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National Diagnostic Reference Level Service Year in Review 2020

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Acknowledgement of Country

ARPANSA respectfully acknowledges Australia's Aboriginal and Torres Strait Islander communities and their rich culture and pays respect to their Elders past and present. We acknowledge Aboriginal and Torres Strait Islander peoples as Australia's first peoples and as the Traditional Owners and custodians of the land and water on which we rely.

We recognise and value the ongoing contribution of Aboriginal and Torres Strait Islander peoples and communities to Australian life and how this enriches us. We embrace the spirit of reconciliation, working towards the equality of outcomes and ensuring an equal voice.

Contents

Executive Summary

ARPANSA collects data to establish and update national diagnostic reference levels (DRLs). The National Diagnostic Reference Level Service (NDRLS), a free on-line service maintained and operated by ARPANSA, provides tools for imaging facilities to record data on radiation doses in imaging procedures and compare their practice with the national DRLs, providing guidance to optimise radiation dose. More than 60 per cent of imaging facilities with computed tomography (CT) scanners use this service, which supports patient safety in CT and other imaging procedures.

A total of 5078 surveys from 722 scanners were completed in 2020 for multi-detector computed tomography (MDCT) procedures. For several scan categories the third quartile of the distribution of scanner median dose metrics for 2020 is more than 10% below the relevant national DRL. In many cases more than 85% of surveys have median values under the national DRL. These data suggest that a general review of the MDCT DRLs is warranted, especially the DRLs for pediatric patients.

Forty-six (46) surveys were submitted for image-guided procedures in 2020, mostly for diagnostic coronary angiography. The third quartiles of the distributions of dose metrics were consistent with the national DRLs for diagnostic coronary angiography. More data submissions are needed to establish national DRLs for other image-guided procedures.

A new survey was developed to collect data for nuclear medicine procedures. Updated DRLs for nuclear medicine and positron emission tomography are expected following the completion of the survey and analysis of the data.

The data collected for MDCT over the last decade demonstrate a reduction in dose per procedure for all procedures which have an established national DRL. These changes reflect advances in technology and optimisation of practice. DRL programs in other modalities are less mature and greater engagement is needed to increase the volume of data submission and foster optimisation.

1. Introduction

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) has a legislated responsibility to "protect the health and safety of people, and to protect the environment, from the harmful effects of radiation."[1] ARPANSA's National Diagnostic Reference Level Service (NDRLS) is maintained to support radiation safety for patients undergoing diagnostic imaging with ionising radiation.

ARPANSA's Medical Imaging section developed the NDRLS in response to the publication and adoption in 2008 of the *Code for Radiation Protection in the Medical Applications of Ionizing Radiation* (RPS 14) (ARPANSA, 2008). The code included a requirement for facilities to compare radiation doses in diagnostic imaging procedures with diagnostic reference levels (DRLs) where such DRLs had been established. Since the inception of the NDRLS in 2011, usage has grown such that nearly 800 facilities with a combined total of more than 1000 computed tomography (CT) scanners are registered with the service. It is estimated that this represents more than 60% of all providers of CT services in Australia. The NDRLS supports patient safety for the approximately 5 million CT imaging procedures performed in Australia each year.

This report analyses data collected through the NDRLS for the 2020 calendar year and presents historical trends over the service's operational lifetime since 2011.

2. ARPANSA's National Diagnostic Reference Level Service

ARPANSA's Diagnostic Reference Level (DRL) program supports optimisation of medical exposures by providing guidance on typical doses for common imaging procedures. Routine comparison against DRLs is included in regulatory requirements such as the Medical Exposure Code (RPS C-5) (ARPANSA, 2019) and the Diagnostic Imaging Accreditation Scheme (DIAS) (ACSQHC, 2016).

The International Commission on Radiological Protection (ICRP) recommends that DRLs should reflect common practice within a given geographical region (ICRP, 2017). ARPANSA achieves this by determining national DRLs based on the results of wide-scale surveys of Australian imaging facilities.

ARPANSA has published national DRLs for multi-detector computed tomography (MDCT), image guided and interventional procedures (IGIP) and nuclear medicine (ARPANSA, 2021; Hayton *et al*., 2013a; Lee *et al*., 2020; Beveridge *et al*., 2019). These three modalities include the imaging procedures with the highest radiation doses and are responsible for the majority of the Australian population's medical imaging dose burden (Hayton *et al*., 2013b).

The NDRLS collects MDCT survey data through a web portal (Wallace *et al*., 2015). Data for IGIP and nuclear medicine procedures are collected using spreadsheet templates[2]. Imaging facilities submit their protocol, patient, and dose information to the ARPANSA NDRLS for a variety of procedures. A single survey consists of the protocol information (technical parameters for the scan or procedure) for a particular scan category along with the dose metrics and patient characteristics for a sample of individual patients undergoing that scan or procedure. Surveys include data for up to 20 patients in MDCT and 50 patients for IGIP. The median value of each dose metric is reported as the facility reference level (FRL) for the survey. The national DRLs

[1] Australian Radiation Protection and Nuclear Safety Act https://www.legislation.gov.au/Details/C2016C00977

[2] IGIP data is collected on an annual basis whereas nuclear medicine has been collected sporadically. For information on the nuclear medicine DRL program please see ARPANSA technical report TR 180 (https://www.arpansa.gov.au/sites/default/files/tr180.pdf)

are based on the 75th percentile (third quartile) of the resulting FRL distributions across all participating facilities for each scan or procedure category.

What are DRLs?

A key principle for radiation protection in medical uses of ionising radiation is that procedures should be optimised, meaning that the ratio of benefit to risk should be maximised. For a given imaging procedure, the risk is assumed to be proportional to the radiation dose delivered. Benefit is harder to quantify but a key requirement is that the images obtained are of sufficient quality to address the clinical question that prompted the imaging procedure in the first place.

Diagnostic reference levels (DRLs) are an optimisation tool. They provide an indication of the expected radiation dose delivered for a given imaging procedure. A medical imaging facility must periodically compare their typical dose with the DRL for each of the common procedures they perform that have a published national DRL. The typical dose at a facility is the median value of the relevant dose metric from a representative sample of patient exposures. If the facility's median value is above the DRL, this is an indication that further optimisation (reduction in dose) may be possible. The facility should review the imaging protocol to determine whether a reduction in dose can be achieved, without compromising the image quality required for the clinical task.

DRLs are usually established from surveys of typical doses for common procedures across many facilities in a nation or region. The International Commission on Radiological Protection (ICRP) recommends that DRLs be established at the 75th percentile of the distribution of facility median dose values. This means that 75% of facilities would have a typical dose either at or below the DRL. The other 25% of facilities may be doing the best they can, but the fact that 75% of facilities can perform the same imaging task at a lower dose level suggests that improvement is possible and worth investigating. Improvement may be possible even for sites that are under the DRL, and this is encouraged where resources permit, but it is likely that the best gains can be made in those sites that are above the DRL.

Continued monitoring of facility median dose levels would be expected to show a reduction in the 75th percentile of the distribution over time as facilities review and optimise their imaging protocols and as new equipment is installed with the capability of producing the required image quality at lower doses. DRLs should thus be reviewed over time and revised as necessary to ensure they are continuing to reflect the typical dose achieved by about 75% of facilities. This ongoing process of continuous improvement helps ensure that the ratio of benefit to risk is maximised for patients.

3. Year in Review – 2020

3.1 Computed Tomography

The MDCT survey continued to show growth in the number of users participating and the amount of data submitted. At the end of 2020, the MDCT survey had 787 registered participants, with 52 registering during 2020. A total of 5078 CT surveys from 722 scanners were completed in 2020, an increase of 297 surveys from the total for 2019. A breakdown of the surveys by age group and scan category is shown in Table 1.

Table 1 - Number of MDCT DRL surveys submitted in 2020 by age group and scan category

Age group	Scan category	Surveys
Adult (15+ years)	Head	729
	Cervical spine	597
	Soft-tissue neck	530
	Chest	682
	Chest-abdo-pelvis	621
	Abdomen-pelvis	693
	Kidney-ureter-bladder	521
	Lumbar spine	672
	Total	5045
Child (5-14 years)	Head	10
	Chest	6
	Abdomen-pelvis	4
	Total	20
Infant (0-4 years)	Head	8
	Chest	3
	Abdomen-pelvis	2
	Total	13
Total Surveys		5078

Table 2 shows the number of facilities and scanners registered with the ARPANSA NDRLS as at 1/1/2021 in each state and territory. Also shown is the number of scanners for which at least one eligible survey (at least 10 patients) for a scan category was submitted in 2020, the total number of such surveys, and the percentage of registered scanners that submitted at least one survey. Overall, 69% of registered scanners contributed at least one survey in 2020 and the proportion was reasonably consistent across the states and territories, varying from 64% to 74%.

Table 2 – Distribution of registered facilities and scanners by state and territory, number of scanners submitting surveys, total surveys, and percentage of registered scanners submitting data in 2020

State	Registered Facilities	Registered Scanners	Scanners with submitted surveys	Surveys	Registered scanners submitting (%)
NSW	278	322	225	1619	70
VIC	225	297	207	1482	70
QLD	153	231	151	1075	65
SA	27	66	49	251	74
WA	64	79	58	409	73
TAS	14	15	11	74	73
ACT	18	19	14	115	74
NT	8	11	7	53	64
Total	787	1040	722	5078	69

According to data submitted to the Organisation for Economic Co-operation and Development (OECD) (OECD, 2022), Australia had 1769 CT scanners in 2019, however this figure is derived from the Medicare Location Specific Practice Number (LSPN) register and it is not known whether all such scanners are in active use, nor how many are used primarily for diagnostic radiology (in contrast to uses as part of hybrid equipment in nuclear medicine imaging or use in radiotherapy for treatment planning). The number of CT scanners registered with the NDRLS thus represents at least 60% of all diagnostic CT scanners in Australia, and the true proportion may be much higher. It seems likely therefore that the data comes from around half or more of all diagnostic CT scanners and is relatively evenly distributed across the country.

Table 3 shows the breakdown of registered facilities and scanners by facility type, along with the number of registered scanners submitting surveys, the total number of surveys, and the proportion of registered scanners submitting surveys. Public hospital facilities show a lower fraction of submissions from registered scanners; however these facilities also show a higher number of scanners per facility and this may reflect different usage patterns or delay in removing replaced scanners from the registration list.

Table 3 – Distribution of registered facilities and scanners by facility type, number of scanners submitting surveys, total surveys, and percentage of registered scanners submitting data in 2020

Facility Type	Registered Facilities	Registered Scanners	Scanners with submitted surveys	Surveys	Registered scanners submitting (%)
Public clinic in a Public Hospital	124	236	129	891	55
Private clinic in a Public Hospital	43	65	49	334	75
Private clinic in a Private Hospital	112	147	112	794	76
Private clinic	508	592	432	3059	73
Total	787	1040	722	5078	69

Third quartiles of the FRL distributions for adult patients in 2020 are shown in Table 4 and compared with the national DRLs. The percentage of surveys with median values under the relevant DRL is also shown. Plots of the cumulative FRL distributions for adult patients in 2020 for each scan category and dose metric are presented in Appendix 1. Historical trends in the FRL distributions for each scan category and dose metric are presented in Appendix 2.

Table 4 – Third quartiles (75th percentiles) of the 2020 CT FRL distributions for adult patients and comparison with the national DRLs, by scan category.

Scan Category	$CTDI_{vol}$ (mGy)			DLP (mGy.cm)		
	75th percentile	National DRL	Surveys < DRL (%)	75th percentile	National DRL	Surveys < DRL (%)
Head	47.4	52	91	835	880	85
Cervical spine	19.7	21	81	407	470	87
Soft-tissue neck	14.5	15	76	420	450	80
Chest	8.6	10	89	344	390	85
Chest-abdo-pelvis	10.3	11	78	842	940	86
Abdomen-pelvis	10.8	13	90	532	600	86
Kidney-ureter-bladder	9.2	10	82	438	460	80
Lumbar spine	21.9	26	88	607	670	85

For several scan categories the third quartile for 2020 is more than 10% below the national DRL. In many cases more than 85% of surveys have median values under the DRL. These data suggest that a general review of the CT DRLs is warranted.

Third quartiles of the FRL distributions for pediatric patients in 2020 are shown in Table 5 and compared with the national DRLs. The percentage of surveys with median values under the relevant DRL is also shown. Nearly all surveys have median values under the DRL. These data suggest that a review of the pediatric CT DRLs is warranted.

Table 5 – Third quartiles (75th percentiles) of the 2020 CT FRL distributions for pediatric patients and comparison with the national DRLs, by scan category.

Age group	Scan Category	$CTDI_{vol}$ (mGy)			DLP (mGy.cm)		
		75th percentile	National DRL	Surveys < DRL (%)	75th percentile	National DRL	Surveys < DRL (%)
Child (5-14 years)	Head	31	35	90	560	600	80
	Chest	1.6	5	100	56	110	100
	Abdomen-pelvis	3.3	10	100	130	390	100
Infant (0-4 years)	Head	23	30	100	390	470	100
	Chest	1*	2	100	25*	60	100
	Abdomen-pelvis	1*	7	100	35*	170	100

*There were insufficient surveys to calculate third quartiles for the Chest and Abdomen-pelvis scan categories for infants; the maximum value is shown instead.

3.2 Image-Guided and Interventional Procedures

Forty-six (46) surveys were submitted for IGIP in 2020, 45 for adult patients and one for pediatric patients. The surveys were submitted by 20 facilities (34 rooms) out of 58 registered facilities (34% of registered facilities). Comparative totals for 2019 were 47 surveys from 21 facilities (41 rooms) out of 49 registered facilities (43%).

Of the adult surveys, 22 were for coronary angiography and the third quartiles of the FRL distributions were consistent with the national DRLs. Data for other procedures were quite sparse and more submissions are needed to establish national DRLs.

Table 6 shows the number of adult IGIP surveys submitted in 2020 for each procedure category.

Table 6 – Adult IGIP surveys submitted in 2020 by procedure category

Procedure category	Surveys
Diagnostic coronary angiography	22
Percutaneous coronary intervention (single lesion)	7
Diagnostic cerebral angiography	4
Pelvic embolisation	1
Endovascular aortic repair	3
Barium swallow	3
Water-soluble swallow	2
Tunnelled line insertion	3
Total	45

Third quartiles of the FRL distributions for adult patients are shown in Table 7 for the three procedure categories with at least 4 submitted surveys. At present, a national DRL has only been published for diagnostic coronary angiography (ARPANSA, 2021) so no comparison can be shown for the other procedure categories. The third quartiles of the FRL distributions for diagnostic coronary angiography in 2020 are consistent with the current national DRLs.

Table 7 – Third quartiles (75th percentiles) of the 2020 IGIP FRL distributions for adult patients and comparison with the national DRLs by procedure category.

Procedure	DAP (Gy.cm^2)			Reference Dose (Gy)		
	75th percentile	National DRL	Surveys < DRL (%)	75th percentile	National DRL	Surveys < DRL (%)
Diagnostic coronary angiography	30.5	30	73	0.38	0.5	95
Percutaneous coronary intervention (single lesion)	62.4			1.2		
Diagnostic cerebral angiography	57.4			0.47		

3.3 Nuclear Medicine

A survey of radiation doses in nuclear medicine and positron emission tomography (PET) procedures was conducted in 2014/15 and DRLs for these procedures were established in 2017 (Beveridge *et al*., 2019). In 2020, a new survey was developed to collect data for nuclear medicine and PET procedures, covering both administered activities of radiopharmaceuticals and metrics for associated CT scans. A liaison panel comprising representatives of relevant professional bodies was formed to advise ARPANSA on the development of the survey. The survey was planned to be conducted towards the end of 2021. Updated DRLs for nuclear medicine and positron emission tomography are expected following the completion of the survey and analysis of the data.

4. Conclusions

The data collected for MDCT in 2020 comes from around half or more of all diagnostic CT scanners and is relatively evenly distributed across Australia and across facility types. For several scan categories the third quartile of the distribution of scanner median dose metrics for 2020 is more than 10% below the relevant national DRL, suggesting that a general review of the MDCT DRLs is warranted, especially for pediatric patients. The data collected for MDCT over the last decade demonstrate a reduction in dose per procedure for all scan categories that have an established national DRL. These changes reflect advances in technology and optimisation of practice.

DRL programs in other modalities are less mature and greater engagement is needed to increase the volume of data submission and foster optimisation.

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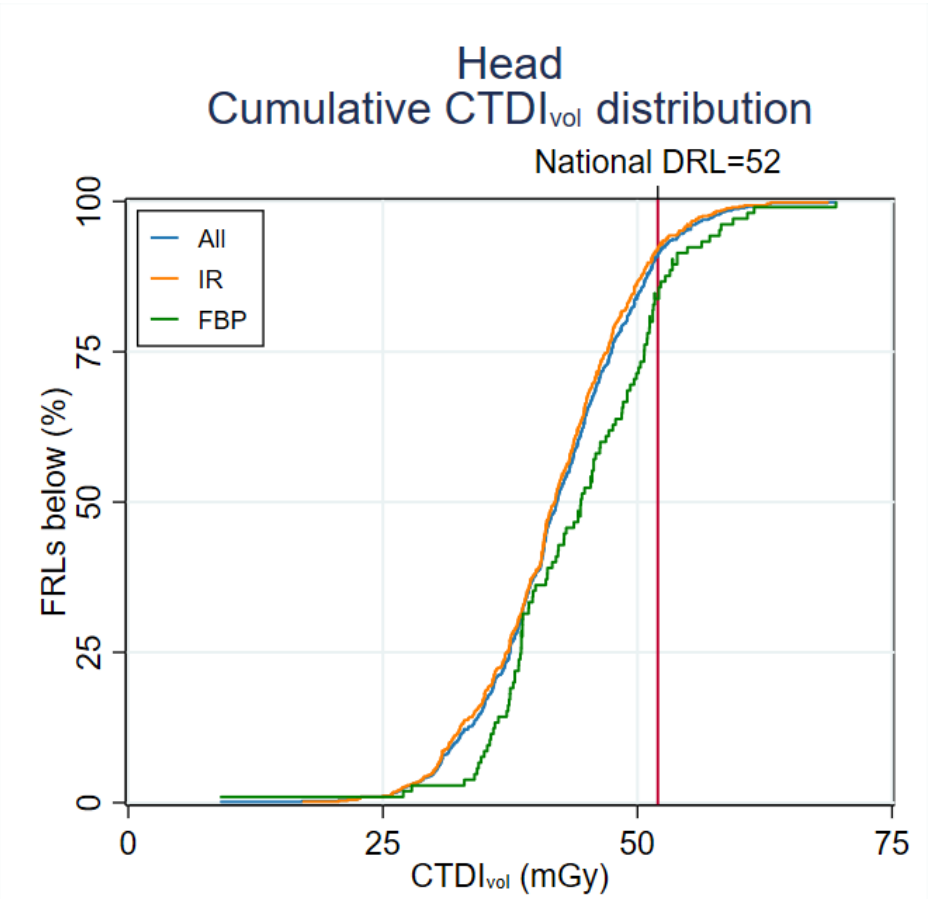
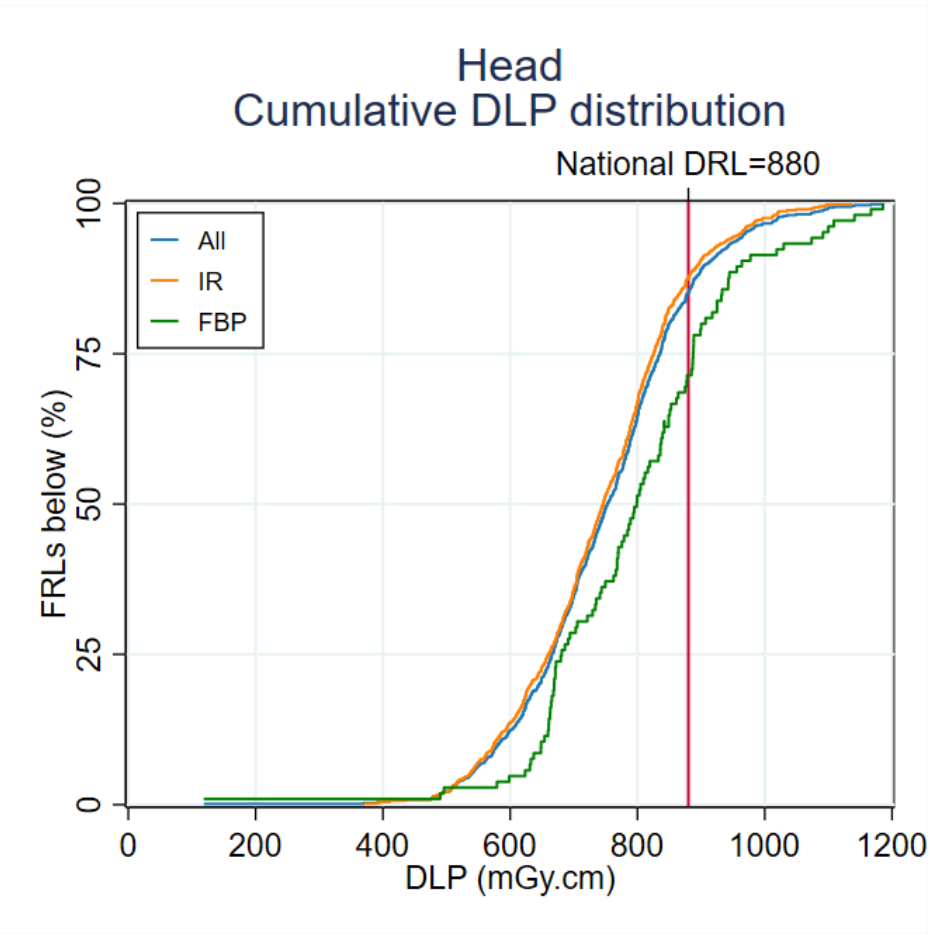
Appendix 1: Cumulative FRL distributions for MDCT surveys in 2020

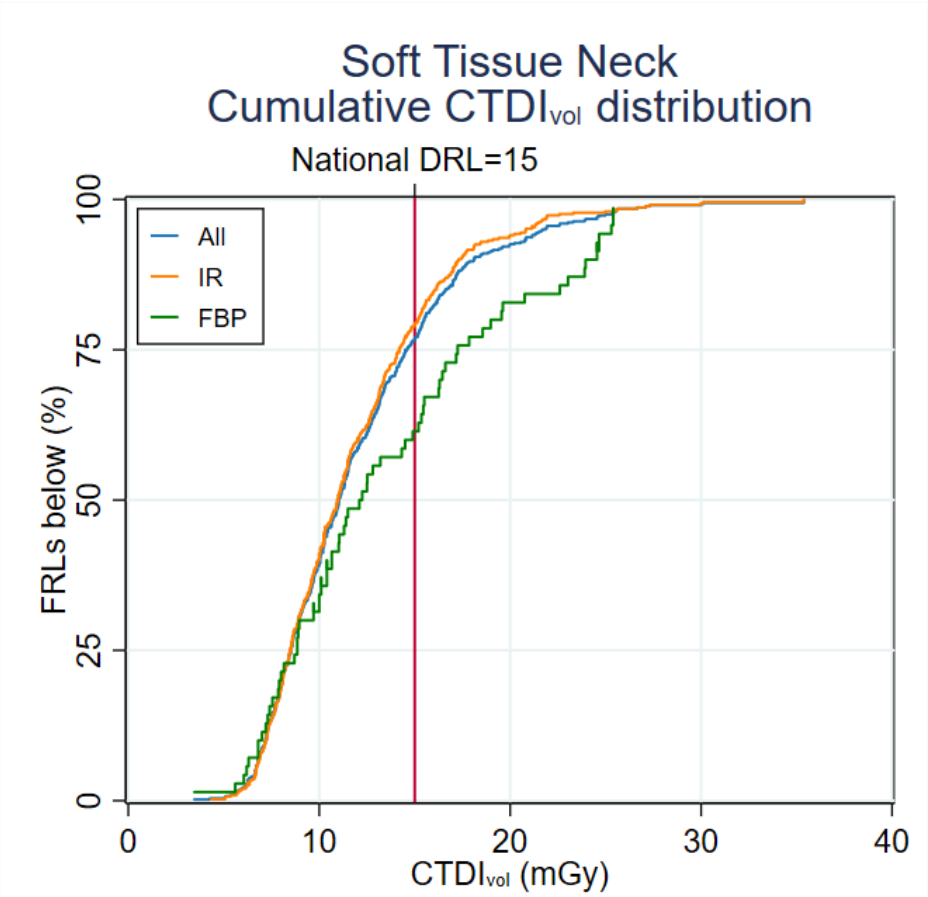
This appendix presents the cumulative distributions for $CTDI_{vol}$ and DLP from adult MDCT DRL surveys submitted to ARPANSA in 2020. The plots display the percentage of surveys that achieved a facility reference level (FRL) below the dose specified on the x-axis.

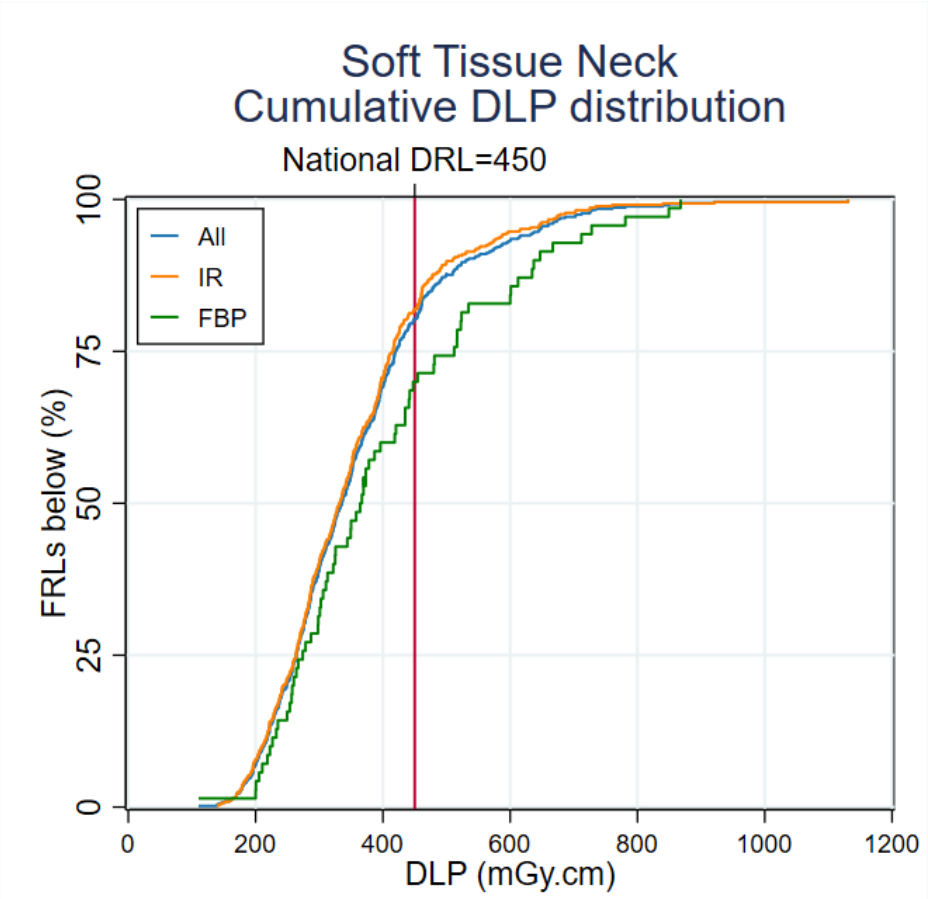
The blue curve represents all the submitted data, the orange curve represents the surveys where iterative reconstruction (IR) was used, and the green curve represents the surveys where IR was not used and image reconstruction was performed using standard filtered back-projection (FBP).

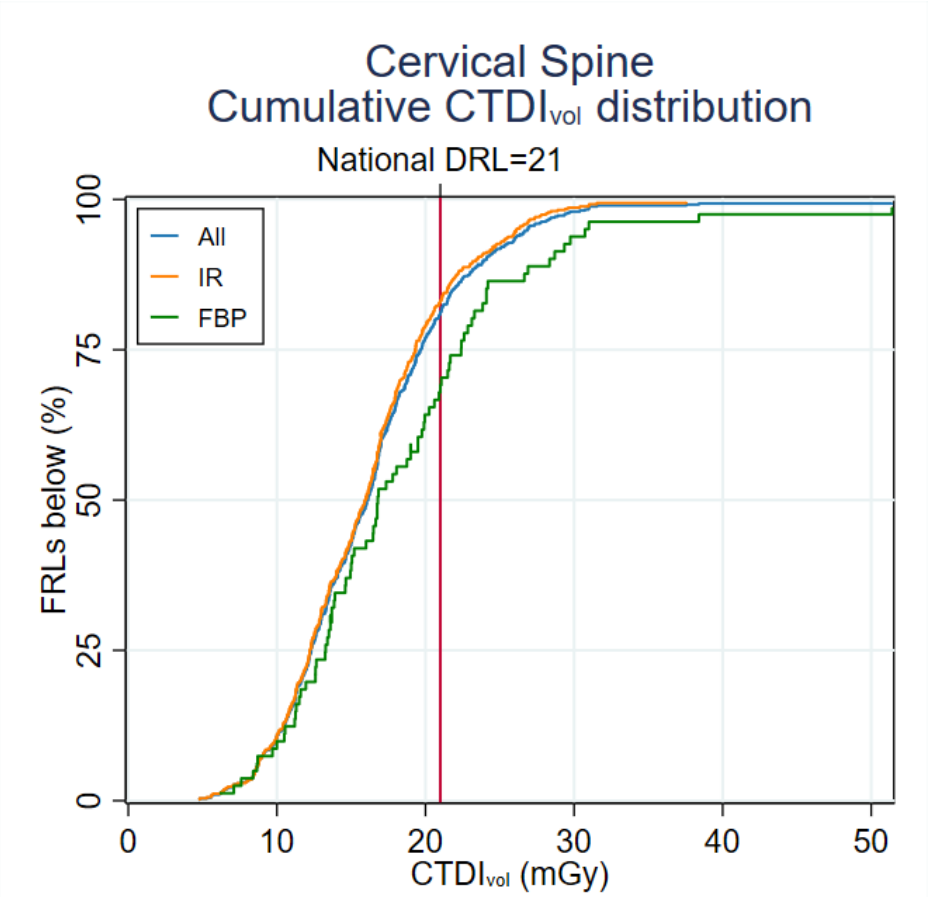
In general, the 75th percentiles of the distributions for all surveys, and for surveys where IR was used, are lower than the present national DRL. The 75th percentiles of the distributions for surveys where IR was not used are higher than the national DRL in some cases, but lower than the national DRL in other cases.

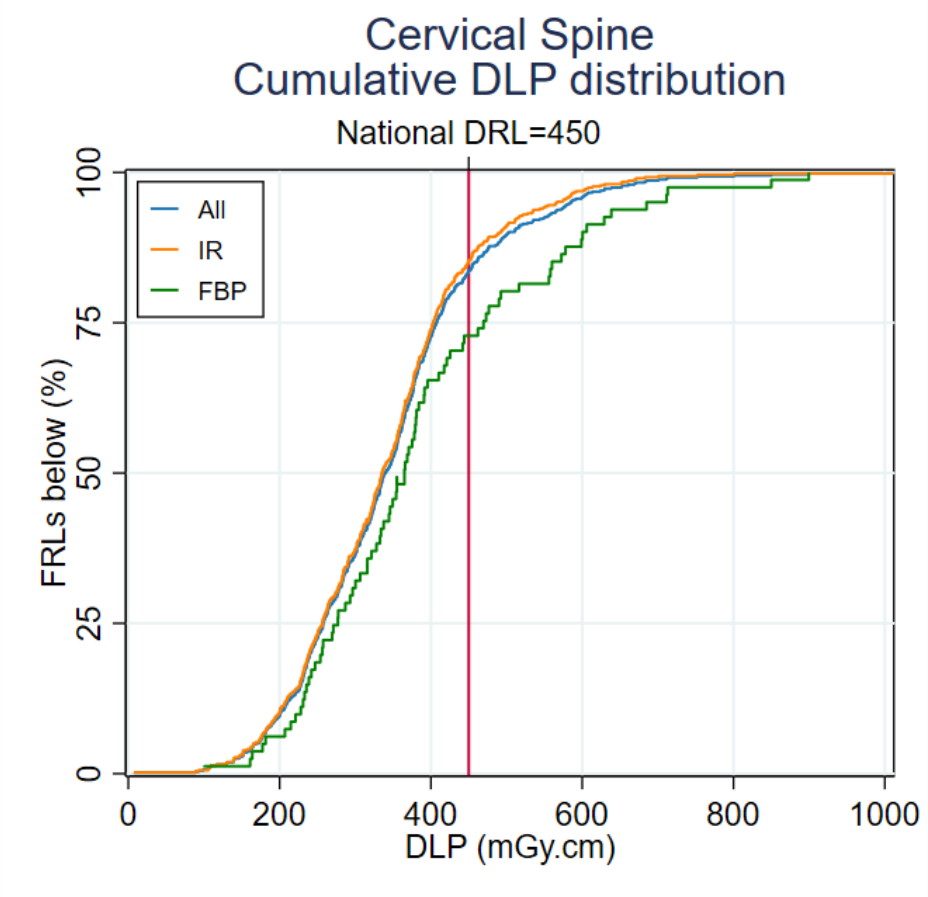

Head
Cumulative CTDIvol distribution
National DRL=52
All
IR
FBP
FRLs below (%)
0
25
50
75
100
0
25
50
75
CTDIvol (mGy)

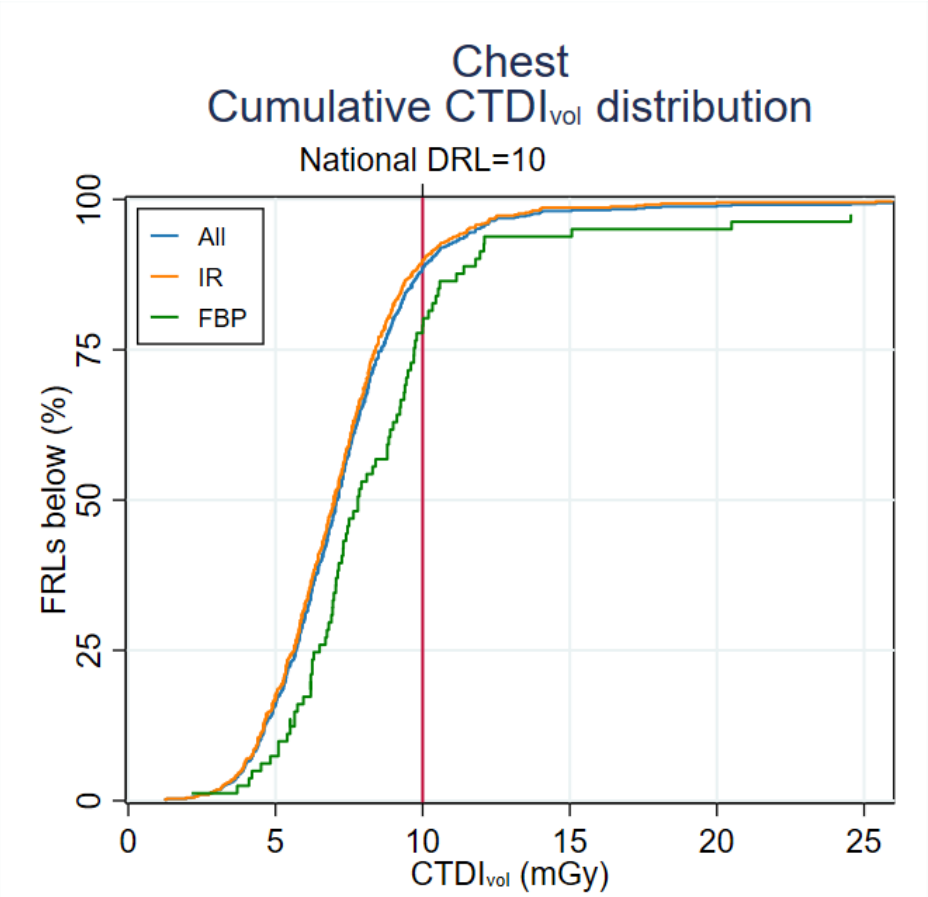

Head
Cumulative DLP distribution
National DRL=880
All
IR
FBP
FRLs below (%)
0
25
50
75
100
0
200
400
600
800
1000
1200
DLP (mGy.cm)

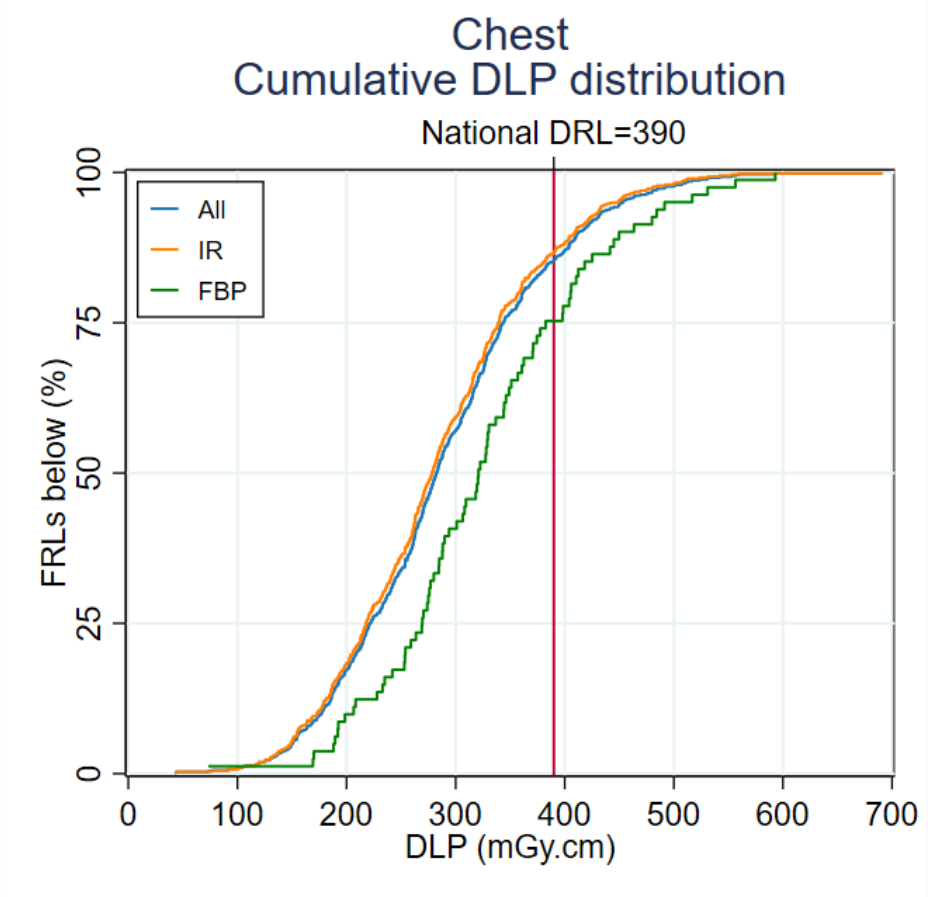

Soft Tissue Neck
Cumulative CTDIvol distribution
National DRL=15
All
IR
FBP
FRLs below (%)
0
25
50
75
100
0
10
20
30
40
CTDIvol (mGy)

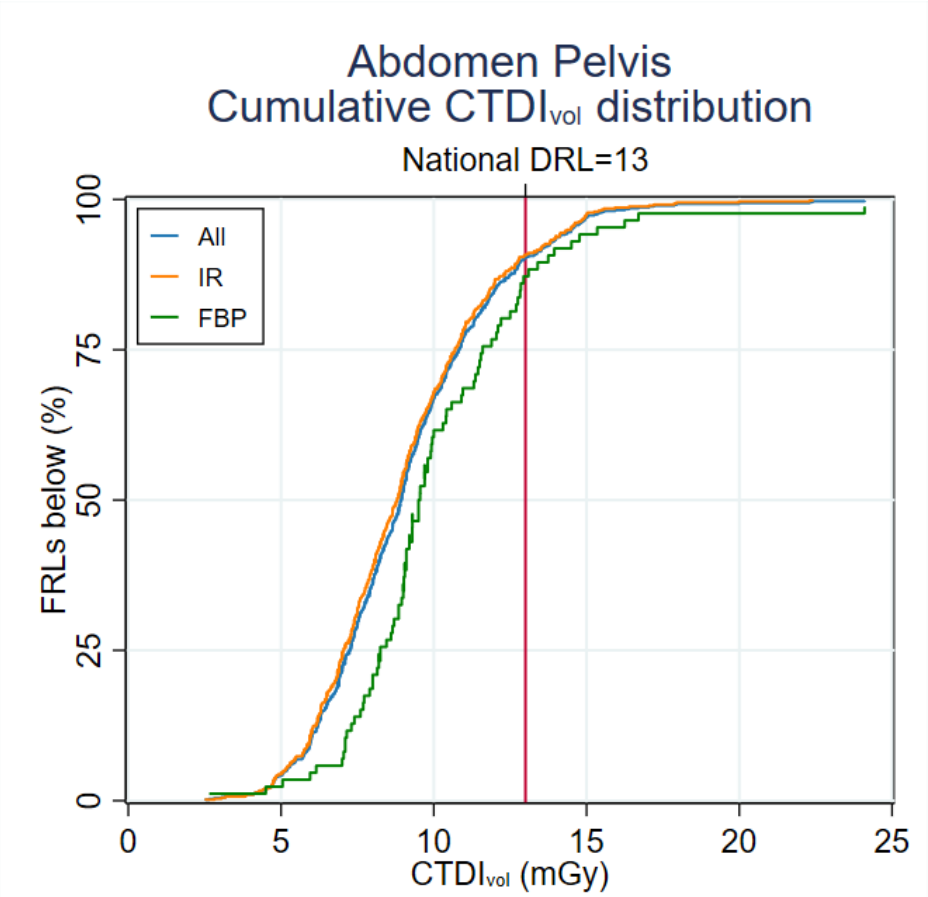

Soft Tissue Neck
Cumulative DLP distribution
National DRL=450
All
IR
FBP
FRLs below (%)
0
25
50
75
100
0
200
400
600
800
1000
1200
DLP (mGy.cm)

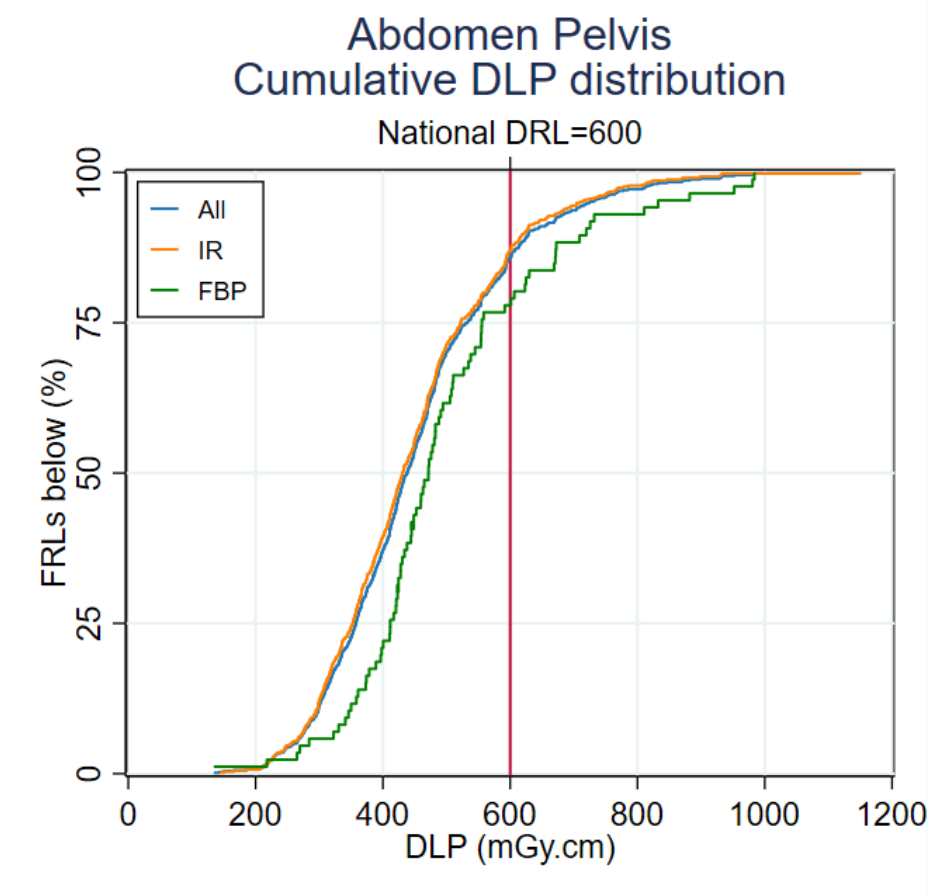

Cervical Spine
Cumulative CTDIvol distribution
National DRL=21
All
IR
FBP
FRLs below (%)
0
25
50
75
100
0
10
20
30
40
50
CTDIvol (mGy)


Cervical Spine
Cumulative DLP distribution
National DRL=450
All
IR
FBP
FRLs below (%)
0
25
50
75
100
0
200
400
600
800
1000
DLP (mGy.cm)


Chest
Cumulative CTDIvol distribution
National DRL=10
All
IR
FBP
FRLs below (%)
0
25
50
75
100
0
5
10
15
20
25
CTDIvol (mGy)


Chest
Cumulative DLP distribution
National DRL=390
All
IR
FBP
FRLs below (%)
0
25
50
75
100
0
100
200
300
400
500
600
700
DLP (mGy.cm)


Abdomen Pelvis
Cumulative CTDIvol distribution
National DRL=13
All
IR
FBP
FRLs below (%)
0
25
50
75
100
0
5
10
15
20
25
CTDIvol (mGy)


Abdomen Pelvis
Cumulative DLP distribution
National DRL=600
All
IR
FBP
FRLs below (%)
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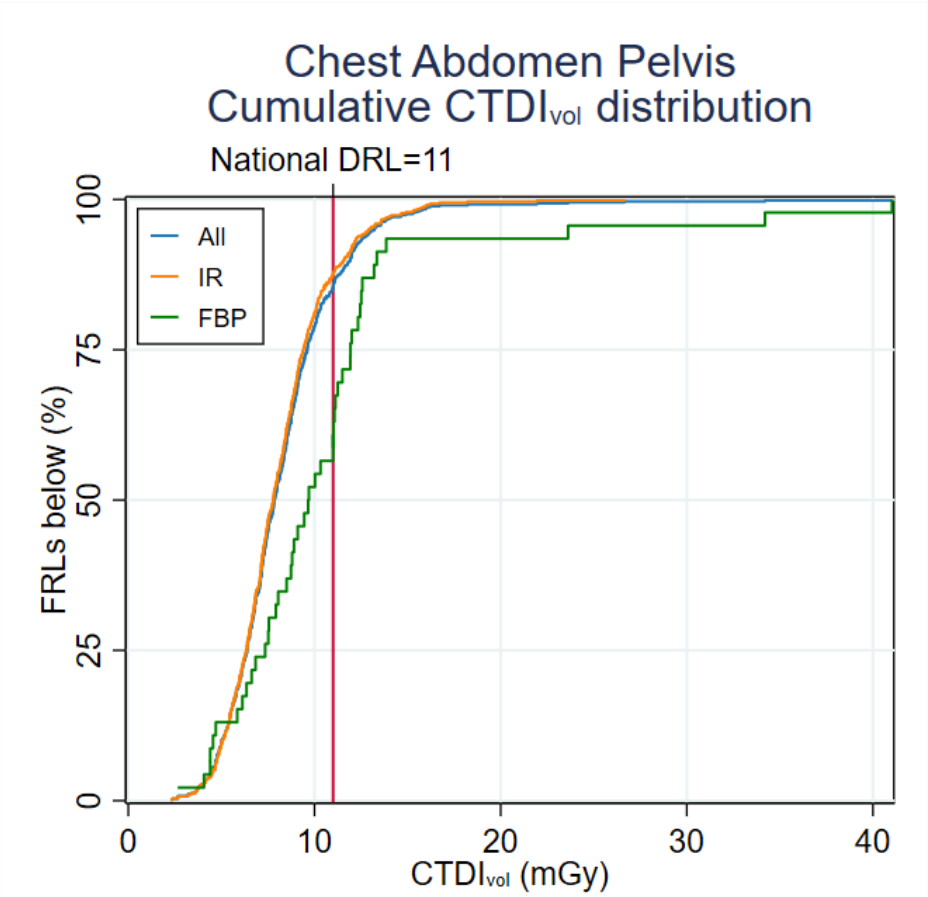
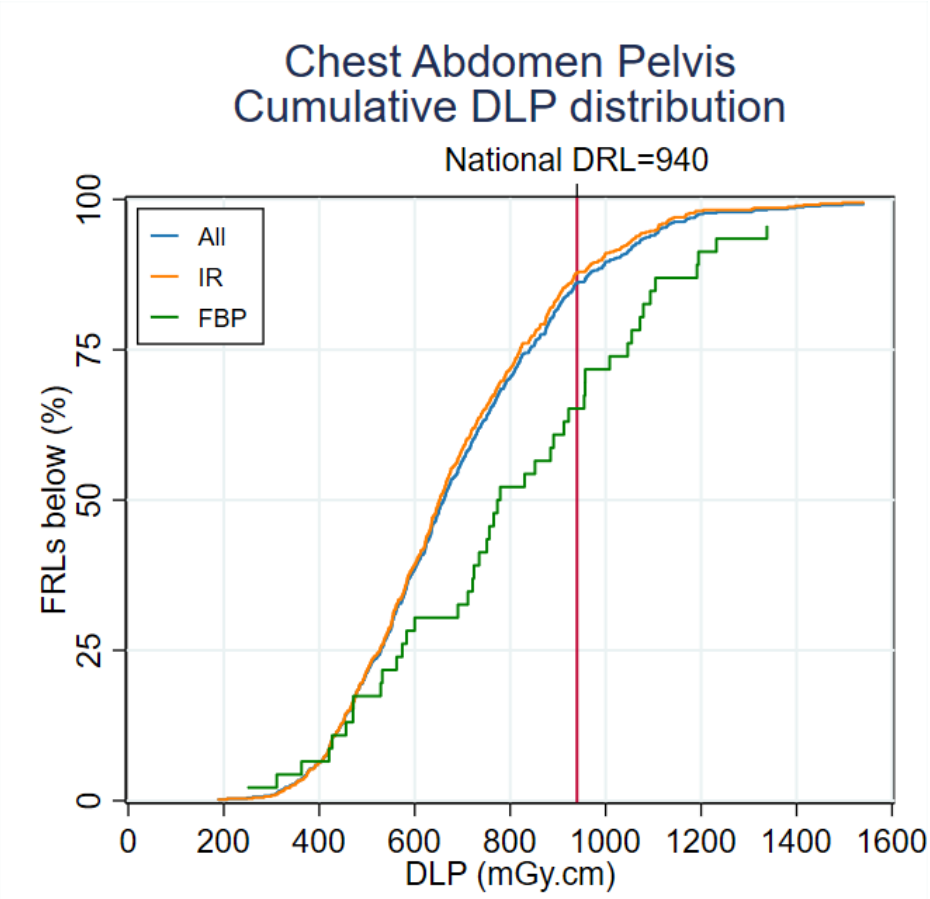
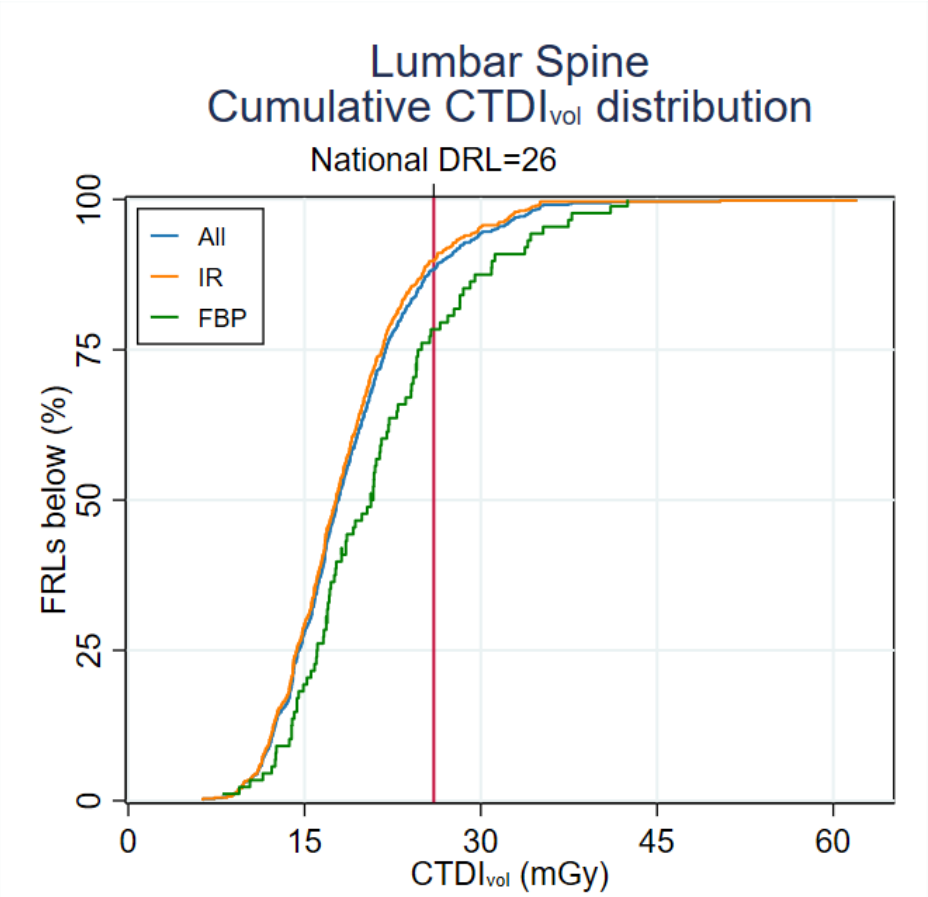
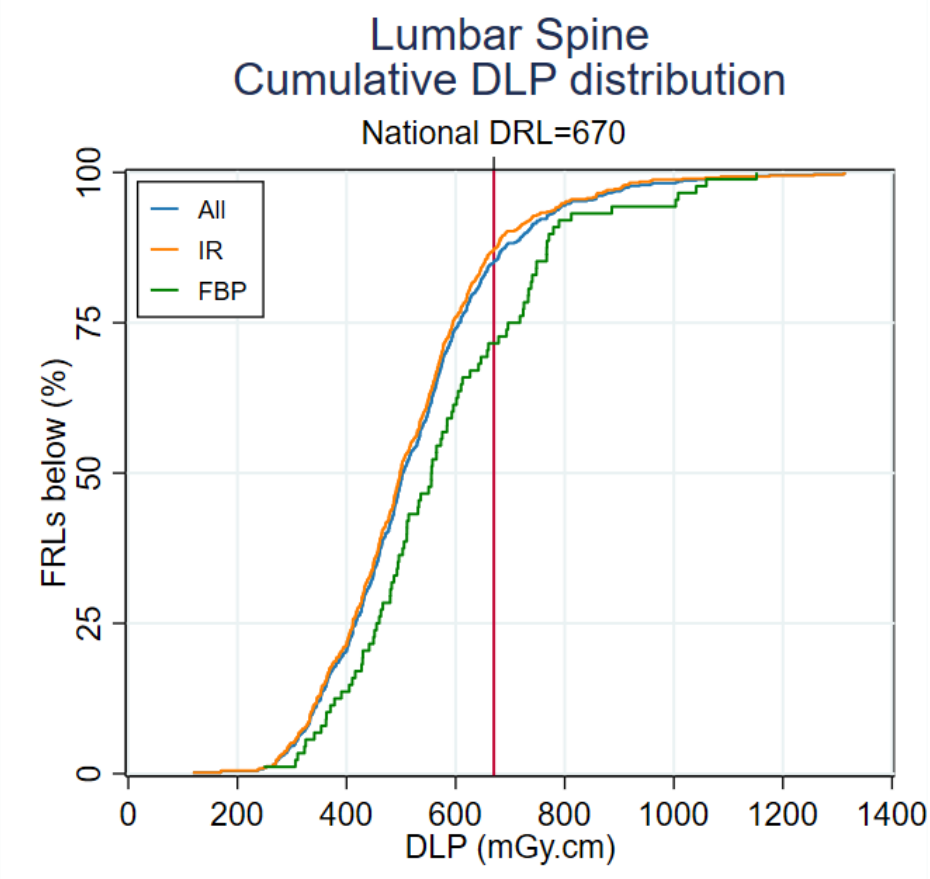
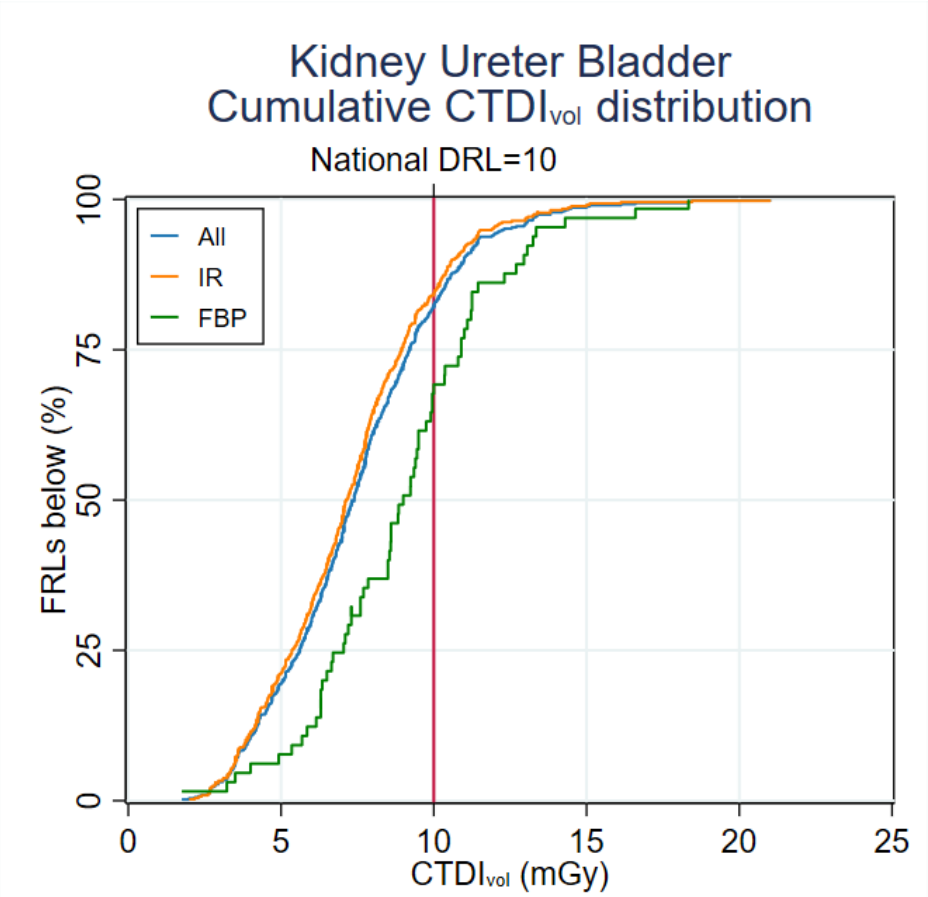
25
50
75
100
0
200
400
600
800
1000
1200
DLP (mGy.cm)

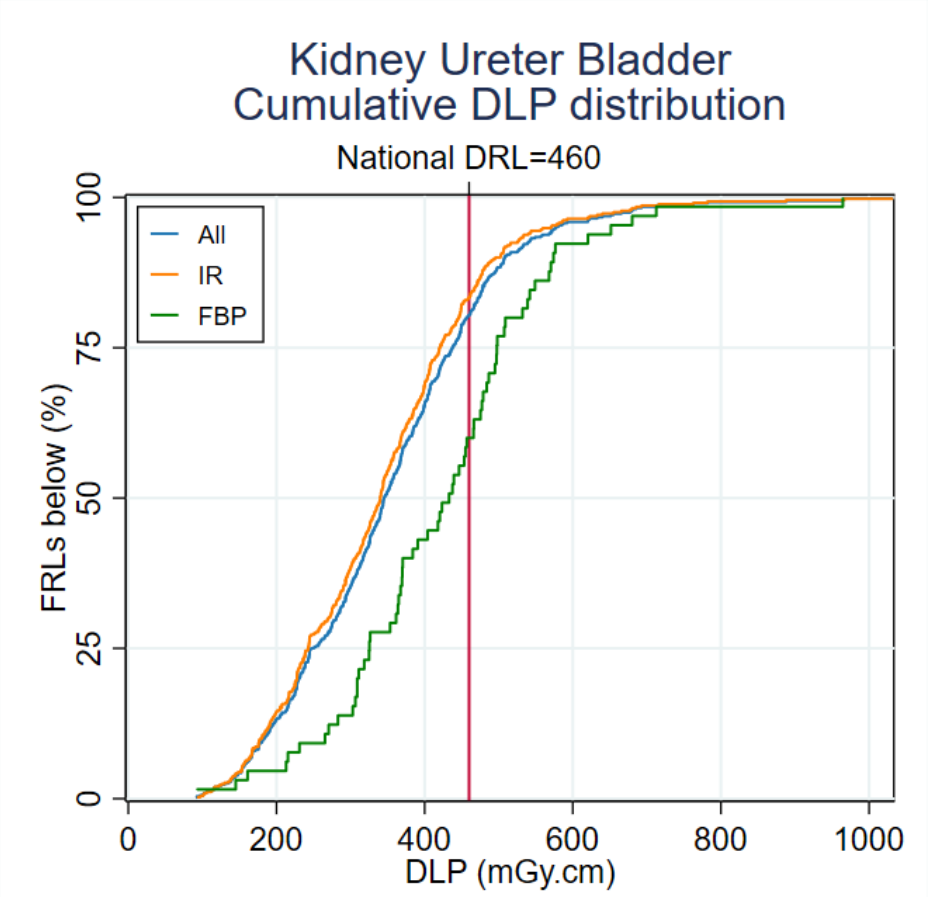

Chest Abdomen Pelvis
Cumulative CTDIvol distribution
National DRL=11
All
IR
FBP
FRLs below (%)
0
25
50
75
100
0
10
20
30
40
CTDIvol (mGy)


Chest Abdomen Pelvis
Cumulative DLP distribution
National DRL=940
All
IR
FBP
FRLs below (%)
0
25
50
75
100
0
200
400
600
800
1000
1200
1400
1600
DLP (mGy.cm)


Lumbar Spine
Cumulative CTDIvol distribution
National DRL=26
All
IR
FBP
FRLs below (%)
0
25
50
75
100
0
15
30
45
60
CTDIvol (mGy)


Lumbar Spine
Cumulative DLP distribution
National DRL=670
All
IR
FBP
FRLs below (%)
0
25
50
75
100
0
200
400
600
800
1000
1200
1400
DLP (mGy.cm)

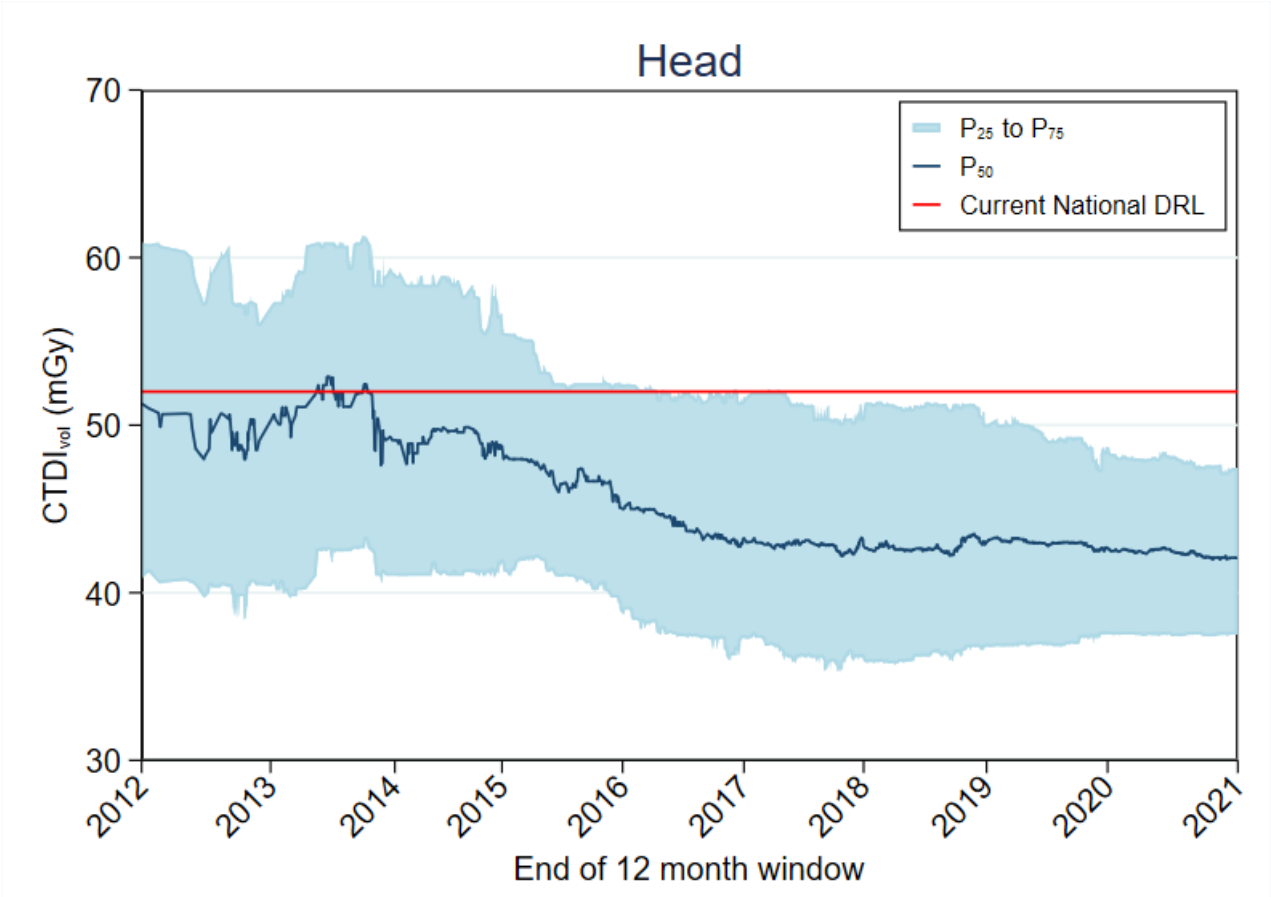

Kidney Ureter Bladder
Cumulative CTDIvol distribution
National DRL=10
All
IR
FBP
FRLs below (%)
0
25
50
75
100
0
5
10
15
20
25
CTDIvol (mGy)

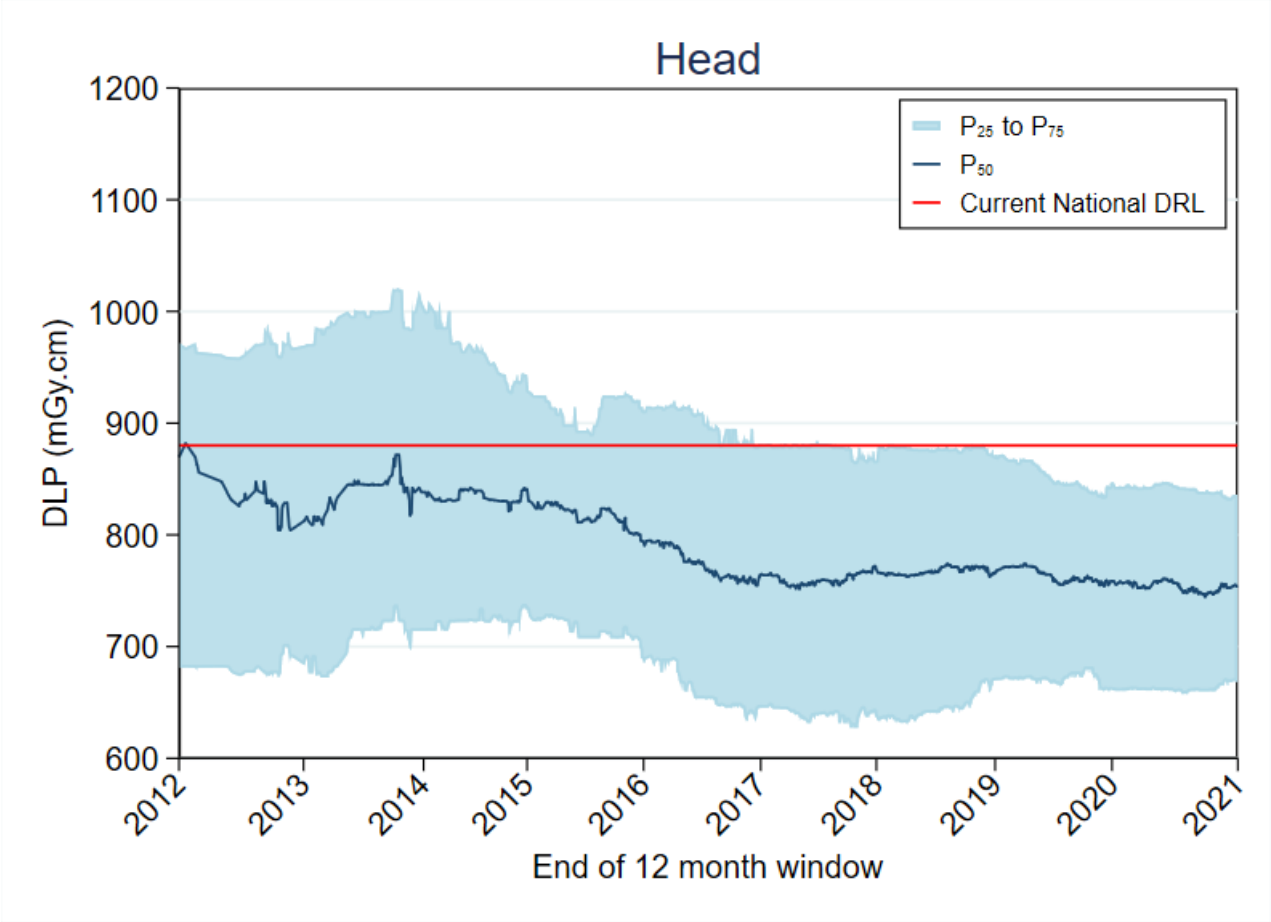

Kidney Ureter Bladder
Cumulative DLP distribution
National DRL=460
All
IR
FBP
FRLs below (%)
0
25
50
75
100
0
200
400
600
800
1000
DLP (mGy.cm)

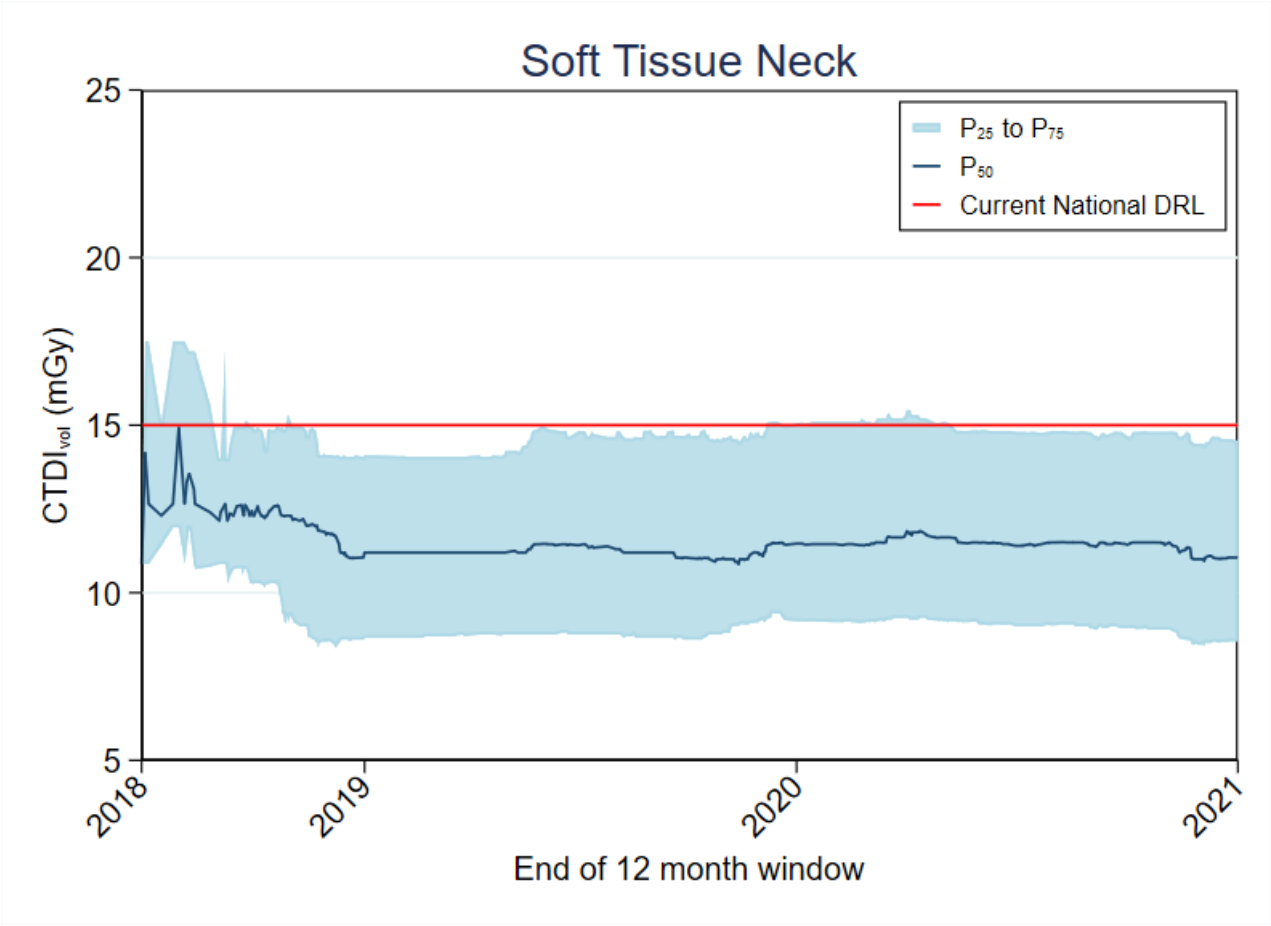
Appendix 2: Historical trends

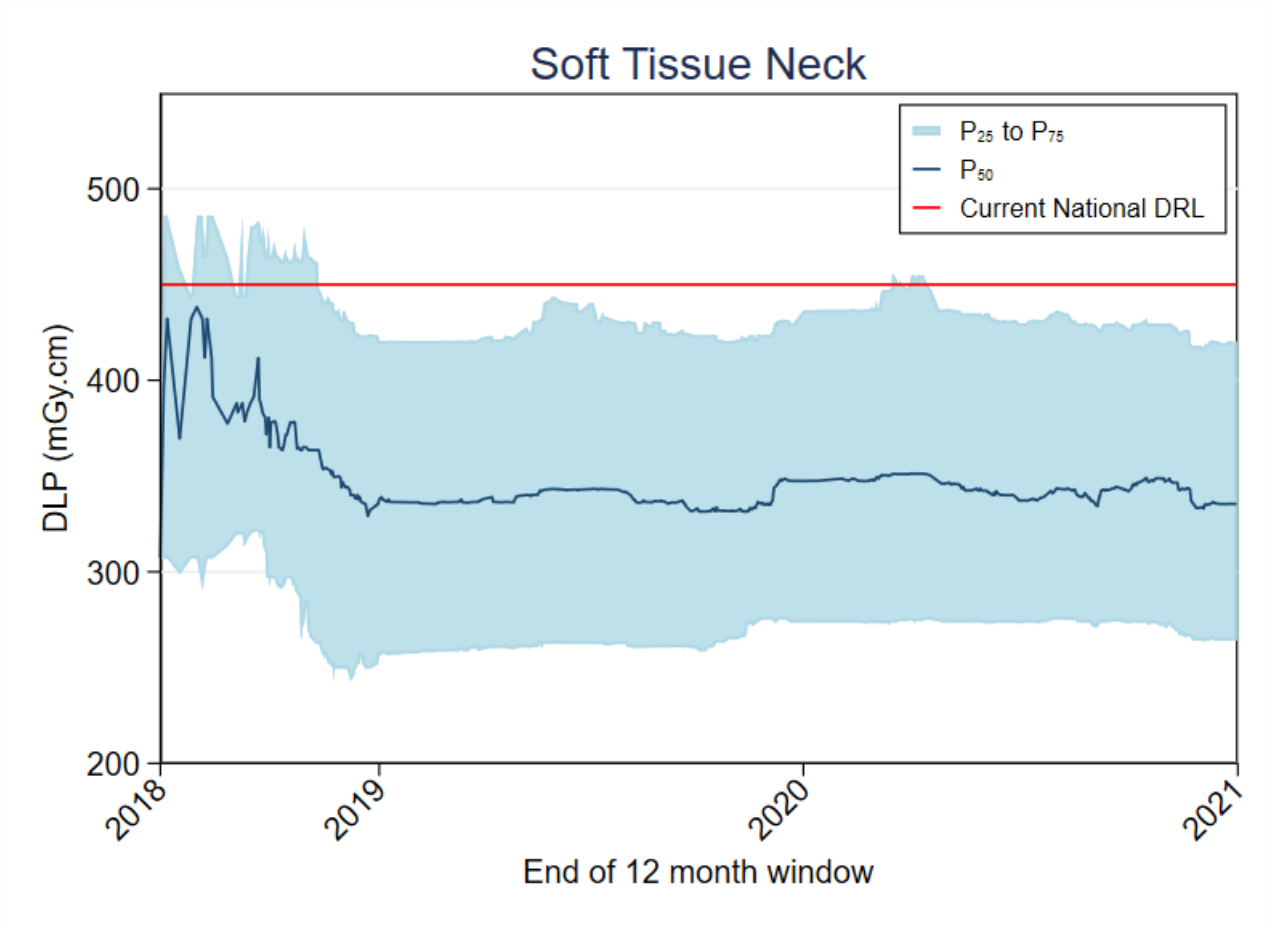
This appendix presents the changes in the FRL distributions since the beginning of 2012 for the MDCT protocols. They have been generated by examining the surveys submitted during a moving 12-month period, where the start and end points of the window have been shifted by daily intervals. The x-axis is the end date of the 12-month interval, the blue line is the median (50^{th} percentile, P_{50}) of the corresponding FRL distribution, the red line denotes the current national DRL and the light blue shaded region indicates the 25^{th}-75^{th} percentile (P_{25} to P_{75}) range.

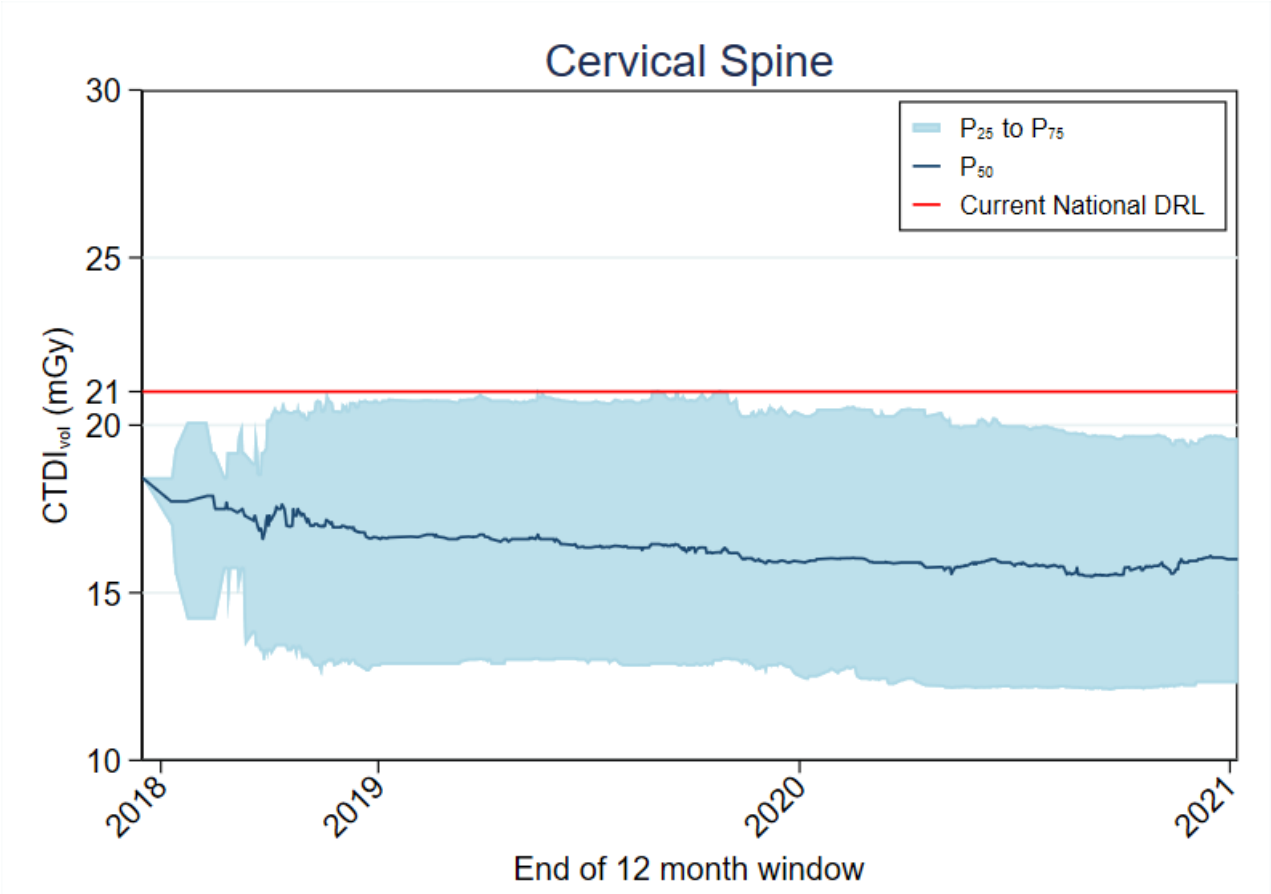
Surveys for soft-tissue neck, cervical spine and kidney-ureter-bladder scans commenced in July 2018.

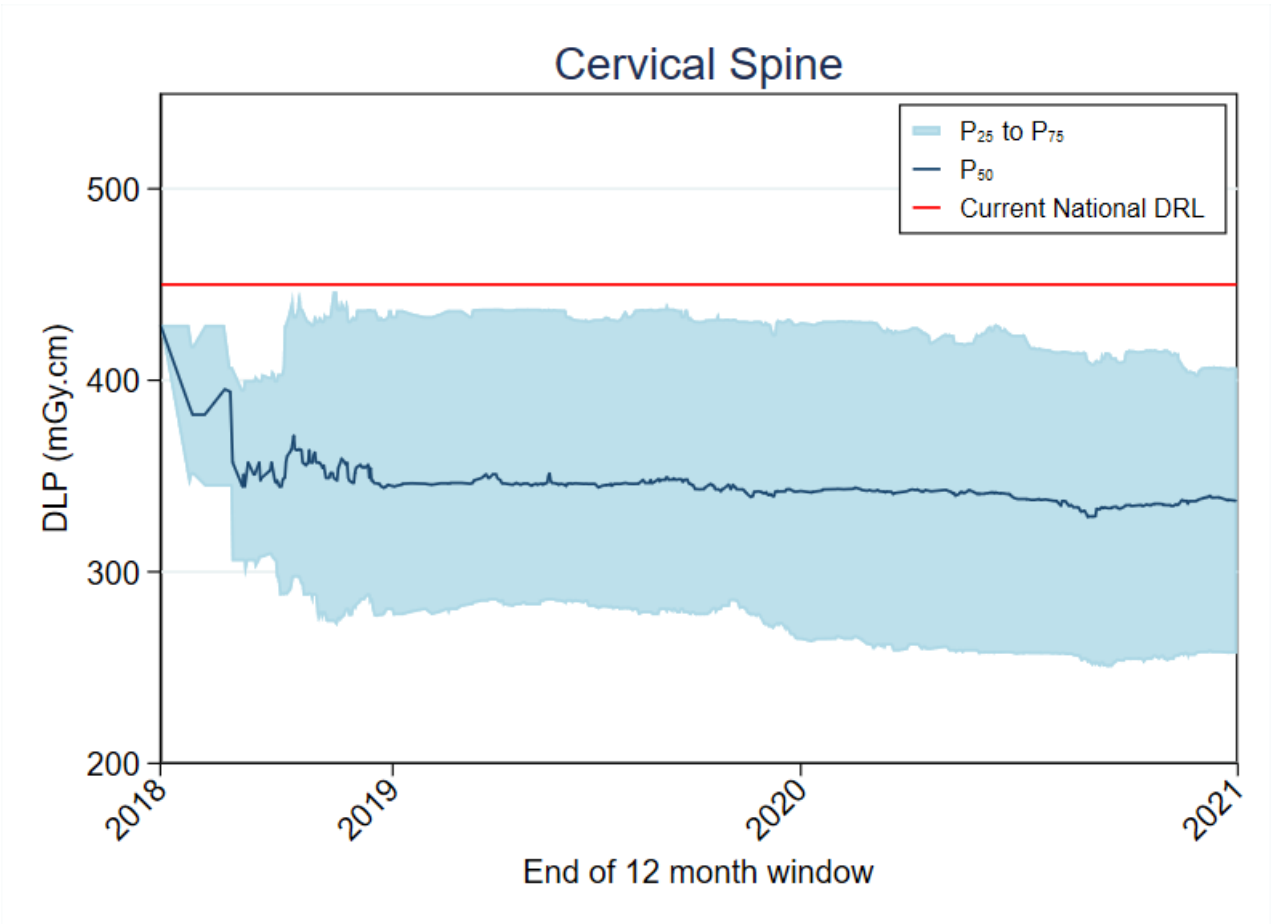

Head
70
60
50
40
30
CTDIvol (mGy)
P25 to P75
P50
Current National DRL
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
End of 12 month window

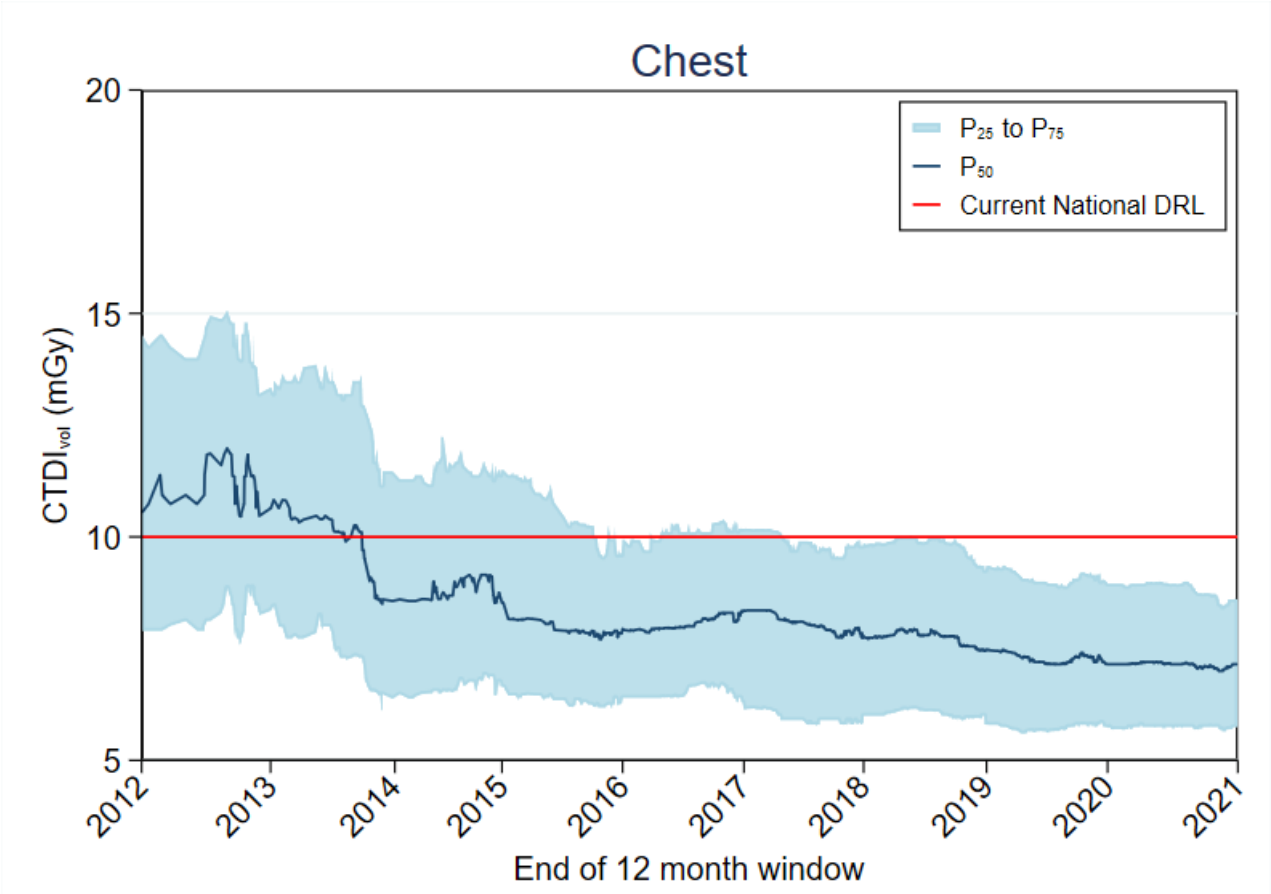

Head
1200
1100
1000
900
800
700
600
DLP (mGy.cm)
P25 to P75
P50
Current National DRL
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
End of 12 month window

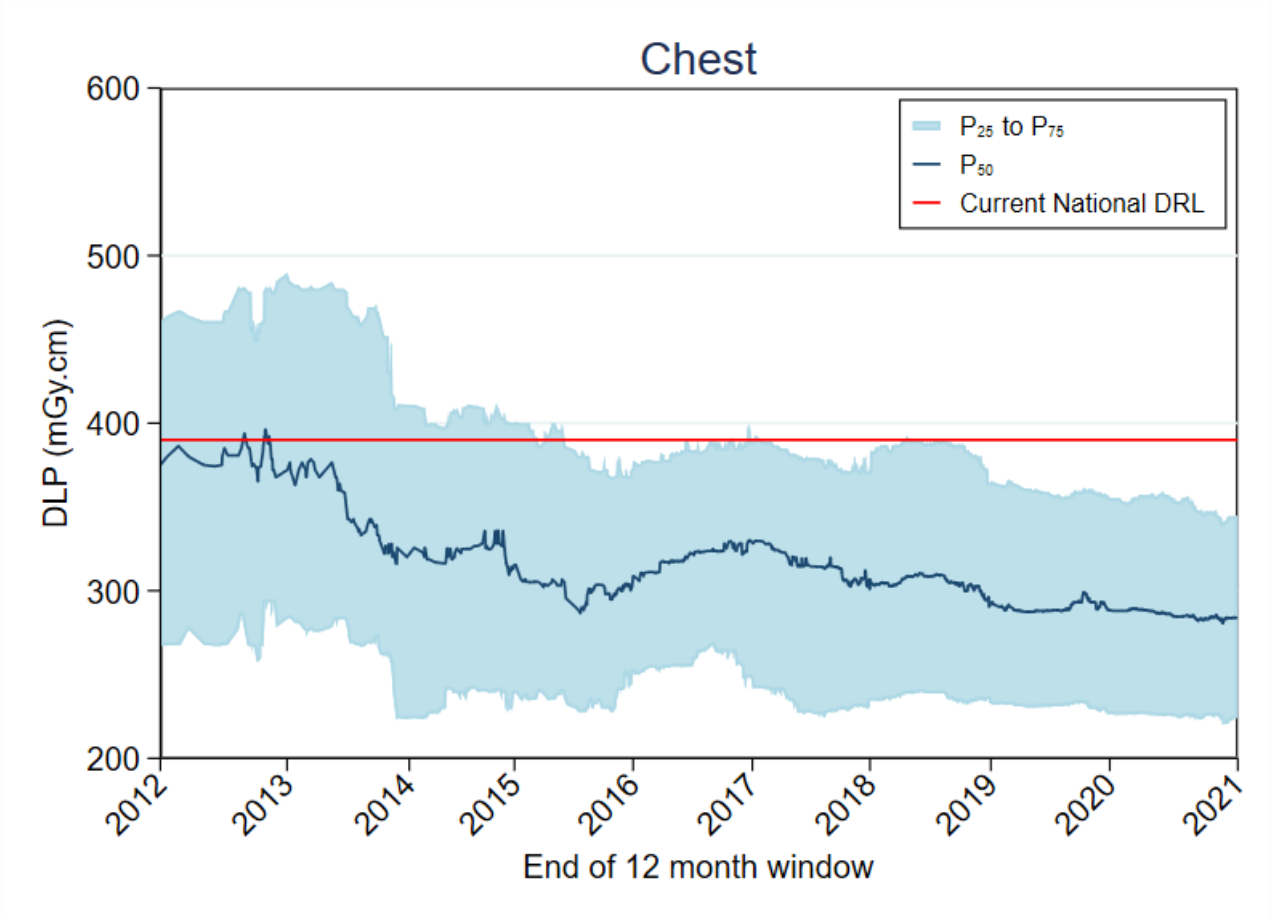

Soft Tissue Neck
25
20
15
10
5
CTDIvol (mGy)
P25 to P75
P50
Current National DRL
2018
2019
2020
2021
End of 12 month window

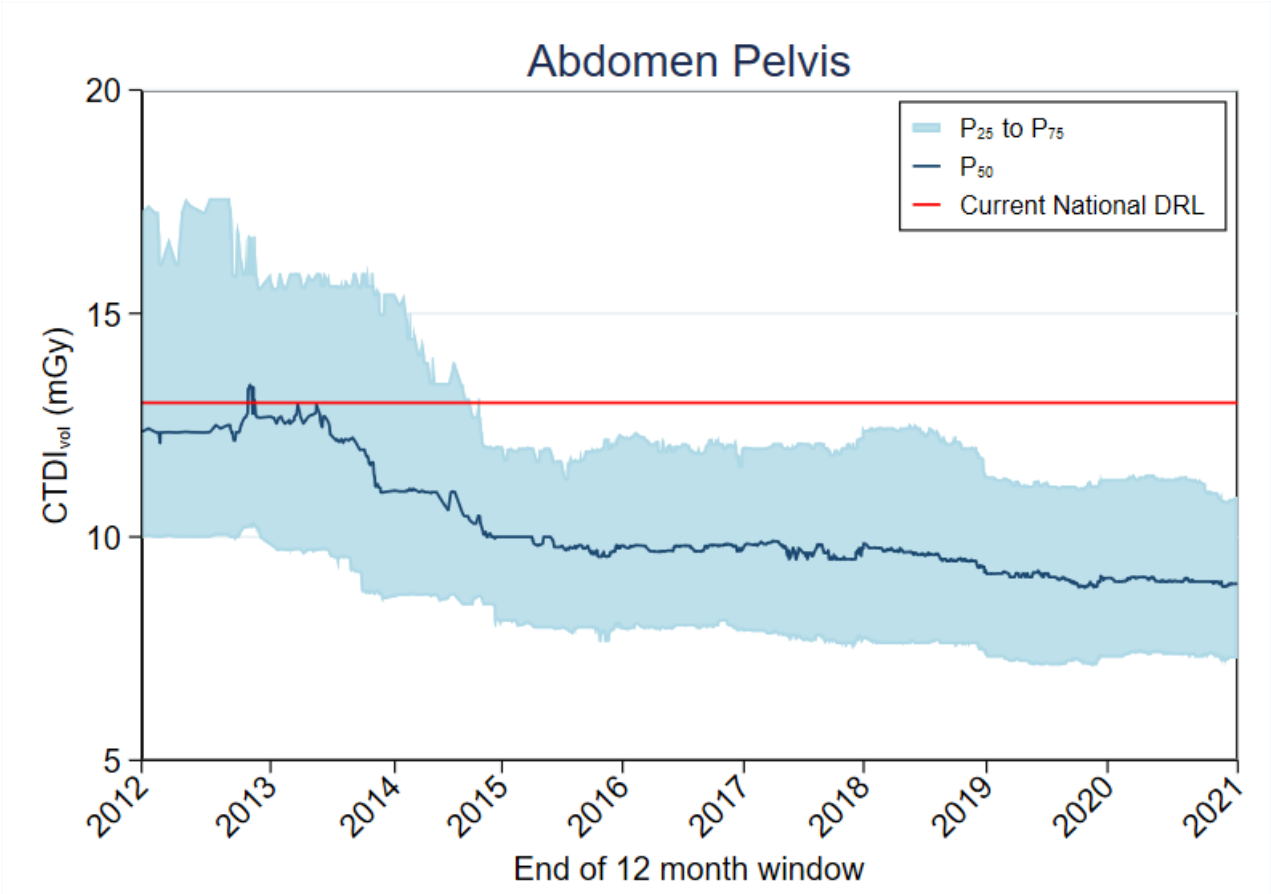

Soft Tissue Neck
500
400
300
200
DLP (mGy.cm)
P25 to P75
P50
Current National DRL
2018
2019
2020
2021
End of 12 month window

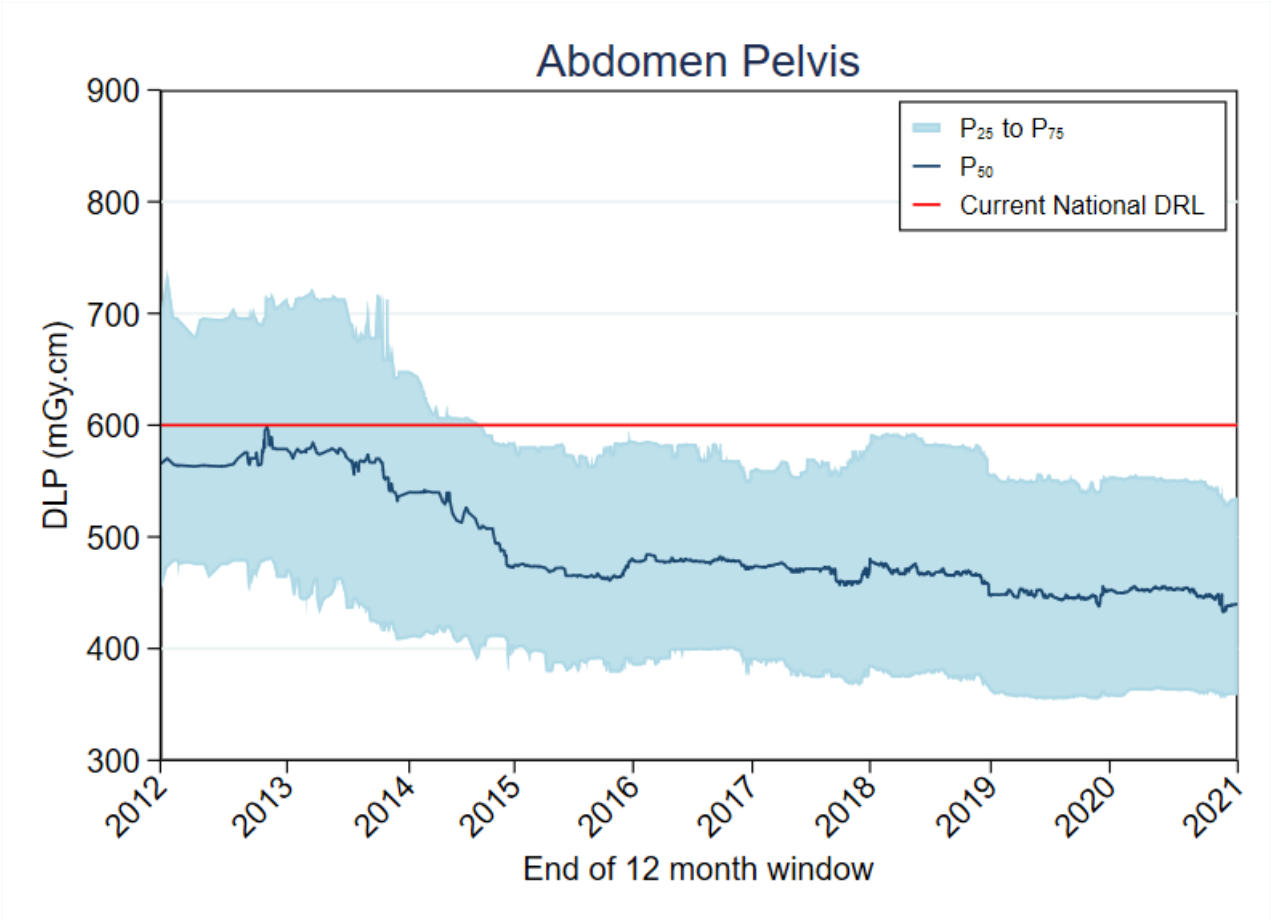

Cervical Spine
30
25
21
20
15
10
CTDIvol (mGy)
P25 to P75
P50
Current National DRL
2018
2019
2020
2021
End of 12 month window

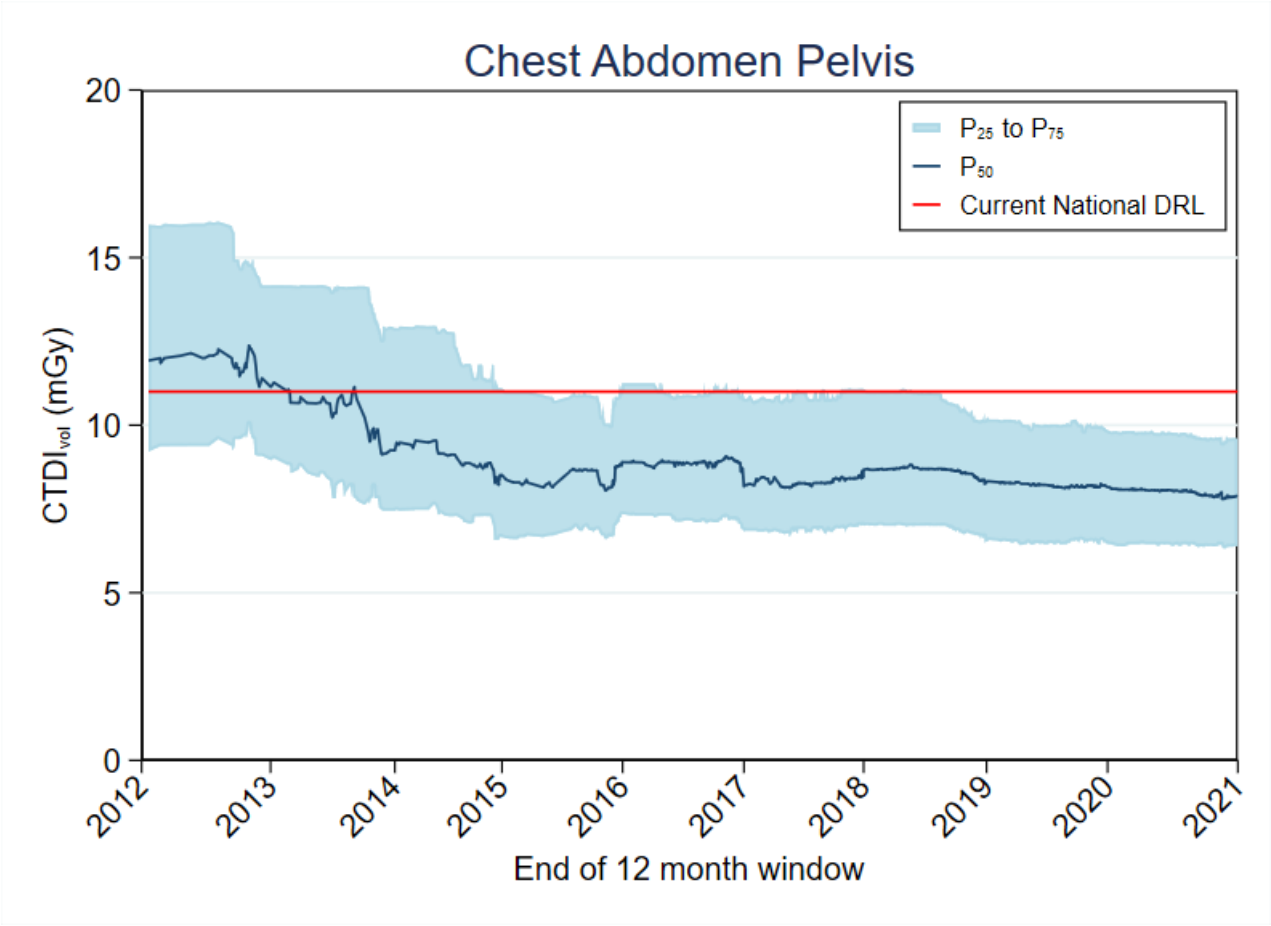

Cervical Spine
500
400
300
200
DLP (mGy.cm)
P25 to P75
P50
Current National DRL
2018
2019
2020
2021
End of 12 month window

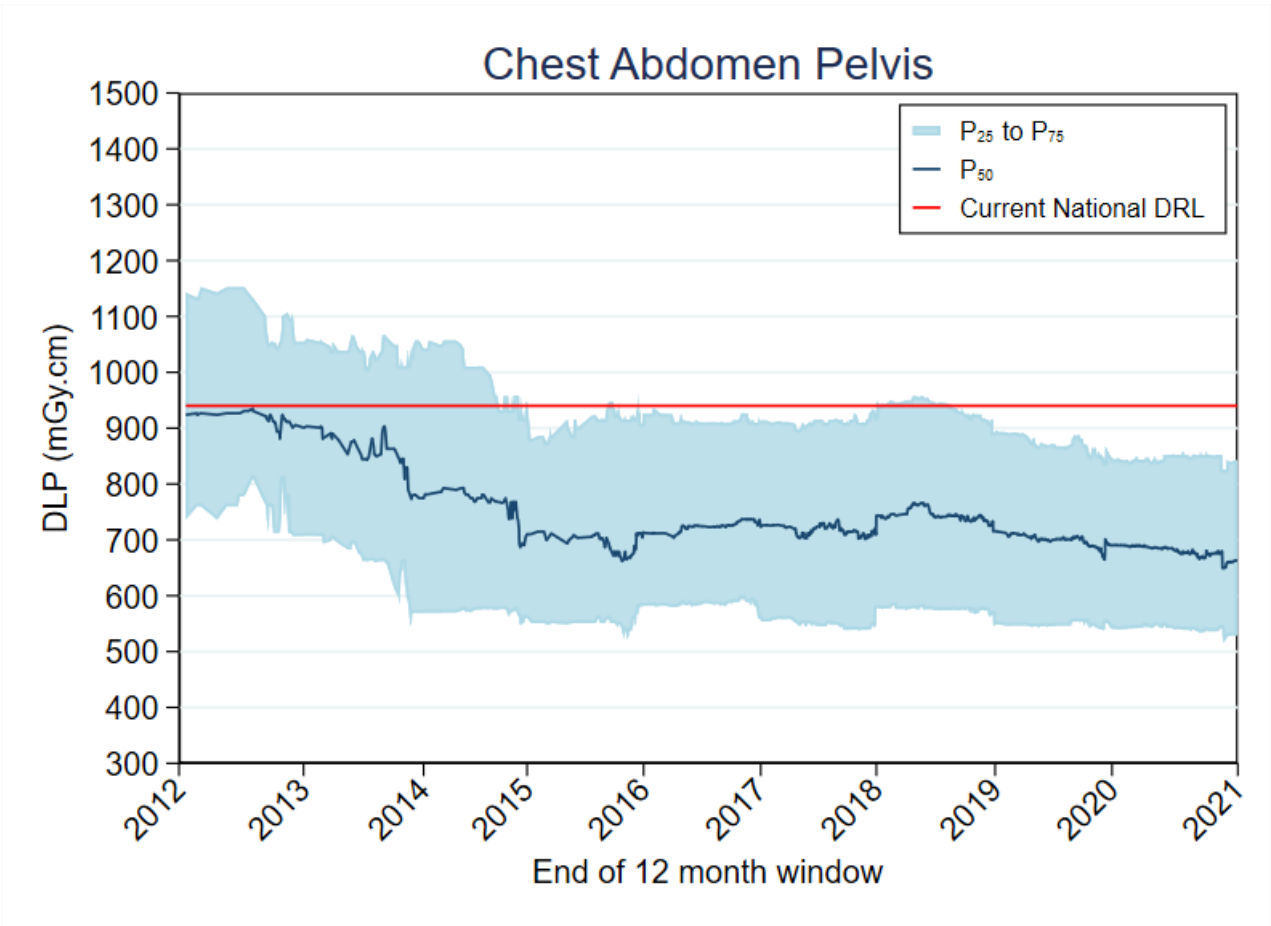

Chest
20
15
10
5
CTDIvol (mGy)
P25 to P75
P50
Current National DRL
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
End of 12 month window

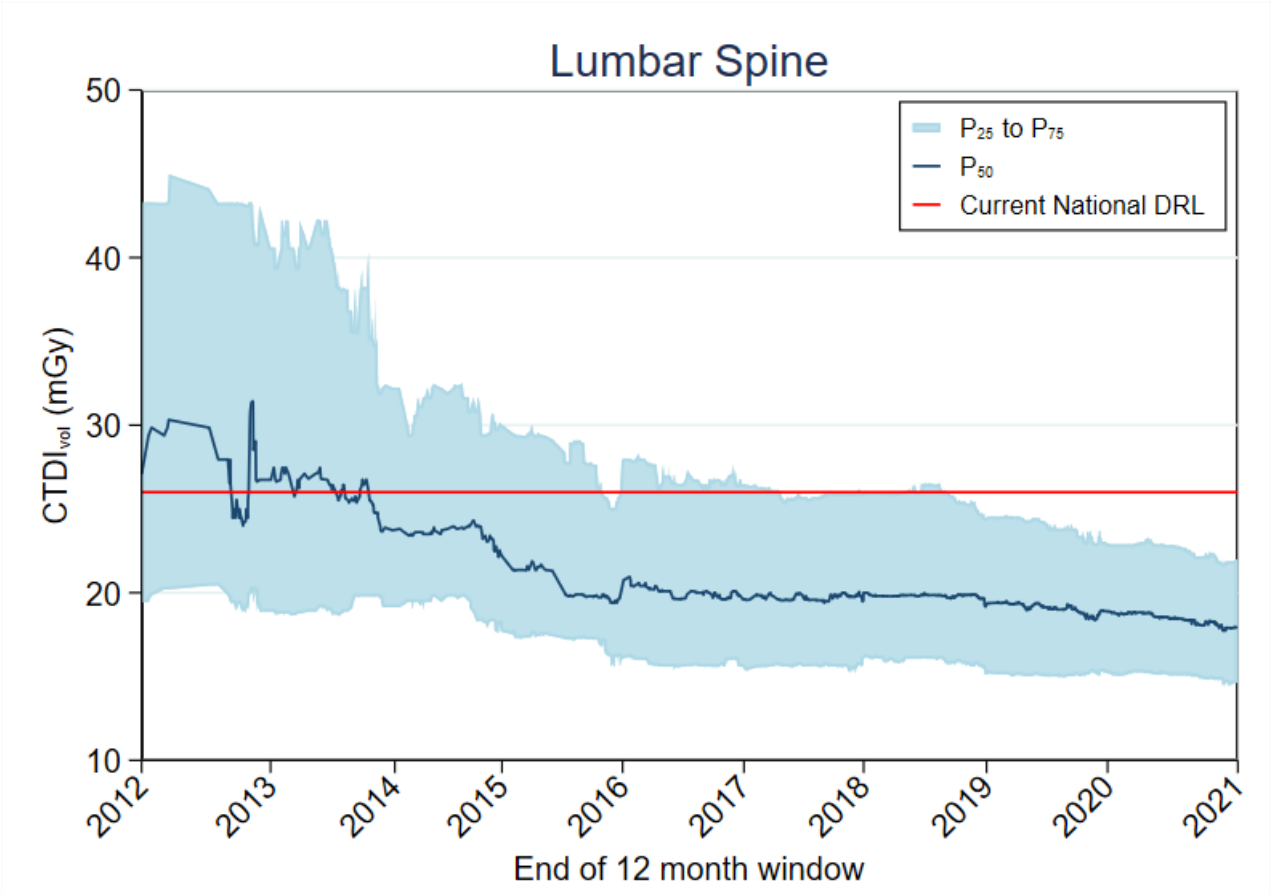

Chest
600
500
400
300
200
DLP (mGy.cm)
P25 to P75
P50
Current National DRL
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
End of 12 month window

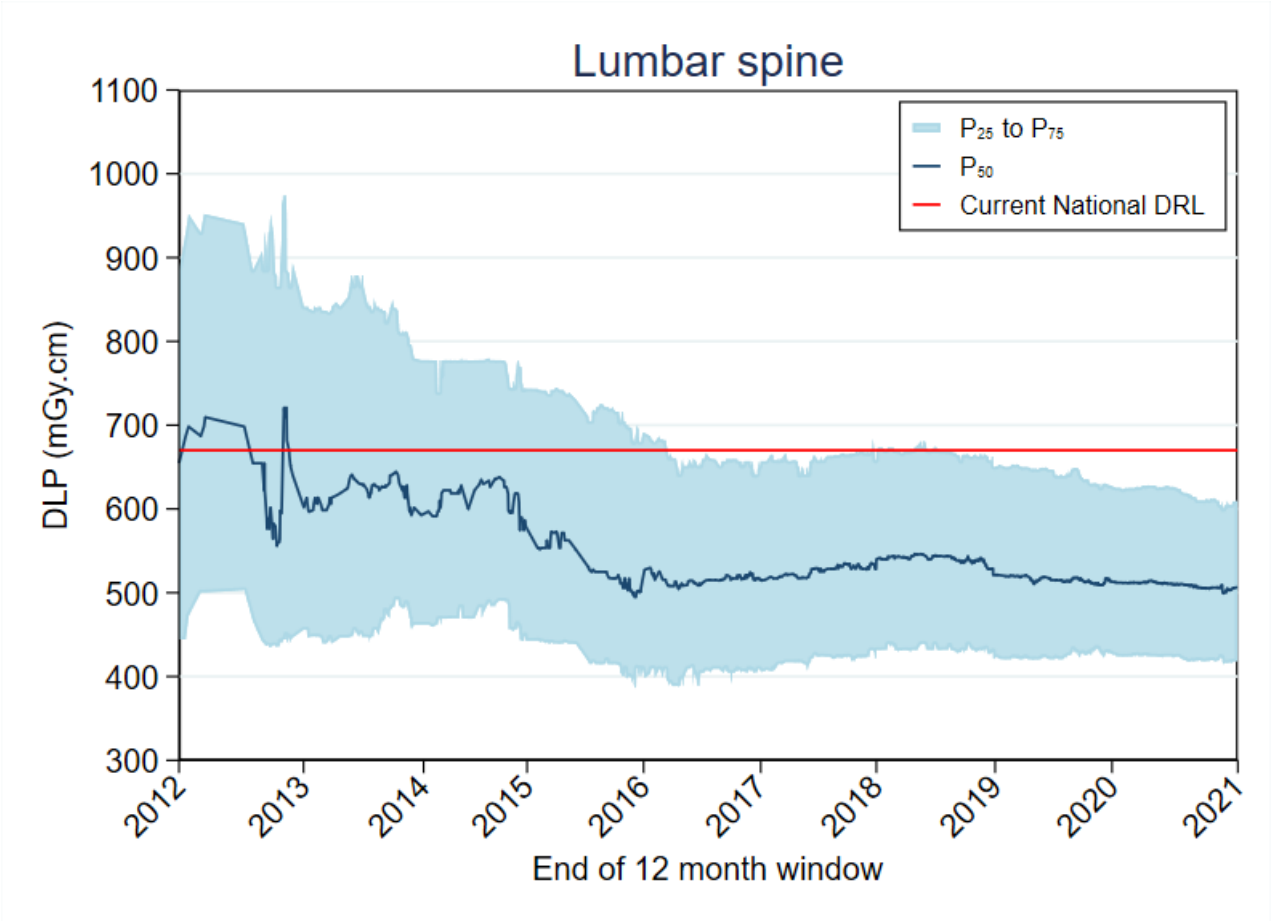

Abdomen Pelvis
20
15
10
5
CTDIvol (mGy)
P25 to P75
P50
Current National DRL
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
End of 12 month window

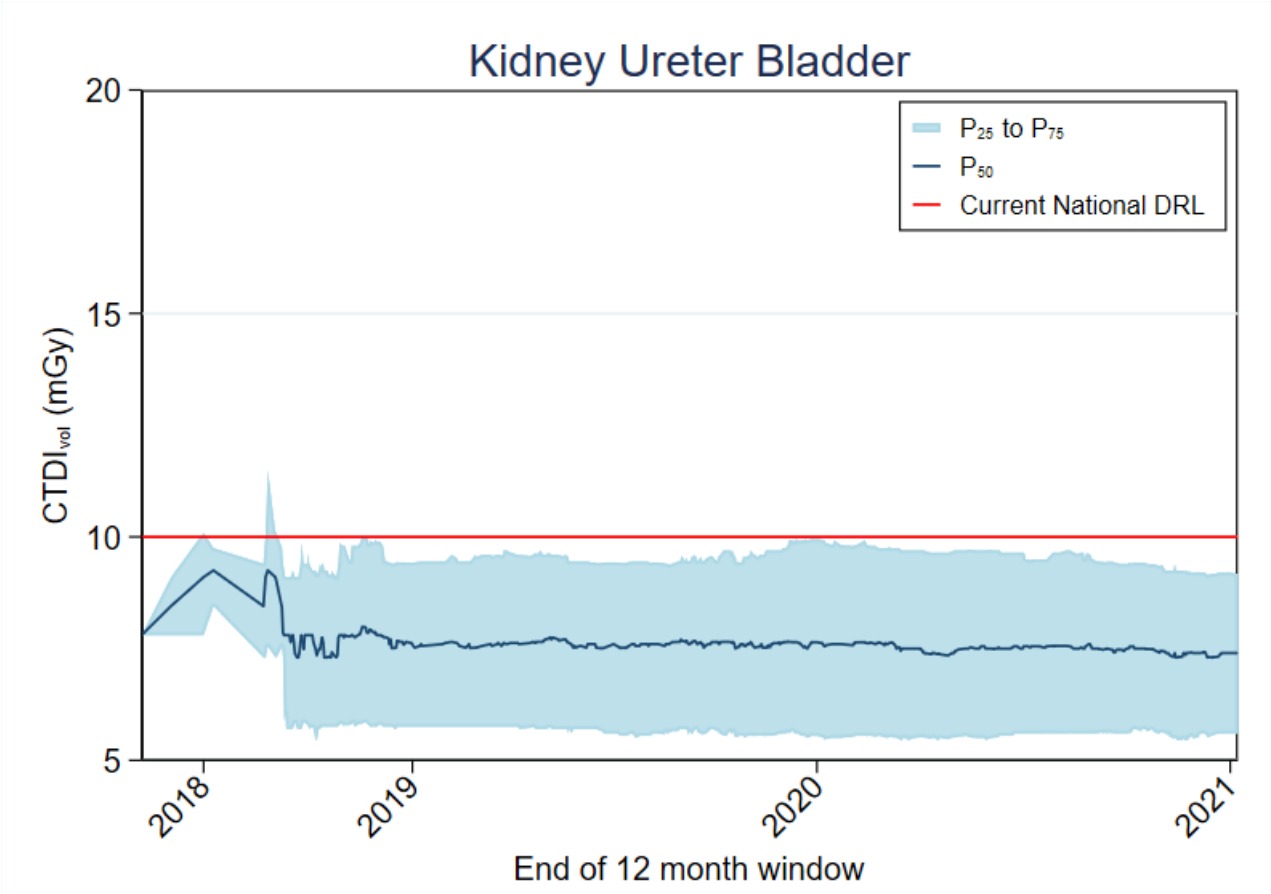

Abdomen Pelvis
900
800
700
600
500
400
300
DLP (mGy.cm)
P25 to P75
P50
Current National DRL
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
End of 12 month window

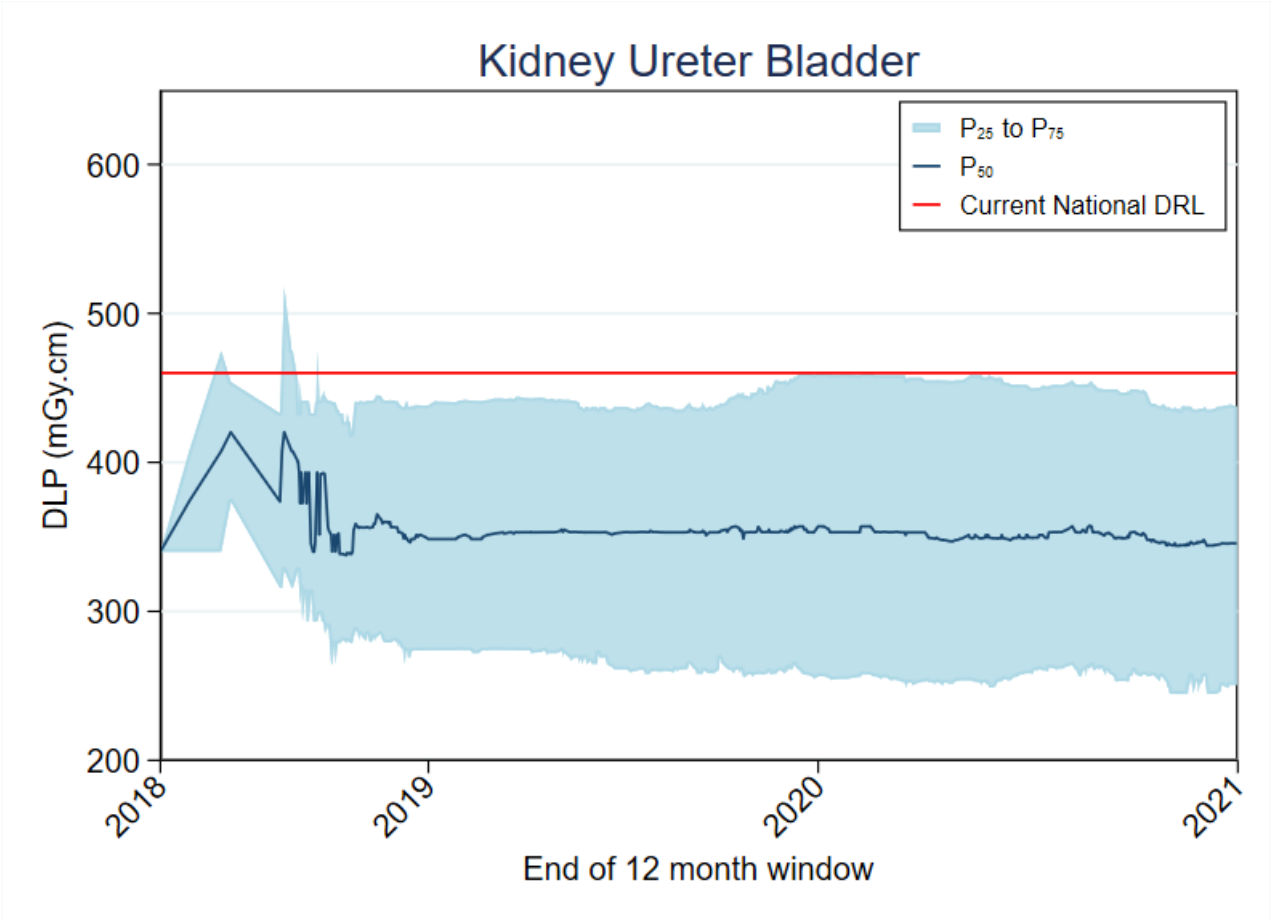

Chest Abdomen Pelvis
P_{25} to P_{75}
P_{50}
Current National DRL
$CTDI_{vol}$ (mGy)
0
5
10
15
20
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
End of 12 month window


Chest Abdomen Pelvis
P_{25} to P_{75}
P_{50}
Current National DRL
DLP (mGy.cm)
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
End of 12 month window


Lumbar Spine
P25 to P75
P50
Current National DRL
CTDIvol (mGy)
50
40
30
20
10
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
End of 12 month window


Lumbar spine
P25 to P75
P50
Current National DRL
DLP (mGy.cm)
1100
1000
900
800
700
600
500
400
300
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
End of 12 month window


Kidney Ureter Bladder
20
15
10
5
CTDIvol (mGy)
P25 to P75
P50
Current National DRL
2018
2019
2020
2021
End of 12 month window


Kidney Ureter Bladder
600
500
400
300
200
DLP (mGy.cm)
P25 to P75
P50
Current National DRL
2018
2019
2020
2021
End of 12 month window