4	Level 4
Siemens	SAFIRE	7	3 (6)	2	3
Siemens	ADMIRE	1	3 (1)	3	3
Toshiba	AIDR	8	Standard (8)	Standard	Standard

Number of scanners in brackets

Mean vs. Median Dose Index

Average index from each scanner	Number of scanners	Min	Max	Median	75th percentile
Mean $CTDI_{vol}$	60	3.5	39.7	15.6	20.1
Median $CTDI_{vol}$	60	3.4	39.6	15.1	20.0
Mean DLP	67	87	1030	365	438
Median DLP	67	84	1003	356	429

All doses based on 32-cm phantom

Proposed new NDRLs

Set using 32-cm body phantom rather than 16-cm head phantom

UK national DRLs	Quoted for 32-cm phantom		Quoted for 16-cm phantom	
	$CTDI_{vol}$ (mGy)	DLP (mGy cm)	$CTDI_{vol}$ (mGy)	DLP (mGy cm)
Existing	(15)	(324)	28	600
Proposed	20	440	(37)	(815)

Comparison to International DRLs

Country	National DRL	
	CTDIvol (mGy)	DLP (mGy cm)
Ireland (Foley et al.,2012)	19	420
Netherlands (van der Molen et al., 2013)	---	321
Switzerland (Trier et al., 2010)	30	600
USA (ACR, 2016)	30	663
Australia* (Wallace et al., 2015)	30	600
Proposed new UK NDRL	**20**	**440**

* The value for Australia was for a neck examination

No details of CTDI phantom provided for any other NDRL

Acknowledgements

IPEM Hybrid Imaging Working Party for permission to reuse the dose data collection form

Members of PHE NDRL Working Party for their help and support

Cat Rivett, Rob Loader for trialling the dose data collection

And everyone who submitted data to the survey!

4th UK CT Dose Survey

3rd UK CT Dose Survey published in 2014

The data is at least 6 years old

Many scanners have since been replaced

It's time for a new dose survey!

Aim to launch within next six months

Timed to fit in with the general X-ray/Fluoroscopy dose survey

Any procedures you'd like to see included this time?

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Any Questions?