NEMA (MITA) XR-25
CT Dose-check Standard

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Outline

- Introduction to CT Dose-check
  - Need for Monitoring
  - Standard Dose Metrics
  - Goals and Definitions
  - Sample
- Clinical Implementation
  - Sources of Information
  - Developing a Workflow
- Conclusions
  - Summary
  - Future Applications
  - Conclusion

From Newsweek

1

Too Much Radiation?

Dec 5, 2008 7:00 PM EST

**CT scans are replacing X-rays as the d
ERs across the country. But for some
outweigh the benefits.**

Print Email Comments +1 Tw

False Alarm Raised on CT Scan Risk

2

February 1, 2008

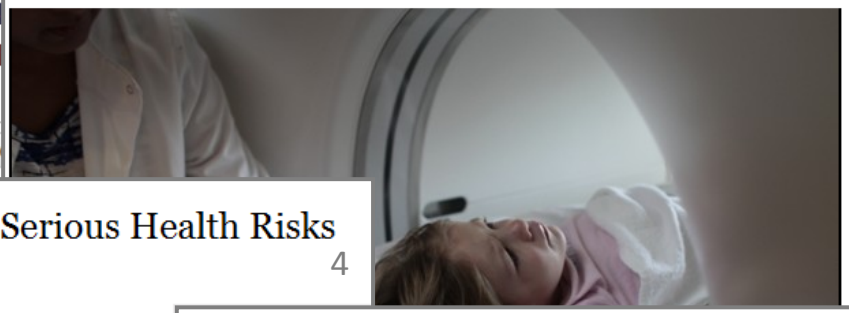
Once again, the media (with considerable help from some in the medical community) are raising misleading and alarmist health fears.

ublished a review article, "Computed Tomography An scientists, David J. Brenner and Eric J. Hall, both of the

l interviews with experts, newspaper articles headlined "CT sing patients to excessive radiation" metastasized all over the

As CT scans become more common for children, concerns about radiation grow

3



THE RADIATION BOOM

After Stroke Scans, Patients Face Serious Health Risks

4

By WALT BOGDANICH
Published: July 31, 2010

When Alain Reyes's hair suddenly fell out in a freakish band circling his head, he was not the only one worried about his health. His co-workers at a shipping company avoided him, and his boss sent him home, fearing he had a contagious disease.

Enlarge This Image

Only later would Mr. Reyes learn what had caused him so much physical and emotional grief: he had received a radiation overdose during a test for a stroke at a hospital in Glendale, Calif.

Other patients getting the procedure, called a CT brain perfusion scan, were being overdosed, too — 37 of them just up the freeway at Providence Saint Joseph Medical Center in Burbank, 269 more at the renowned Cedars-Sinai Medical Center in Los Angeles and dozens more at a

Hospital error leads to radiation overdoses

5

After Cedars-Sinai reset a CT scan machine in February 2008, more than 200 brain scans on potential stroke patients were performed at eight times the normal dose of radiation, the hospital says.

October 13, 2009 | Alan Zarembo

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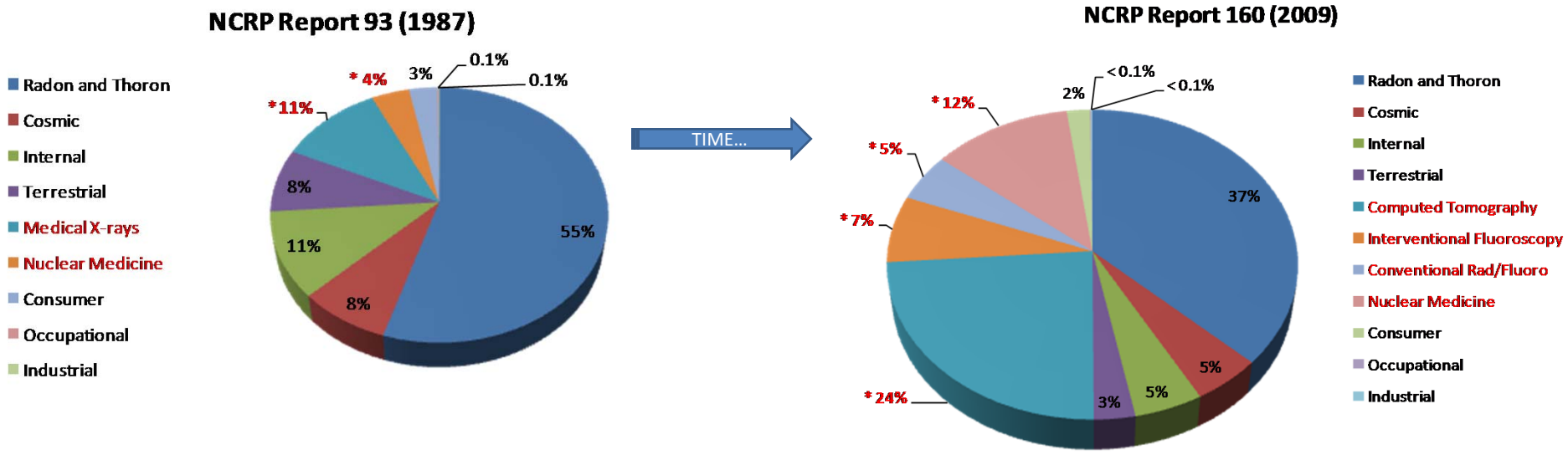
Scores of radiation overdoses at Cedars-Sinai Medical Center have been traced to a single cause: a mistake the hospital made resetting a CT scanner.

Hospital officials said Monday that the error occurred in February 2008, when the hospital began using a new protocol for a specialized type of scan used to diagnose strokes. Doctors believed it would provide them more useful data to analyze disruptions in the flow of blood to brain tissue.

1. *Too Much Radiation?*. Newsweek. Accessed via <http://www.thedailybeast.com/newsweek/2008/12/05/too-much-radiation.html> on 17 Oct 2012.
2. Cihak, Robert and Arnold Glueck. *False Alarm Raised on CT Scan Risk*. The Heartland Institute. Accessed via <http://news.heartland.org/newspaper-article/2008/02/01/false-alarm-raised-ct-scan-risk> on 17 Oct 2012.
3. Ungar, Laura. *As CT scans become more common for children, concerns about radiation grow*. The Washington Post. Accessed via <http://www.washingtonpost.com/national/health-science/as-ct-scans-become-more-common-for-children-concerns-about-radiation-grow/2012/06/08/gJQAZjWnUV_story.html> on 17 Oct 2012.
4. Bogdanich, Walt. *After Stroke Scans, Patients Face Serious Health Risks*. The New York Times. Accessed via <http://www.nytimes.com/2010/08/01/health/01radiation.html?pagewanted=all> on 17 Oct 2012.
5. Zarembo, Alan.*Hospital error leads to radiation overdoses*.Los Angeles Times.Accessed via <http://articles.latimes.com/2009/oct/13/local/me-cedars13> 17 Oct 2012.

Radiation in CT

Annual Dose



		% Annual Effective Dose (1987)	Annual Effective Dose in 1987 [mSv]		% Annual Effective Dose (2009)	Annual Effective Dose in 2009 [mSv]
BKG	Radon and Thoron	55%	2.00	3.0 mSv vs. 3.1 mSv	37%	2.30
	Cosmic	8%	0.27		5%	0.34
	Internal	11%	0.40		5%	0.28
	Terrestrial	8%	0.28		3%	0.19
MEDICAL	Computed Tomography	11%	0.39	0.5 mSv vs. 3.0 mSv (6X More)	24%	1.50
	Interventional Fluoroscopy				7%	0.43
	Conventional Rad/Fluoro				5%	0.33
	Nuclear Medicine	4%	0.14		12%	0.80
	Consumer	3%	0.07		2%	0.12
	Occupational	0.1%	< 0.01		< 0.1%	< 0.01
	Industrial	0.1%	< 0.01		< 0.1%	< 0.01

3.6 mSv vs. 6.2 mSv Annual Effective Dose

c.f. NCRP Press Report. *Medical Radiation Exposures of the U.S. Population Greatly Increased Since the Early 1980s. 3 March 2009 [Adapted]*

Aims

WHAT WE KNOW:

- There exists a potential for radiation injury from medical imaging[1, 2]
- Prominent news coverage[3] has led to a higher level of patient awareness that has driven the demand for greater oversight
- Dose-check, a new method of CT dose monitoring has become available

WHAT WE WANT TO DO:

- Minimize the potential for CT overdose
- Evaluate and implement vendor mandated alert value (AV) and notification value (NV) for usage in neuro radiology:
  1. Understand the new Dose-check nomenclature and definitions
  2. Introduce reasonable AV/NV into the clinical scanner (neuro)
  3. Establish a clinical workflow incorporating usage of Dose-check

1. S. Balter, J. W. Hopewell, D. L. Miller, L. K. Wagner and M. J. Zelefsky, "Fluoroscopically guided interventional procedures: a review of radiation effects on patients' skin and hair," Radiology **254**, 326-341.
2. Wagner, LK, Eifel PJ, Geise RA. Potential Biological effects following high x-ray dose interventional procedures. J Vasc Interv Radiol 1994;5:71-84.
3. Bogdanich, W., "After Stroke Scans, Patients Face Serious Health Risks," The New York Times, 31 Jul 2010.

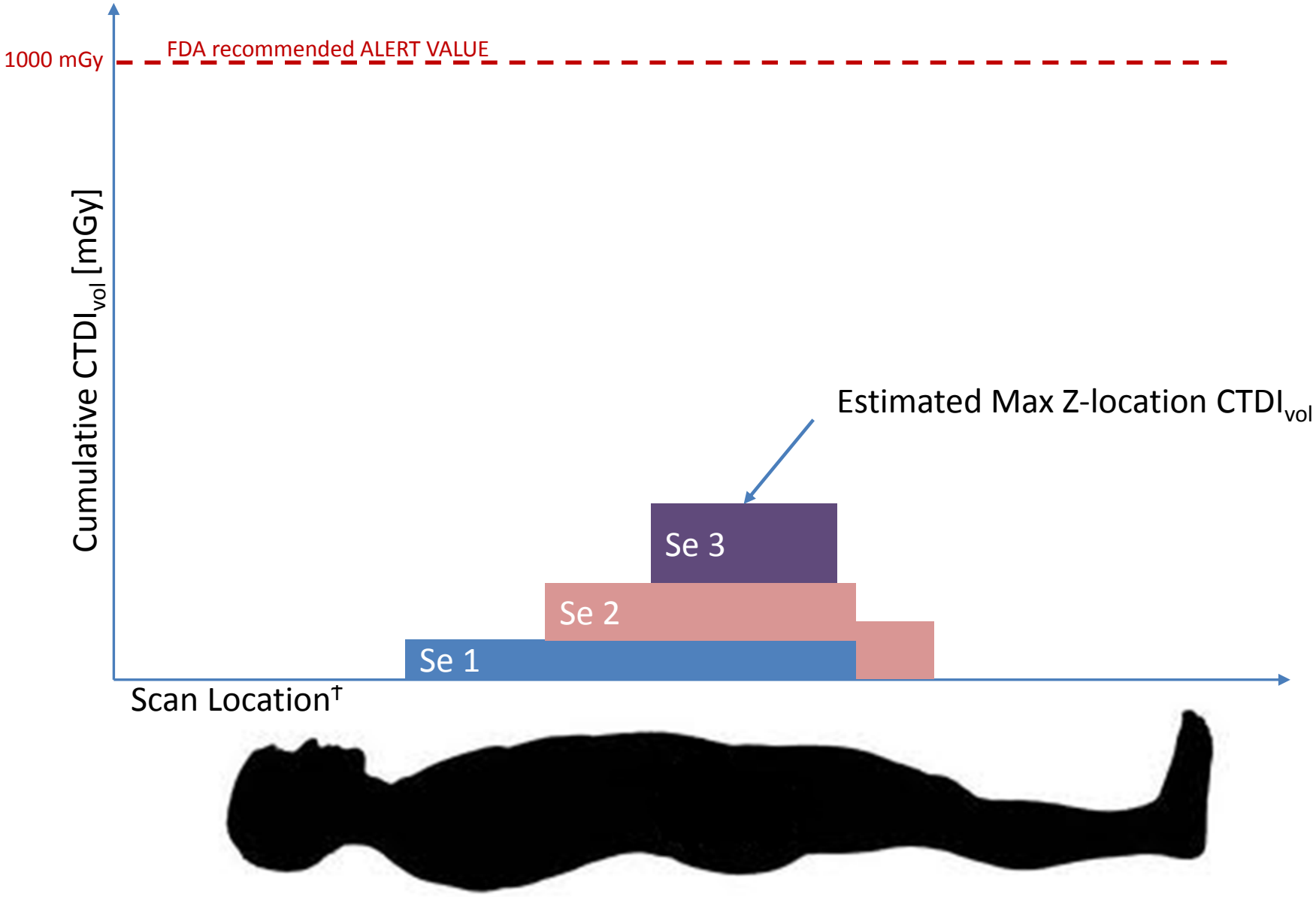
INTRO TO CT DOSE CHECK

Background

Definitions

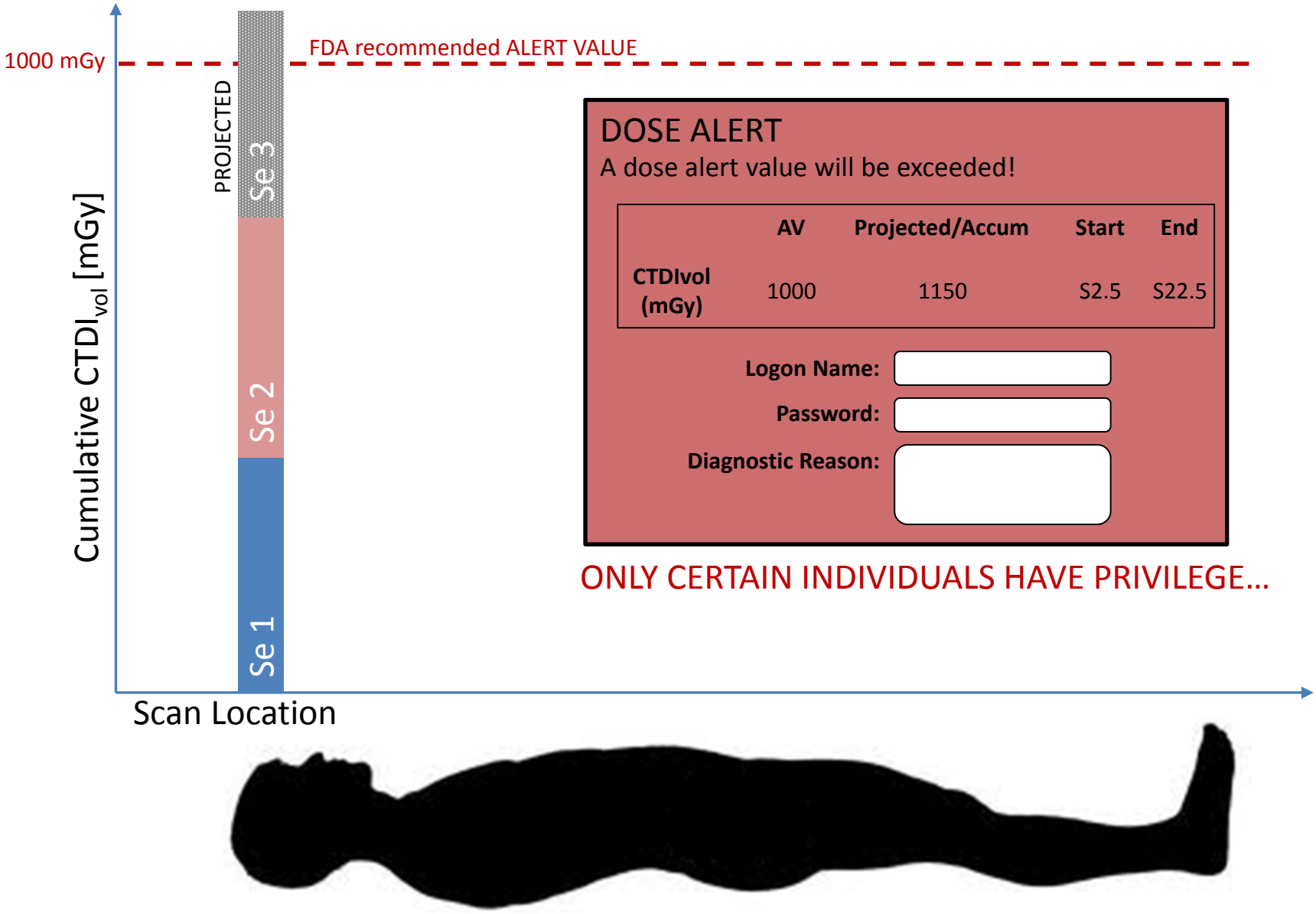
- What is NEMA (MITA) XR-25 CT Dose-Check?
  - Standard defined and created collaboratively between NEMA (MITA) and manufacturers
- GOAL:
  - Increase *active* awareness of standard CT dose metrics ($CTDI_{vol}$ and/or DLP)
  - Introduce tighter controls to mitigate singular over-exposure events
- Primary Terminology
  - ALERT VALUE (AV)
    - Global threshold
    - Compares: Accumulated dose index value (spatially) and the assigned AV
    - Passing AV: requires 'AV Exceeder' login credentials
  - NOTIFICATION VALUE (NV)
    - Localized or incremental threshold
    - Compares: Line-item (by group) estimated CTDI and the line-item NV
    - Passing NV: warning message

ALERT VALUE



† Notice delineation between scan location (i.e. focal spot location) and image location (reconstructed images) – helical overscan included

ALERT VALUE



DOSE ALERT

A dose alert value will be exceeded!

	AV	Projected/Accum	Start	End
CTDIvol (mGy)	1000	1150	S2.5	S22.5

Logon Name:

Password:

Diagnostic Reason:

ONLY CERTAIN INDIVIDUALS HAVE PRIVILEGE…

NOTIFICATION VALUE

PROTOCOL NAME	SERIES/GROUP	$CTDI_{vol,estimated}$ [mGy]	NV [mGy]
ADULT HEAD 1.1 HEAD Axial NON CONTRAST	Series 2 Group 1 Scan Settings		
ADULT HEAD			
ADULT HEAD			
ADULT HEAD			
ADULT HEAD			
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ADULT HEAD			

Dose Information Setup

Images	CTDIvol mGy (NV)	DLP mGy·cm	Dose Eff. %	Phantom cm
1-28	43.96 (50)	615.42	92.70	Head 16

Est. max Z location CTDIvol:	43.96	mGy
Projected series DLP:	615.42	mGy·cm
Accumulated exam DLP:	0.00	mGy·cm

CLINICAL IMPLEMENTATION

Implementation

Global Perspective

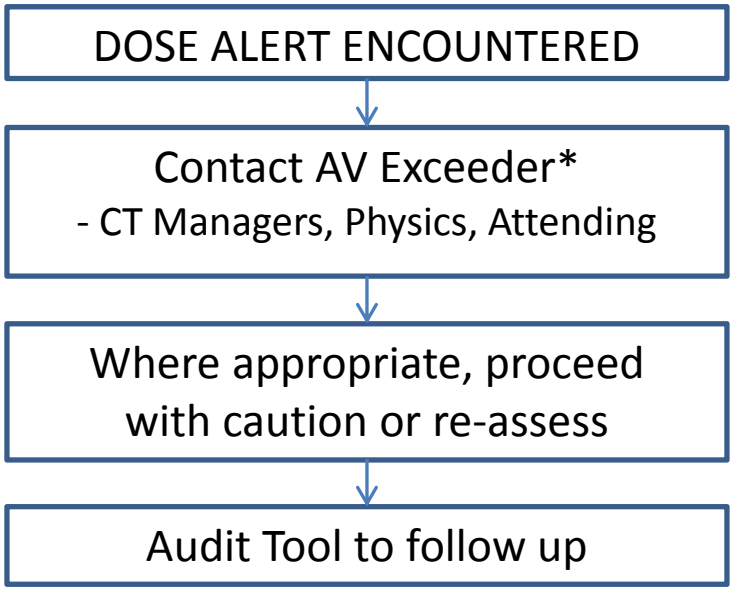
- CONSIDER THE PERSONALITY OF YOUR HOSPITAL
  - The decisions you make should match the hospital setting
    - General Hospital
    - Cancer Center
    - Trauma Hospital
    - Neighborhood Clinic

- THIS PROCESS SHOULD INVOLVE MULTIPLE CLINICAL GROUPS
  - Implementation should maximize benefits with minimal unnecessary clinical interruption
    - Physics
    - Clinical Personnel (Radiologist / Technologist)
    - Protocol Committee
    - Managerial Staff

Implementation

AV Workflow

- SUGGESTION:
  - Determine the largest 'expected reasonable' single cumulative dose
- Default value of AV = 1000 mGy seems reasonable at this time
- Future technology/techniques may allow decrease in AV



* Limited, but available, access

Implementation

NV Assignment

EASY

DIFFICULT

- Fixed mA
- Consistent anatomy
- Minimal number of series
- Minimal nested groups

- Modulated mA
- Largely varying anatomy
- Multi-stage acquisitions
- Multiple groups within series

Dose Awareness

vs.

Clinical Workflow

Implementation

NV Assignment

EASY

DIFFICULT

Projected CTDI Values

- Readily available (protocol dump)
- Separated by group
- Based on what? ⚠

[†] *AAPM Recommendations Regarding Notification and Alert Values for CT Scanners: Guidelines for Use of the NEMA XR 25 CT Dose-Check Standard, <http://www.aapm.org/pubs/CTProtocols/documents/NotificationLevelsStatement.pdf>, 27 April 2011.*

ADULT HEAD 1.1 HEAD Axial NON CONTRAST

Exam Dose Settings								
ExamCtdi	ExamDLP							
NA	NA							
Series 1	Scout	HeadFirst	Supine					
AutoStore	Gating	SeriesLev	Injector					
No	No	No	No					
AutoTrans	vPACS By Exam							
Scan	kV	mA	Start	End	Plane	Message	Light	Timer
1	120	10	S150	I100	90	0	No	No
2	120	10	S150	I100	0	0	No	No
Series 2	Axial	HeadFirst	Supine					
AutoStore	Gating	SeriesLev	SmartPrep	Biopsy	Injector			
No	No	Yes	No	No	No			
AutoTrans	vPACS By Exam							
Series 2 Group 1								
Group	Imag							kV
1								140
Series 2 Group 1								
Group	DFOV							
1								

Message	Light	Timer	CTDI NV	CTDI	DLP
No	No	No	NA	43.9586	NA

Implementation

NV Assignment

EASY — DIFFICULT

Projected CTDI Values

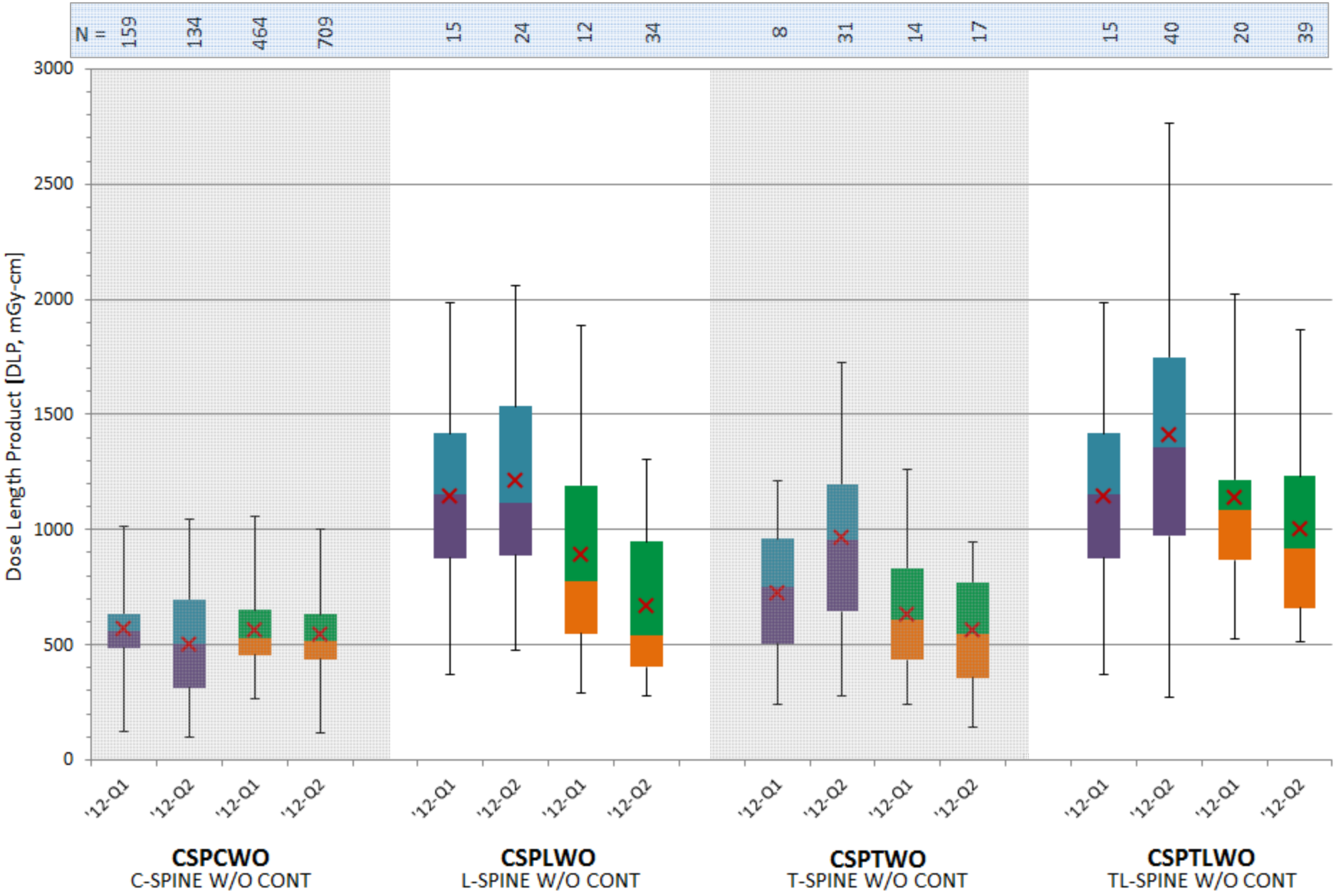
- Readily available (protocol dump)
- Separated by group
- Based on what? ⚠

Internal Dose Metrics

- Site specific
- Cumulative DLP
- Assumed scan extent

[†] *AAPM Recommendations Regarding Notification and Alert Values for CT Scanners: Guidelines for Use of the NEMA XR 25 CT Dose-Check Standard, <http://www.aapm.org/pubs/CTProtocols/documents/NotificationLevelsStatement.pdf>, 27 April 2011.*

HMC Spines - DLP vs. Procedure Type



Implementation

NV Assignment

EASY — DIFFICULT

Projected CTDI Values
- Readily available (protocol dump)
- Separated by group
- Based on what? ⚠

ACR Dose Index Registry
- Separated by protocol type
- Provides ‘max’ and ‘cumulative’

Internal Dose Metrics
- Site specific
- Cumulative DLP
- Assumed scan extent

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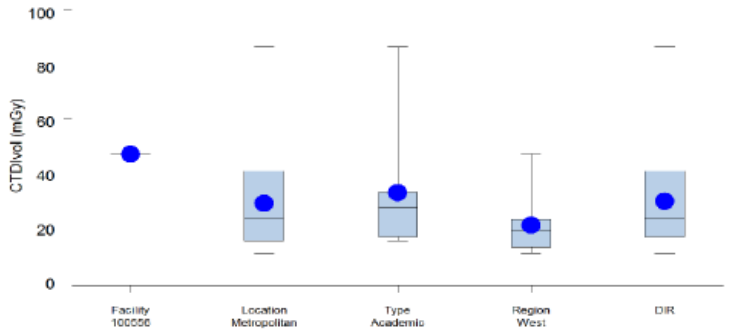
Sample ACR DIR Report

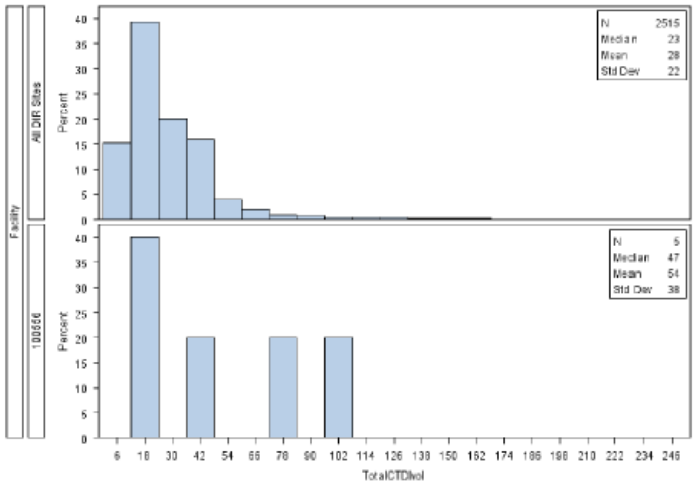
CT ABD

CTDIvol Per Exam

Summary Stats for Facility Median Value

# of facilities	1	19	9	8	29
Median	47	23	27	19	23
Mean	47	29	33	21	29
Min	47	10	15	10	10
Max	47	87	87	47	87

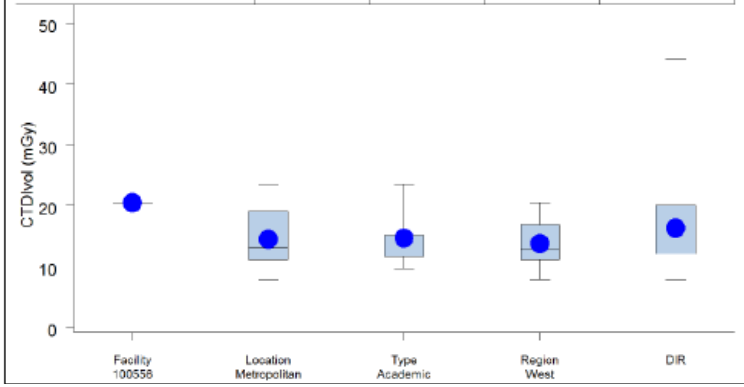


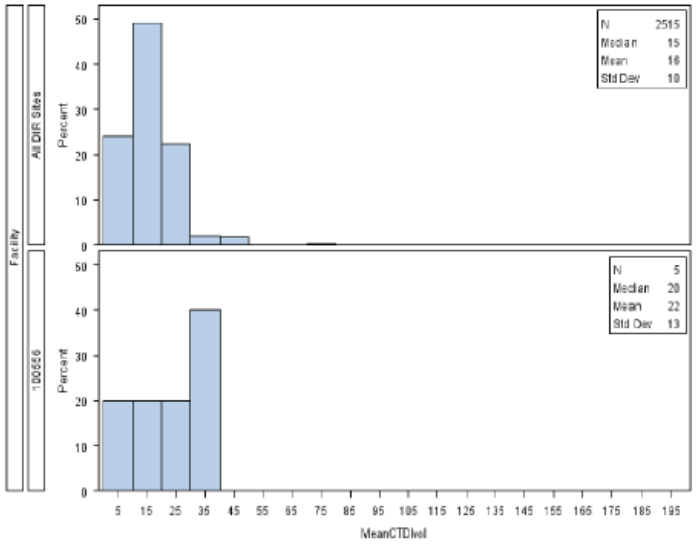


CTDIvol Per Scan

Summary Stats for Facility Median Value

# of facilities	1	19	9	8	29
Median	20	13	14	13	14
Mean	20	14	15	14	16
Min	20	8	10	8	8
Max	20	23	23	20	44





Implementation

NV Assignment

EASY — DIFFICULT

Projected CTDI Values
- Readily available (protocol dump)
- Separated by group
- Based on what? ⚠

ACR Dose Index Registry
- Separated by protocol type
- Provides ‘max’ and ‘cumulative’

Internal Dose Metrics
- Site specific
- Cumulative DLP
- Assumed scan extent

AAPM Recommendations†
- Simple and direct
- Simple and direct

† *AAPM Recommendations Regarding Notification and Alert Values for CT Scanners: Guidelines for Use of the NEMA XR 25 CT Dose-Check Standard, <http://www.aapm.org/pubs/CTProtocols/documents/NotificationLevelsStatement.pdf>, 27 April 2011.*

Table 1: Notification Values recommended by the AAPM Working Group on Standardization of CT Nomenclature and Protocols

CT Scan Region (of each individual scan in an examination)	CTDIvol Notification Value (mGy)
Adult Head	80
Adult Torso	50
Pediatric Head	
<2 years old	50
2 – 5 years old	60
Pediatric Torso	
<10 years old (16-cm phantom)[a]	25
<10 years old (32-cm phantom)[b]	10
Brain Perfusion (examination that repeatedly scans the same anatomic level to measure the flow of contrast media through the anatomy)	600
Cardiac	
Retrospectively gated (spiral)	150
Prospectively gated (sequential)	50

[a] As of January 2011, GE, Hitachi and Toshiba scanners use the 16-cm-diameter CTDI phantom as the basis for evaluating dose indices ($CTDI_{vol}$ and DLP) displayed and reported for pediatric body examinations.

[b] As of January 2011, Siemens and Philips scanners use the 32-cm-diameter CTDI phantom as the basis for evaluating dose indices ($CTDI_{vol}$ and DLP) displayed and reported for pediatric body examinations.

[†] *AAPM Recommendations Regarding Notification and Alert Values for CT Scanners: Guidelines for Use of the NEMA XR 25 CT Dose-Check Standard, <http://www.aapm.org/pubs/CTProtocols/documents/NotificationLevelsStatement.pdf>, 27 April 2011.*

Implementation

NV Assignment

EASY — DIFFICULT

Projected CTDI Values
- Readily available (protocol dump)
- Separated by group
- Based on what? ⚠

ACR Dose Index Registry
- Separated by protocol type
- Provides 'max' and 'cumulative'

Manual Sample
- Accurate and specific
- Time Consuming

Internal Dose Metrics
- Site specific
- Cumulative DLP
- Assumed scan extent

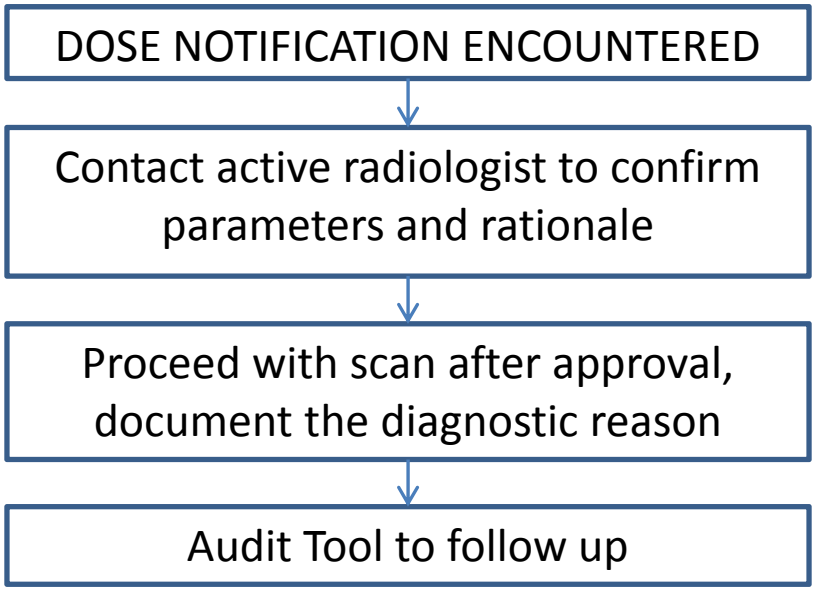
AAPM Recommendations†
- Simple and direct
- Simple and direct

† *AAPM Recommendations Regarding Notification and Alert Values for CT Scanners: Guidelines for Use of the NEMA XR 25 CT Dose-Check Standard, <http://www.aapm.org/pubs/CTProtocols/documents/NotificationLevelsStatement.pdf>, 27 April 2011.*

Implementation

NV Workflow

- RECALL: A dose notification is *not* a hard stop, the technologist *could* simply click through the window
- We have requested that the technologist get radiologist approval
- The Audit Tool tracks the conditions during dose notification



Implementation

Audit Tool

- The Audit Tool:
  - Allows for a protocol dump
  - Instances surpassing AV/NV
    - Protocol Number
    - Series Number
    - Notification Value
    - Projected $CTDI_{vol}$

Date/Time			
Event Initiator	New Patient		
Event Type	Dose Check		
Diagnostic Reason	PT HAS RODS/SCREWS IN LSPINE /CONFIRMED DOSE WITH STAFF		
Operator ID			
Exam Number			
Protocol Selector	User	**Protocol Category**	Adult
Protocol Number	1.34	**Protocol Name**	L SPINE NON CON

Series#	2	**Series Description**	L SPINE NON CON
	Images	**NV**	**Projected**
CTDIvol (mGy)	1 - 636	30	32.92

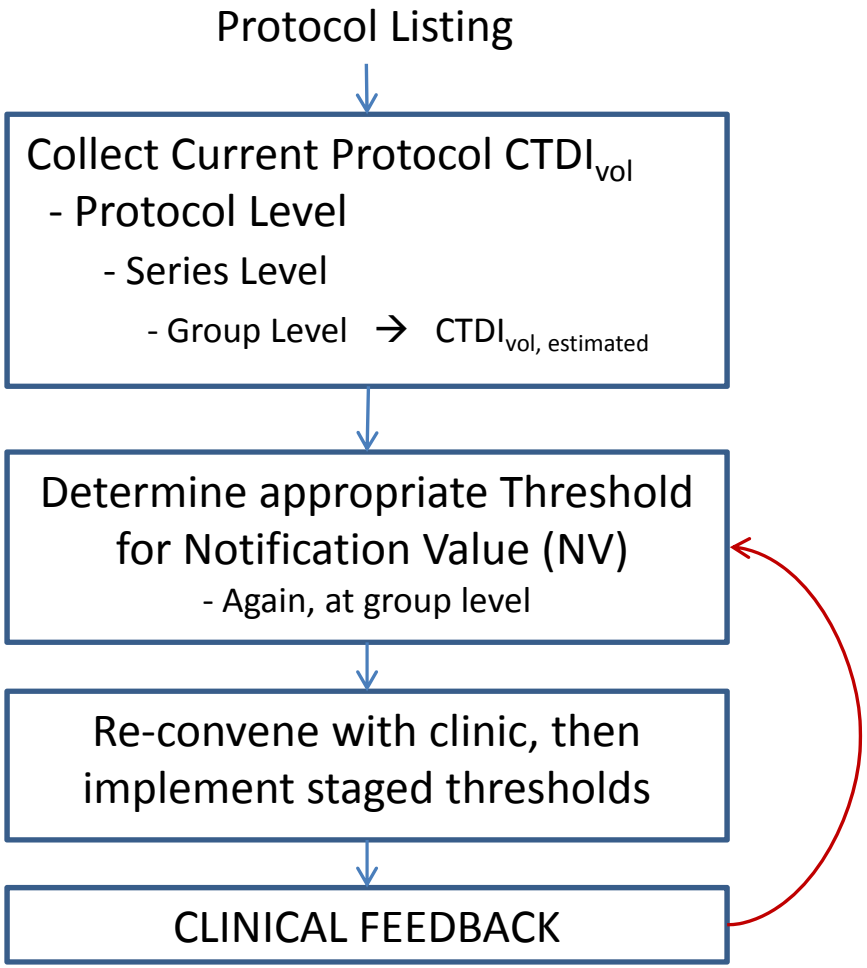
After 3 Months on One Scanner

Instance	Protocol	NV (CTDIvol) [mGy]	Projected CTDIvol [mGy]	% Diff from NV
1	L-spine Non-contrast	30	32.12	7.1%
2	L-spine Non-contrast	30	32.92	9.7%
3	T-spine Non-contrast	30	32.13	7.1%
4	T-spine Non-contrast	30	32.93	9.8%
5	Neck Soft Tissue w/ IV	50	59.27	18.5%
6	Neck Soft Tissue w/ IV	50	59.27	18.5%

AVERAGE [SPINE]	8.4%
AVERAGE [NECK]	18.5%

CONCLUSIONS

Conclusions



Conclusions

- Active monitoring using AV and NV is a useful, non-invasive tool in minimizing the likelihood of gross overdose (AV) and of 'abnormal' incremental overdose (NV).
  1. Understand the new Dose-check nomenclature and definitions
  2. Introduce reasonable AV/NV into the clinical scanner (neuro)
  3. Establish a clinical workflow incorporating usage of Dose-check
- There are a variety of resources that are available to us in setting the AV/NV; however, there is inherent difficulty in reducing this data down to the group level of the protocol
- <u>Future Work</u>
  - Introduce NV into more complicated protocols (abdominal, ATCM)
  - Consider modification of clinical workflow based on feedback
  - Incorporation of Size Specific Dose Estimates (SSDE)?

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THANK YOU FOR YOUR ATTENTION

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