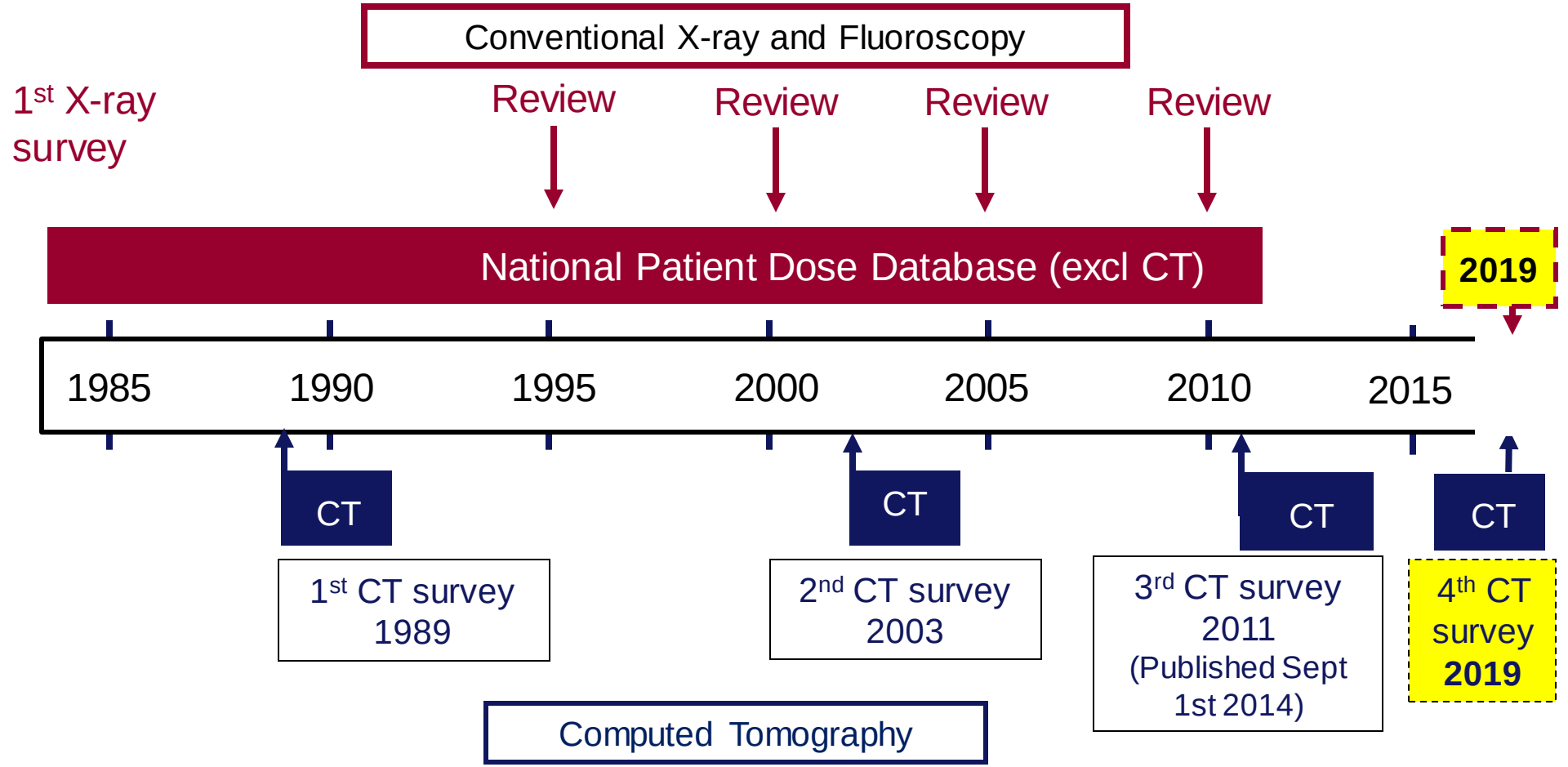
Public Health England

Protecting and improving the nation's health

4th UK CT dose survey - an update

John Holroyd

Dose survey history



Selection of examinations

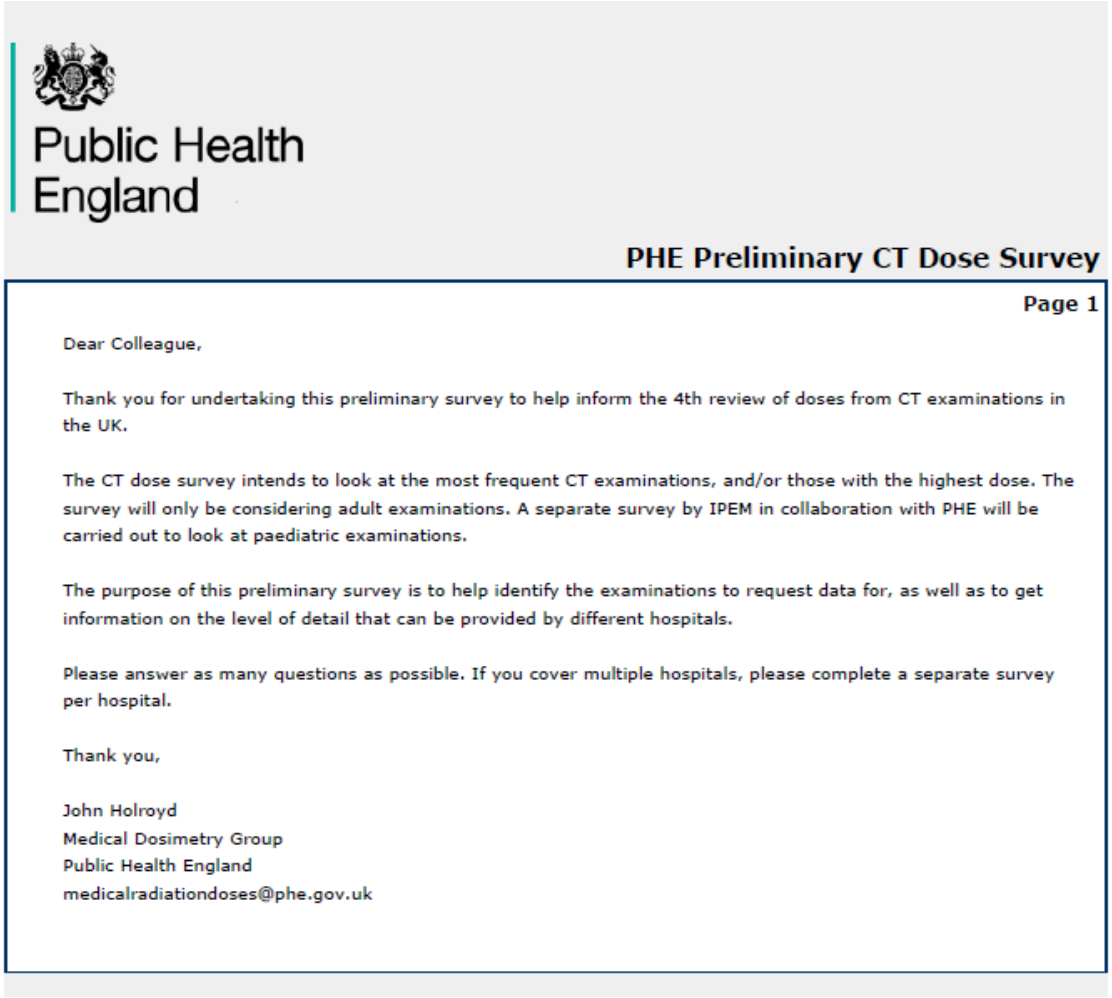
NHS England Diagnostic Imaging Dataset (DID)

- Number of exams carried out
- Filtered by NICIP/SNOWMED CT code

Preliminary Survey

- Frequent Exams
- Availability of data

Preliminary survey



Public Health England

PHE Preliminary CT Dose Survey

Page 1

Dear Colleague,

Thank you for undertaking this preliminary survey to help inform the 4th review of doses from CT examinations in the UK.

The CT dose survey intends to look at the most frequent CT examinations, and/or those with the highest dose. The survey will only be considering adult examinations. A separate survey by IPEM in collaboration with PHE will be carried out to look at paediatric examinations.

The purpose of this preliminary survey is to help identify the examinations to request data for, as well as to get information on the level of detail that can be provided by different hospitals.

Please answer as many questions as possible. If you cover multiple hospitals, please complete a separate survey per hospital.

Thank you,

John Holroyd
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Public Health England
medicalradiationdoses@phe.gov.uk

Preliminary survey results

Parameter	Automatic (%)	Manual (%)
Age	84	79
Patient diameter	15	33
Height	5	8
Weight	7	8
Size specific dose estimate (SSDE)	27	23
Water equivalent diameter, D_w	24	34

Selected examinations

Examination	Clinical indication	Suggested scan justifications that may use a similar exposure setup
Head	Acute stroke	head trauma, onset of headaches/facial pain, visual disturbances, aura/migraine, atypical seizure. Confusion, vomiting, slurred speech, limb weakness/worsening mobility. Existing aneurism. Previous surgery: CVA, evacuation of haematoma, biopsy
Paranasal sinuses	**Sinus disease**	**Tumour, infection**
Cervical spine (C-spine)	Fracture	head and neck injury. Fall/trauma/polytrauma. Previous vertebral tension. Neck pain or tenderness. RTC. Contact sports neck related injury
Neck, chest, abdomen and pelvis	**Query Cancer**	**Query Lymphoma, lymphadenopathy, nodal disease**
Chest	Query Lung cancer	Query cause of shadowing. Query lymphadenopathy. Previous lymph node enlargement. Bulky hilum (that persist on plain film). Abnormal CXR, pleural effusion
Chest – high resolution	Interstitial lung disease	Severe breathlessness, hypoxia, query parenchymal involvement. Subpleural ground-glass opacity
Chest and abdomen	Query Lung cancer	chest mass, abnormal CXR, shadowing, pleural effusion
Chest-abdomen-pelvis (CAP)	Query Cancer	Night sweats, weight loss, sepsis
CT pulmonary angiography (CTPA)	Pulmonary embolism	Pleuritic chest pain, decreased saturations, breathlessness. Sudden onset SOB. Previous surgery/PE
Abdomen and pelvis	Abscess	abdo pain, acute abdomen, weight loss, sepsis
Colonography/Virtual colonoscopy (VC)	Polyps/tumour	Anaemia, change of bowel habit, (do not include bowel cancer screening)
Kidney-ureters-bladder (KUB)	Stones/colic	Colicky pain, vomiting, previous calculus, haematuria
Urogram	Stones/colic or tumour	Query urological injury. Colicky pain, vomiting, previous calculus, haematuria. Query Urothelial tumour

CT Angiography, Abdomen, Enteroclysis not included

Data collection survey

By Excel spreadsheet, familiar design
- PHE cervical spine CT audit
- IPEM SPECT/PET CT and radiotherapy audits

Distributed via
- CTUG mailing list
- Medical-Physics-Engineering mailing list
- SCoR website and newsletter

Next CTUG meeting: 3rd October 2019

The next meeting of the CT Users Group will be held at The Studio in Birmingham, on 3rd October 2019. The draft programme, meeting details and booking form are now available on the 2019 meeting page.

UK Paediatric CT dose survey

The IPEM paediatric optimisation working party, in collaboration with PHE, launched a UK paediatric CT dose survey in June 2019.

Further details, along with the spreadsheet for dose data entry and guidance on what information is needed can be found on the CTUG dose survey page.

Fourth UK National CT dose survey

Public Health England announced on 23rd March 2019 their next review of doses from CT examinations in the UK. This survey aims to collect protocol and patient dose index data for adult CT examinations.

SoR

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Participants urgently needed for PHE's CT dose survey

22 July, 2019

More responses are urgently needed for Public Health England's (PHE) Fourth National CT Dose Survey.

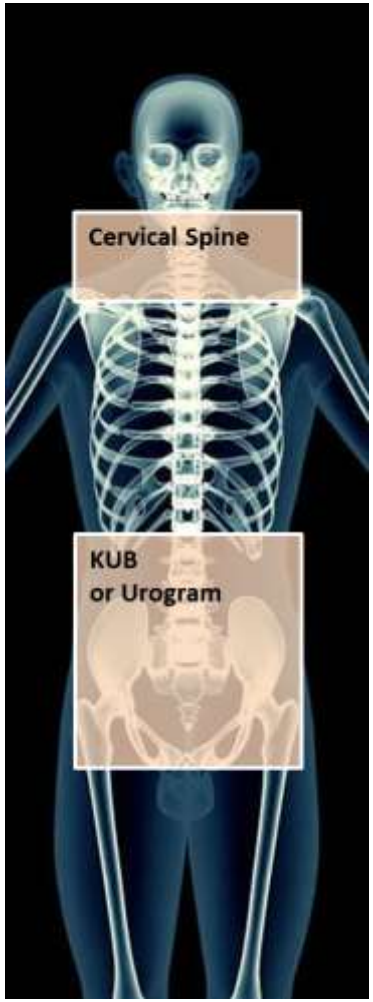
SCoR members are encouraged to submit data for any of the 13 examinations or other adult examinations that are routinely performed and/or have the highest doses.

"It has been decided to extend the deadline date for submitting data until the end of September 2019 to give participants additional time. If you have data ready to submit, please do so as soon as you can which will help us with processing," says PHE.

The data collection form and scanner help sheets are available on the CT users group website at http://www.ctug.org.uk/ctsurvey.html

For any queries and to submit data please email medicalradiationdoses@phe.gov.uk

Scan region guidance



Protocol details: scanner details

Hospital and Scanner Information

Hospital Name*:	
Local system ID*:	
System manufacturer*:	
System model*:	
Number of detector rows (eg. 16, 32, 64, 128, etc):	
Year of manufacture of scanner:	
Software version:	

Calibration Data

Error of indicated CTDIvol when last checked (+/- %)	

Standard Protocol Settings

Local protocol name*:	
Number of scan acquisitions* (e.g. 1 contrast & 1 non-contrast scan = 2 acquisitions):	

Protocol details: scout view details

Scout view details

Number of scout views:	
Does the total DLP (provided opposite) include the DLP from scout views?*	
Typical total DLP for all scout views (mGy.cm):	
Tube voltage (kV):	
Tube current (mA):	
Tuber current time (mAs):	
Imaged scan length (mm):	

Protocol details: scan details

Acquisition 1 details

See notes on scanner specific help sheet

CTDI phantom size (cm) (i.e. 16 cm head or 32 cm body)*:			[a]
Is Automatic Exposure Control (AEC) used?*			[b]
AEC name (e.g. AutomA, ZDOM, CARE Dose 4D, SureExpose):			[c]
AEC setting type (e.g. ref noise index, reference mAs, etc):			[d]
AEC setting value (e.g. SD 7.5, ref mAs 200):			[e]
minimum mA for AEC (where applicable):			[f1]
maximum mA for AEC (where applicable):			[f1]
mA where AEC is not used:			[f2]
Is iterative reconstruction used?			
Iterative recon type (e.g. ASIR, SAFIRE, iDose, AIDR):			[g]
Iterative recon value (e.g. ASIR 40%, SAFIRE 3, iDose level 4):			[h]
Radiation beam collimation	**- Collimated Beam width (mm):**		[i]
	- Number of slices:		[j]
	- Detector size (mm) (e.g. 0.625,0.6):		[k]
Is Automatic tube voltage selection used? (eg. CarekV)			
If no, Fixed Tube voltage (kV):			[l]
Tube rotation time (s):			[m]
Primary image slice thickness (mm):			[n]
Scan field of view (SFOV) (mm):			[o]
Reconstruction field of view (DFOV) (mm):			[p]
Axial or helical?			[q]
Pitch (where applicable):			[r]
Reconstruction algorithm or kernel (e.g. B30; FC17; Std)			[s]
Is contrast used?			
Anatomical landmarks for start and end points	**Start point (e.g. base of skull)**		
	End point (e.g. vertex)		

Patient details and dose

Patient No	At time of scan:			Acquisition 1								Total DLP* (whole scan) mGy.cm
				Scan length (mm)			If different from protocol:					
	Age (yrs)	Weight (kg)	Height (cm)	Imaged length	Start position	End position	kV	CTDI phantom	Scan FOV (mm)	$CTDI_{vol}$ (mGy)*	DLP (mGy.cm)*	
1												
2												
3												
4												
5												

Local audit details and doses

Summary dose data from local audit

No of Patients	Mean Age at time of scan (yrs)	Mean Body Mass (kg)	Mean Total DLP* (whole scan)	Median Total DLP* (whole scan)	Comments on the data collection method (eg. inclusion criteria, data analysis method)

Acquisition 1									
Mean $CTDI_{vol}$ (mGy)*	Standard deviation	Median $CTDI_{vol}$ (mGy)*	25th Percentile	75th Percentile	Mean DLP (mGy.cm)*	Standard deviation	Median DLP (mGy.cm)*	25th Percentile	75th Percentile

Survey timetable

Survey launched 22 March 2019

Data submission open until end of July 2019

Extended until end of September 2019

Further extended until end of October 2019

CTUG attendees time to submit data if not already done so

Submissions so far…

	This survey	2011 survey
Number of Hospitals	60	127
Number of Scanners	115	182
Number of local audit spreadsheets	677	189
Number of patient spreadsheets	421	682
Number of patients	413,257	46,938

Number of scanners

Examination	This survey		2011 Survey	
	$CTDI_{vol}$	DLP	$CTDI_{vol}$	DLP
Head	**67**	**101**	**114**	**152**
Paranasal sinuses	30	54		
Cervical spine (C-spine)	26	43	37	54
Neck, chest, abdomen and pelvis	36	55		
Chest	**58**	**88**	**99**	**130**
Chest – high resolution	**36**	**64**	**82**	**110**
Chest and abdomen	48	70		
Chest-abdomen-pelvis (CAP)	72	109	11	39
CT pulmonary angiography (CTPA)	56	85	80	89
Abdomen and pelvis	69	104	95	120
Colonography/Virtual colonoscopy (VC)	**15**	**45**	**51**	**68**
Kidney-ureters-bladder (KUB)	**59**	93	**92**	100
Urogram	**22**	57	**63**	74

Bold exams: <70% of scanners in 2011 survey

Automatic exposure control (AEC)

Examination	% of scanners
Head	**60%**
Paranasal sinuses	**20%**
Cervical spine (C-spine)	93%
Neck, chest, abdomen and pelvis	95%
Chest	97%
Chest – high resolution	**86%**
Chest and abdomen	94%
Chest-abdomen-pelvis (CAP)	94%
CT pulmonary angiography (CTPA)	94%
Abdomen and pelvis	97%
Colonography/Virtual colonoscopy (VC)	93%
Kidney-ureters-bladder (KUB)	96%
Urogram	96%

Yes if at least 1 sequence uses AEC

Iterative reconstruction (IR)

Examination	% of scanners
Head	65%
Paranasal sinuses	**59%**
Cervical spine (C-spine)	70%
Neck, chest, abdomen and pelvis	67%
Chest	72%
Chest – high resolution	66%
Chest and abdomen	69%
Chest-abdomen-pelvis (CAP)	72%
CT pulmonary angiography (CTPA)	74%
Abdomen and pelvis	71%
Colonography/Virtual colonoscopy (VC)	**60%**
Kidney-ureters-bladder (KUB)	74%
Urogram	67%

Yes if at least 1 sequence uses IR

Dose analysis

Rough data

- Not to be assumed as new NDRLs (yet)

Initial data cleansing

- Obvious spurious data removed/corrected
- Some data queried with submitters

Data samples with less than 20 patients excluded

DLP is for the complete exam

- May be 1 or more sequences, scout views and/or monitoring scans

$CTDI_{vol}$ is for an individual sequence

- Where more than 1 sequence for an exam, the mean is used

Dose: comparison to 2011 survey

Examination	2019 3rd Quartile		2011 3rd Quartile		% Difference	
	$CTDI_{vol}$	DLP	$CTDI_{vol}$	DLP	$CTDI_{vol}$	DLP
Head	48.7	821	63	973	-23	-16
Paranasal sinuses	12.0	173				
Cervical spine (C-spine)	17.6	473	21	440	-16	7
Neck, chest, abdomen and pelvis	12.1	1026				
Chest	**9.3**	**327**	**12**	**614**	**-22**	**-47**
Chest – high resolution	*8.5*	*346*	*9*	*299*	*-6*	*16*
Chest and abdomen	11.0	539				
Chest-abdomen-pelvis (CAP)	11.3	740	13	1003	-13	-26
CT pulmonary angiography (CTPA)	10.0	358	13	441	-23	-19
Abdomen and pelvis	13.6	652	15	745	-9	-13
Colonography/Virtual colonoscopy (VC)	7.2	857	11	947	-34	-10
Kidney-ureters-bladder (KUB)	7.5	370	10	458	-25	-19
Urogram	9.9	1010	13	1148	-24	-12

Dose: mean vs. median

Examination	Mean doses		Median doses		% Difference	
	$CTDI_{vol}$	DLP	$CTDI_{vol}$	DLP	$CTDI_{vol}$	DLP
Head	48.7	821	48.0	797	-1	-3
Paranasal sinuses	12.0	173	11.6	165	-3	-4
Cervical spine (C-spine)	17.6	473	17.6	443	0	-6
Neck, chest, abdomen and pelvis	12.1	1026	10.0	904	-17	-12
Chest	9.3	327	8.4	292	-10	-11
Chest – high resolution	8.5	346	8.0	331	-5	-4
Chest and abdomen	11.0	539	9.3	464	-15	-14
Chest-abdomen-pelvis (CAP)	11.3	740	9.0	656	-20	-11
CT pulmonary angiography (CTPA)	10.0	358	9.9	317	-2	-11
Abdomen and pelvis	13.6	652	11.6	548	-15	-16
Colonography/Virtual colonoscopy (VC)	7.2	857	6.8	820	-6	-4
Kidney-ureters-bladder (KUB)	7.5	370	6.8	309	-10	-17
Urogram	9.9	1010	8.9	913	-10	-10

High resolution chest CT

Toshiba axial sequences

3 scanners with axial sequences, 1 mm beam width

Scanner	"$CTDI_{vol}$"	DLP
Aquilion CX	43	51
Aquilion One	50	60
Aquilion Prime	33	83

Current NDRL is ~ 4 mGy

The average $CTDI_{vol}$ from other axial sequences in this study (n=11) is ~ 2 mGy

Other manufactures appear to correct for step between scans, Toshiba do not

High resolution chest CT

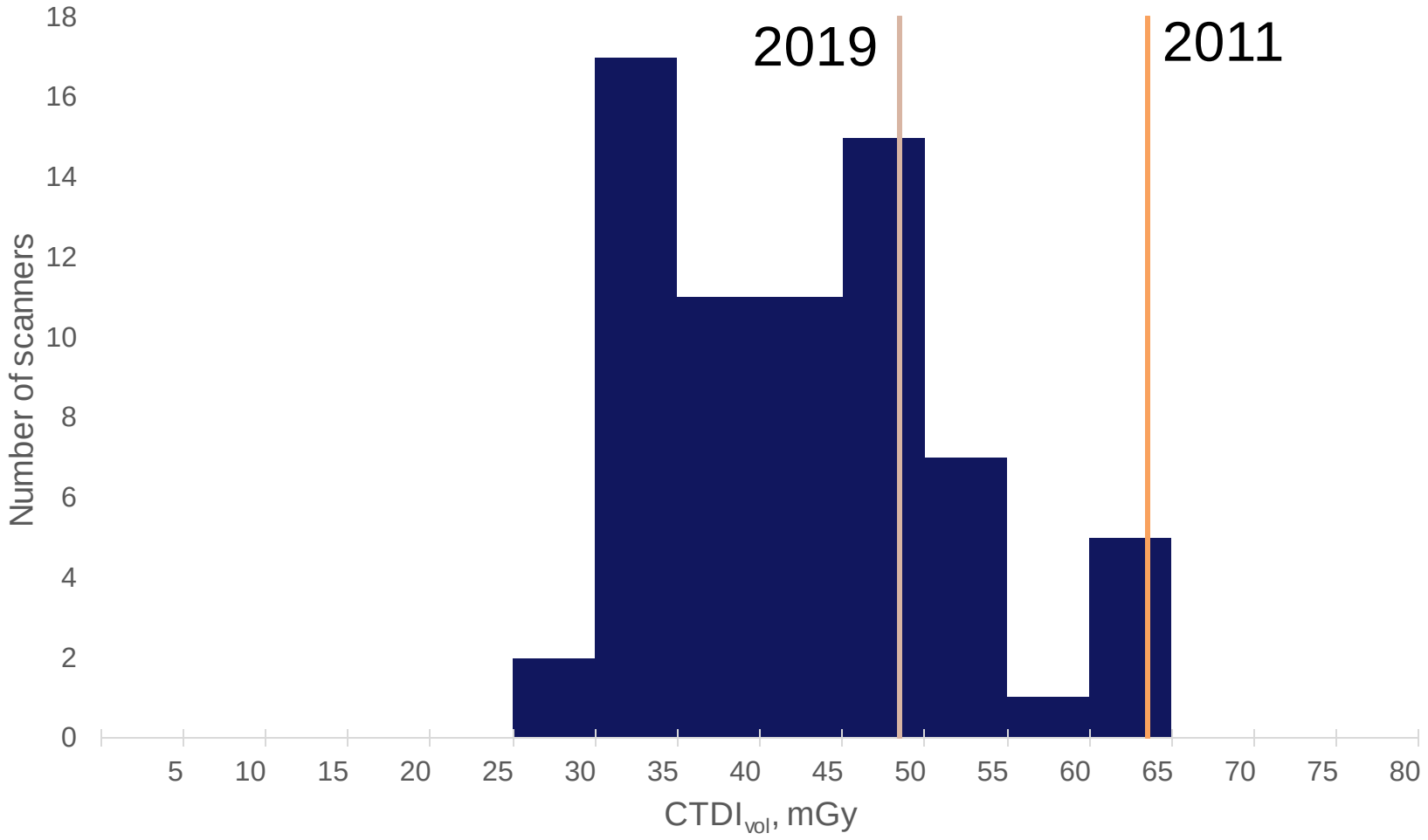
High Resolution Chest CT	2019 3rd Quartile		Current NDRL		% Difference	
	$CTDI_{vol}$	DLP	$CTDI_{vol}$	DLP	$CTDI_{vol}$	DLP
Axial sequence	2.2	66	4	139	-45	-53
Helical sequence	7.8	266	12	350	-35	-24
Any sequences	8.5	346	9	299	-6	16

14 Axial sequences

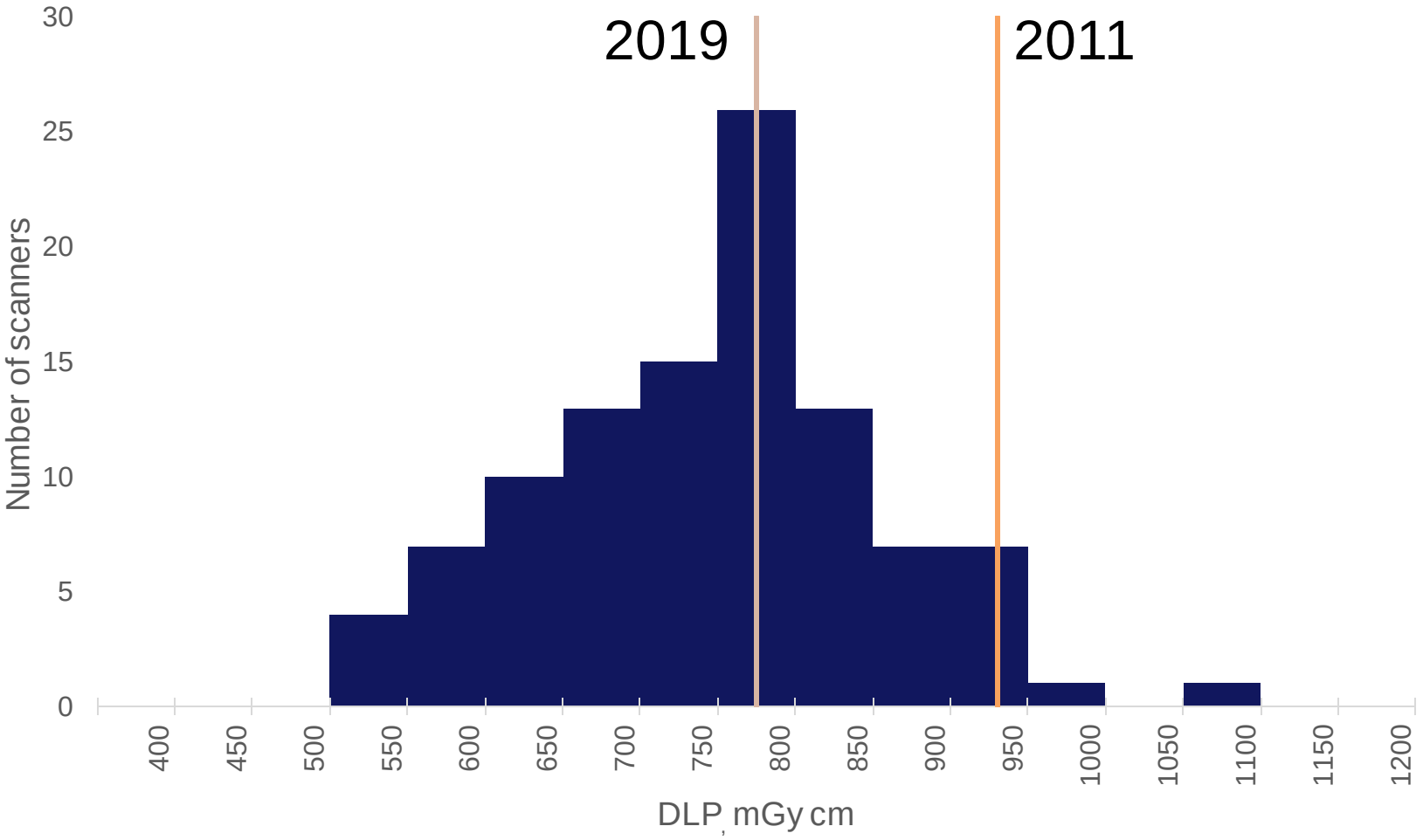
27 Helical sequences

36 total sequences for CTDI, 64 for DLP

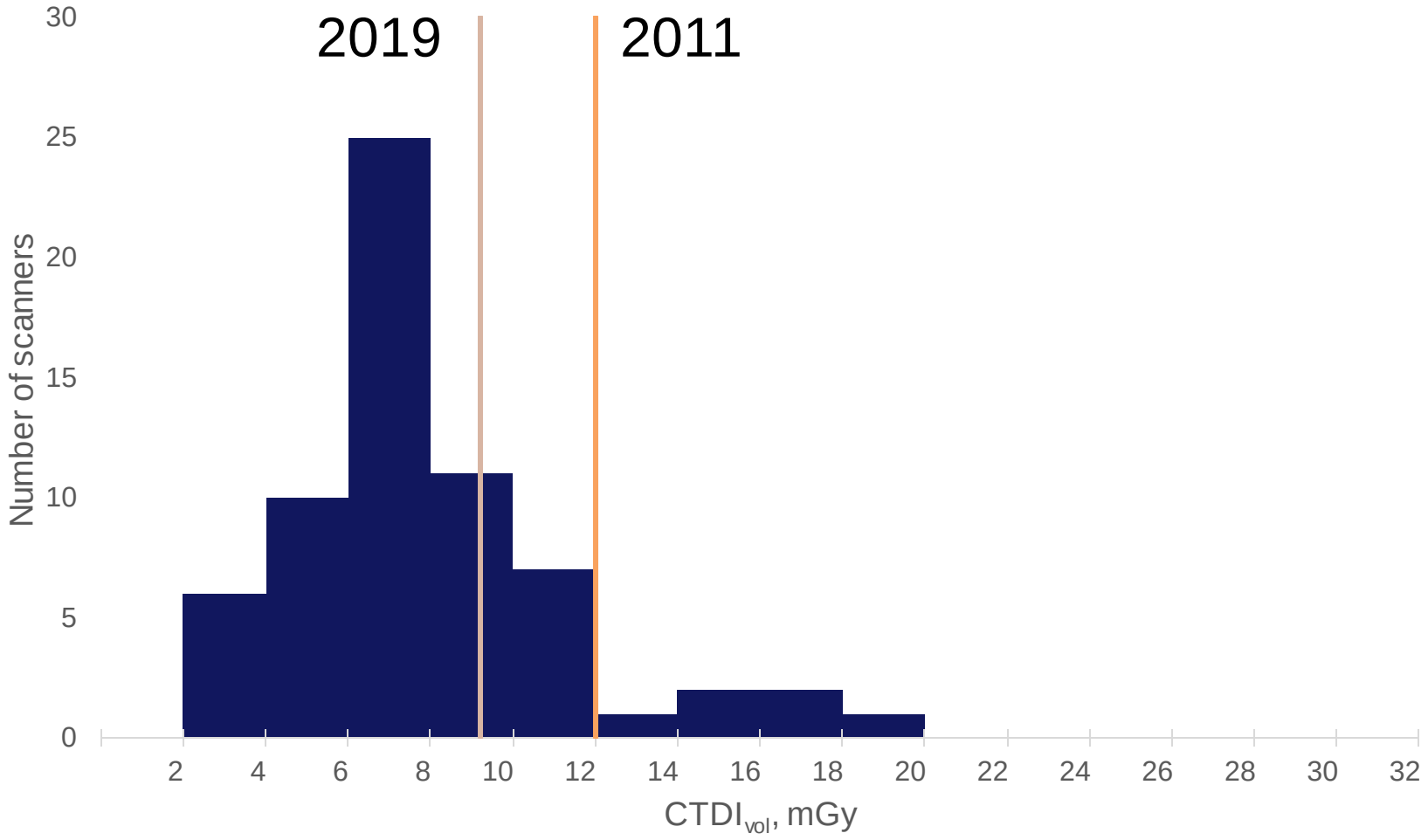
Head exams: $CTDI_{vol}$



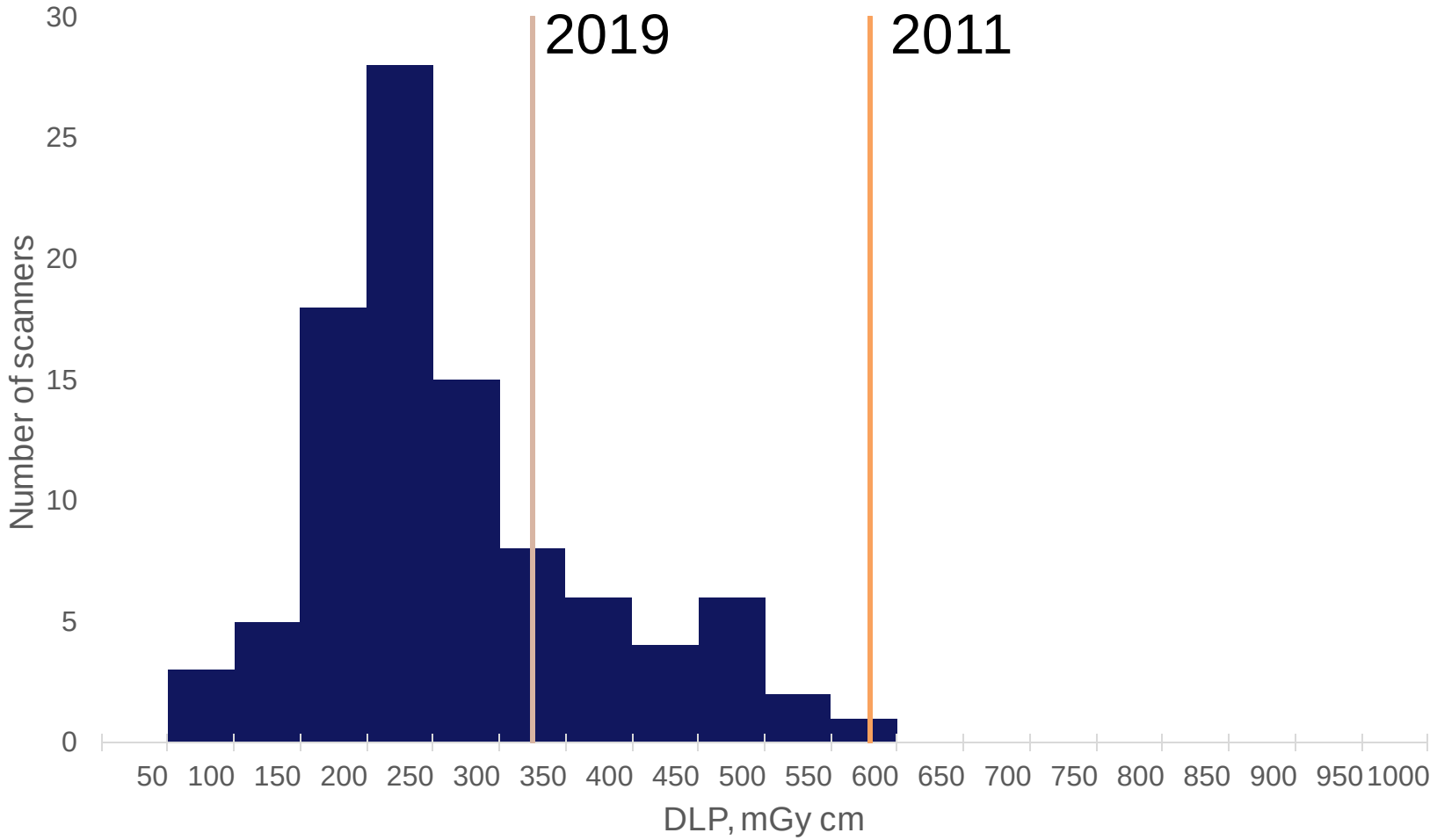
Head exams: DLP



Chest exams: $CTDI_{vol}$



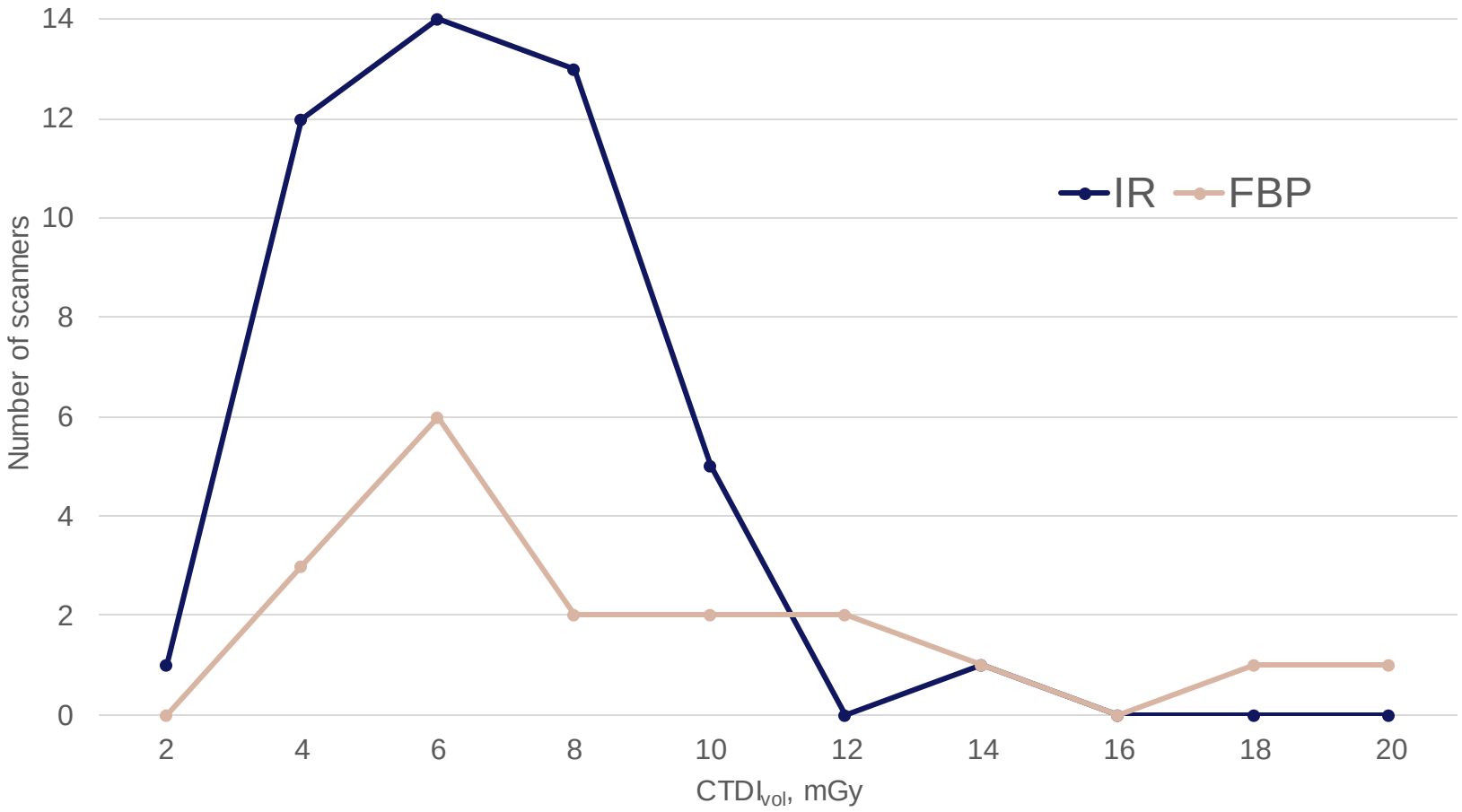
Chest exams: DLP



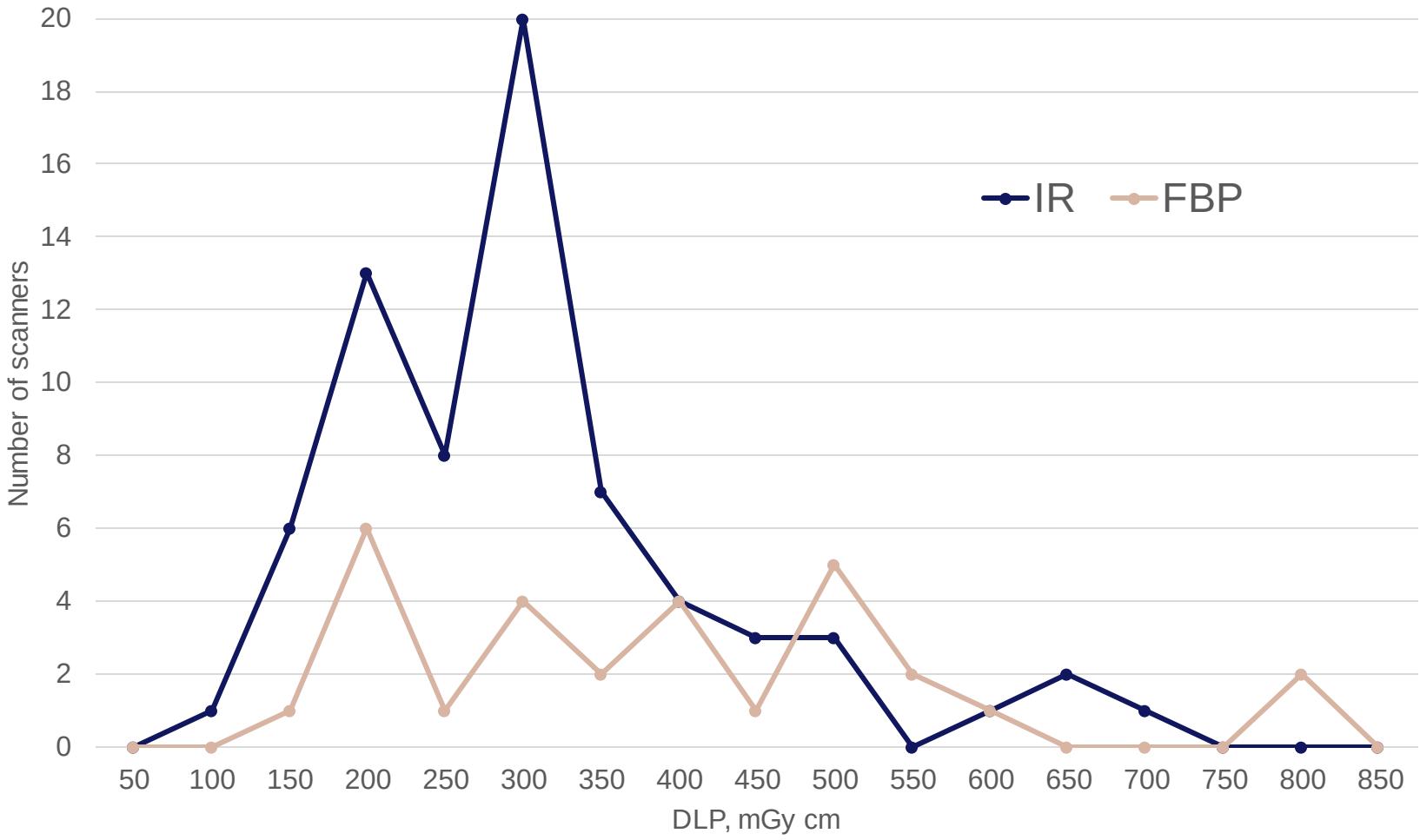
Separate dose by reconstruction technique

Examination	IR		FBP		% Difference	
	$CTDI_{vol}$	DLP	$CTDI_{vol}$	DLP	$CTDI_{vol}$	DLP
Head	43.9	815	52.8	838	-17	-3
Paranasal sinuses	8.0	167	13.1	177	-39	-5
Cervical spine (C-spine)	15.2	431	22.0	492	-31	-12
Neck, chest, abdomen and pelvis	12.0	944	14.3	1060	-16	-11
Chest	8.8	290	10.7	374	-18	-22
Chest – high resolution	*10.5*	*341*	*7.2*	*356*	*47*	*-4*
Chest and abdomen	10.5	516	15.2	583	-31	-11
Chest-abdomen-pelvis (CAP)	11.1	734	14.6	754	-24	-3
CT pulmonary angiography (CTPA)	9.6	347	10.5	393	-8	-12
Abdomen and pelvis	12.8	640	14.0	670	-9	-5
Colonography/Virtual colonoscopy (VC)	6.0	842	8.0	835	-24	1
Kidney-ureters-bladder (KUB)	**7.0**	**319**	**10.8**	**474**	**-35**	**-33**
Urogram	9.4	974	9.2	966	3	1

IR vs. FBP: KUB exams - $CTDI_{vol}$



IR vs. FBP: KUB exams - DLP



Where might the NDRLs change?

General

10-30% reductions across the range of exams

Head

No axial or multiple sequence exams carried out anymore

Chest

Significant number of low dose protocols being used

New values

Paranasal sinuses

Neck, Chest, Abdomen and Pelvis

What next

Data collection still open until the end of October

Please let me know if you can submit data but it will be after October

Data analysis and report writing ongoing

Aiming for publication Spring 2020

- Updated NDRLs shortly after

Don’t forget the IPEM/PHE paediatric CT dose survey

- Data submission open until the end of December 2019
- Weight information is mandatory for body exams
- Please submit data wherever possible

Public Health England

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Thank you to all those who have or will submit data to this survey