

# Dose Monitoring Programs: What You Need to Know for TJC Compliance

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# Bio



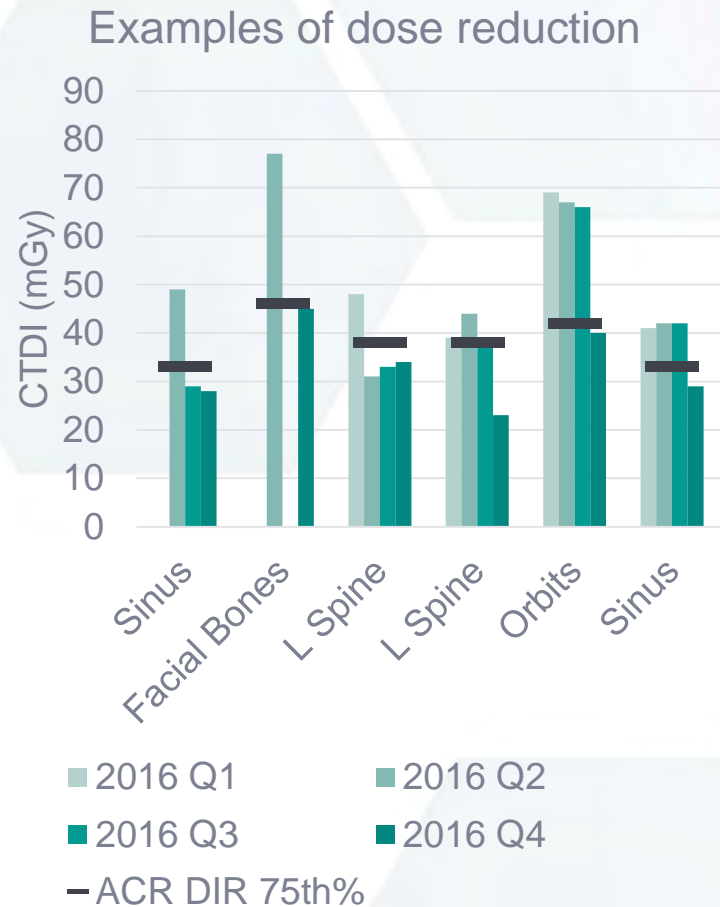
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Practice Manager – CDOS, LANDAUER Medical Physics

- Developed a dose monitoring program used at Duke University Medical Center
- Developed software used by the ACR DIR
- Member of the AAPM Task Group 220:  
**Determination of a Patient Size Metric for CT Size Specific Dose Estimate**
- Numerous publications and presentations including  
**Strategies to Support Specific Joint Commission Standards for Diagnostic Imaging and Prepare for Future Quality Initiatives** and  
**Dose analytics – More than a low number**

# CDOS overview

- Clinical Dose Optimization Service
- Started at the end of 2014
- ~200 hospitals across the country
- Experience with ACR DIR, DoseWatch, NexoDose, Radimetrics, Sectra, and more...
- 100% pass rate with TJC requirements around CT dose



# Disclaimers

- No affiliations with any commercial dose monitoring software
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# Objectives

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- What is actually required by the TJC?
- How to establishing expected dose index ranges
- How to implement expected dose index ranges
- What to do when exams exceed expected dose index ranges

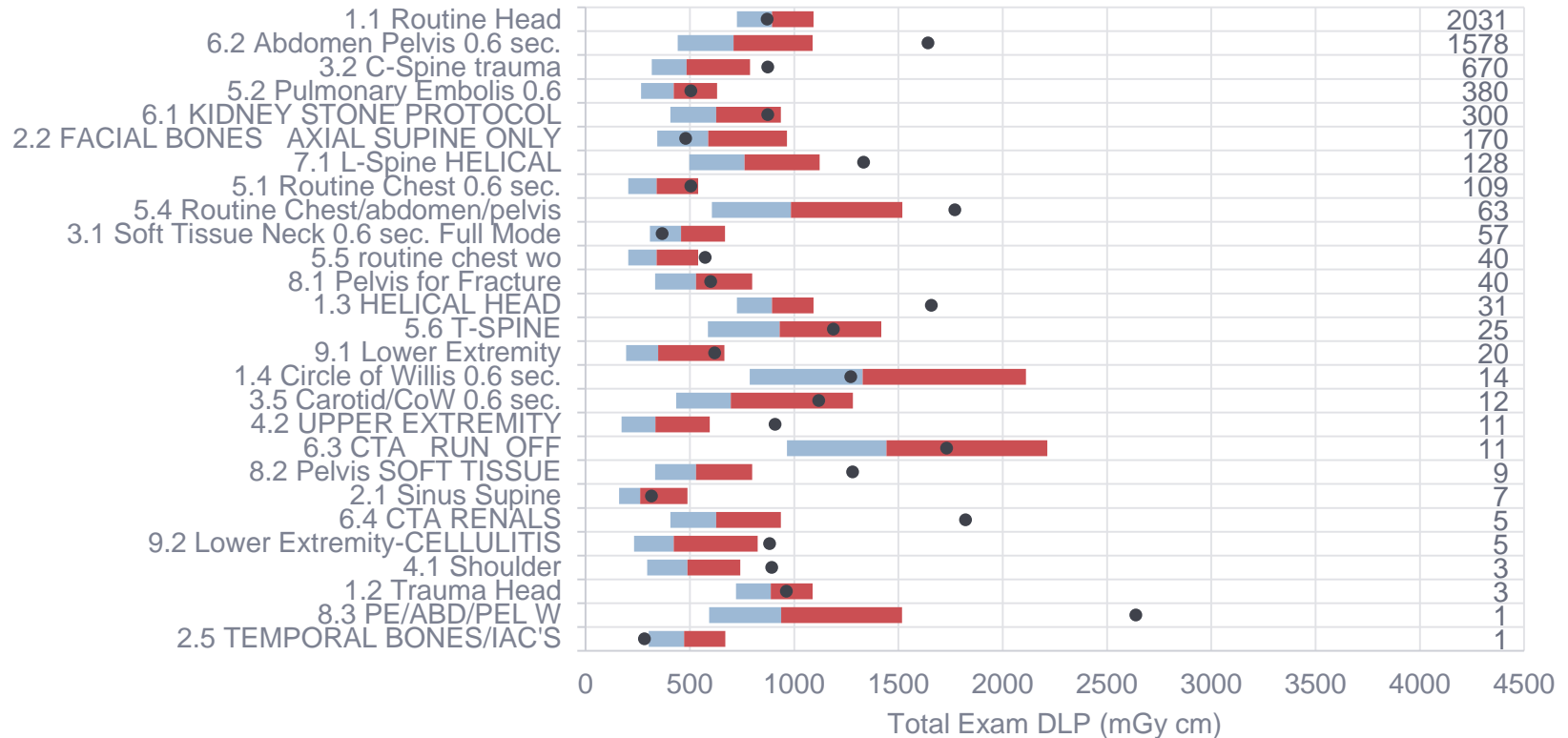
# TJC requirements

Standard	Description
PC.01.02.15 C5	The organization documents the radiation dose index (CTDIvol, DLP, or size-specific dose estimate [SSDE]) on every study produced during a diagnostic computed tomography (CT) examination. The radiation dose index must be exam specific, summarized by series or anatomic area, and documented in a retrievable format.

# Protocol review

- Form a committee
- Dose benchmarking
- High dose incidents
- Image quality review
- Use of dose reduction techniques

# Benchmarking



Work with a medical physicist to select appropriate benchmarks and interpret results



# Choosing a dose metric for expected dose index ranges

- CTDI
  - Dose to phantom, not patient
  - Reported in mGy
  - Cannot sum acquisitions (most of the time)
- SSDE
  - Closest to patient dose
  - Size-adjusted CTDI
  - Reported in mGy
  - Cannot sum acquisitions (most of the time)
- DLP
  - Dose to phantom, not patient
  - Reported in mGy-cm
  - Can sum acquisitions



Recommend expected dose index ranges include total DLP or number of irradiation events

# Practical Advice – Operator Education

- Operator education is **ESSENTIAL**
  - Be absolutely clear that these values are **NOT** limits.
  - If patient is large, the higher CTDI<sub>vol</sub> and DLP may be necessary to achieve adequate image quality, and the operator can proceed with confidence
  - Notification events simply draw attention to a potentially “high” exposure so that users can confirm that settings are appropriate

# Existing standards/recommendations

- ACR pass fail criteria

Protocol	Reference Value (mGy)	Pass/Fail Criteria (mGy)
Adult Head	75	80
Adult Abdomen	25	30
Pediatric Head (1 year old)	35	40
Pediatric Abdomen (40-50 lb.) – 16 cm phantom	15	20
Pediatric Abdomen (40-50 lb.) – 32 cm phantom	7.5	10

Appropriate for typical patient, but what about large patients?

# Existing standards/recommendations

- ACR/AAPM DRLs

Protocol	Achievable Dose [50 <sup>th</sup> %] (mGy)	Diagnostic Reference Level [75 <sup>th</sup> %] (mGy)
Adult head	57	75
Adult abdomen-pelvis	17	25
Adult chest	14	21
Pediatric head (5 year old)	31	40
Pediatric abdomen-pelvis (5 year old)	14	20

Designed for benchmarking, not for upper dose limits

# Existing standards/recommendations

- AAPM Notification Values

Protocol	Notification Value (mGy)
Adult Head	80
Adult Torso	50
Pediatric Head (<2 years old)	50
Pediatric Head (2 – 5 years old)	60
Pediatric Abdomen (<10 years old)– 16 cm phantom	25
Pediatric Abdomen (<10 years old) – 32 cm phantom	10
Brain Perfusion	600
Cardiac Retrospectively Gated	150
Cardiac Prospectively Gated	50

# Existing standards/recommendations

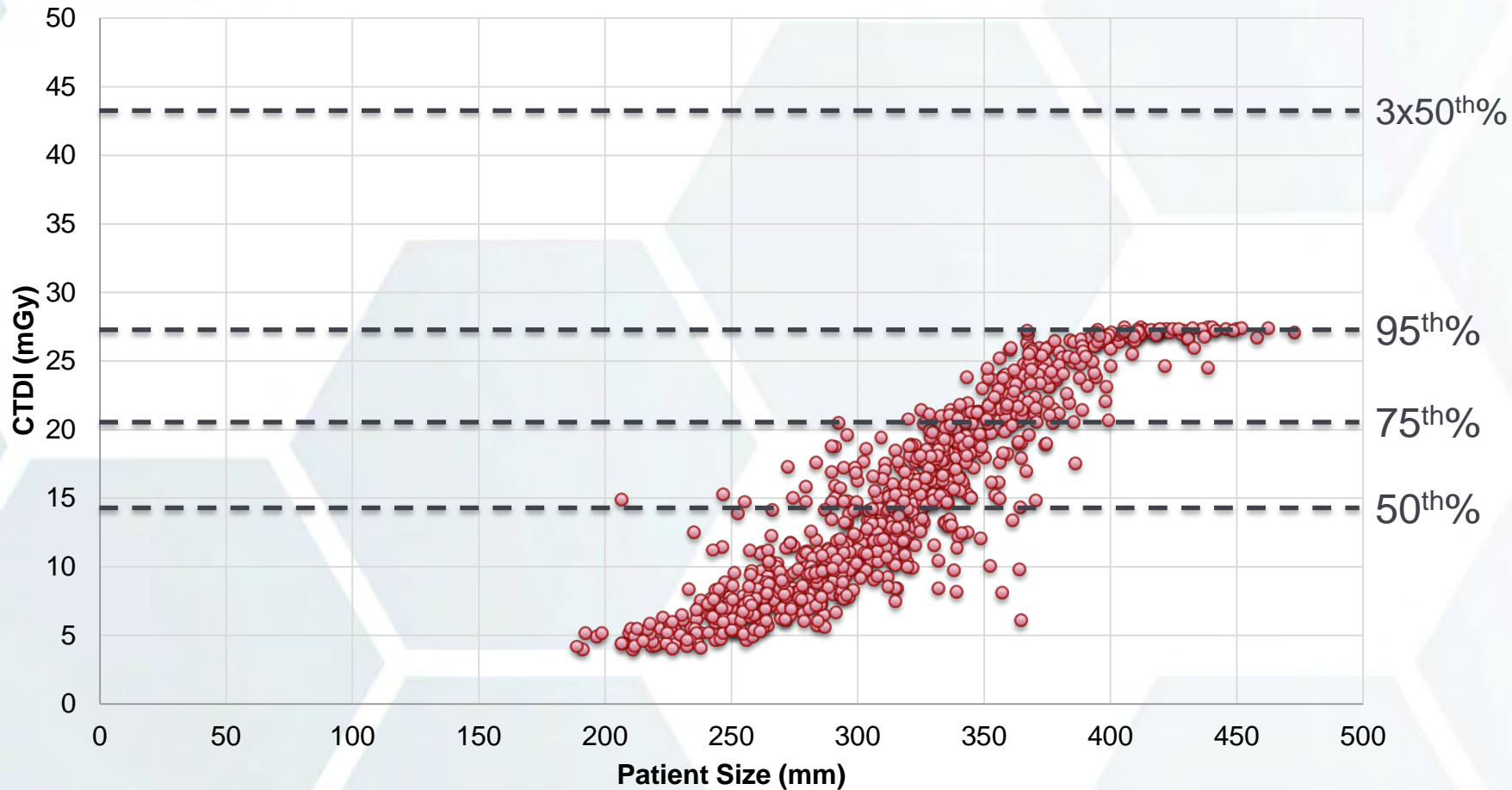
- ACR DIR

Protocol	CTDI 75 <sup>th</sup> %	DLP 75 <sup>th</sup> %	CTDI 95 <sup>th</sup> %	DLP 95 <sup>th</sup> %
CT HEAD BRAIN WO IVCON	58	1093	69	1956
CT ABDOMEN PELVIS W IVCON	19	1088	29	2042
CT ABDOMEN PELVIS WO IVCON	19	1003	29	1673
CT CHEST WO IVCON	14	539	23	969
CT CHEST W IVCON	16	767	26	1861
CT C SPINE WO IVCON	30	788	60	1919
CT CHEST ABDOMEN PELVIS W IVCON	19	1518	29	2744
CT CHEST PULMONARY ARTERIES W IVCON	18	630	29	1114
...				

Designed for benchmarking, not for upper dose limits

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# Historical practice at your facility



# Sample expected dose index ranges

- Hospital 1

Protocol	Criteria	Threshold
All	-	DLP: 3000 mGy cm



# Sample expected dose index ranges

- Hospital 2

Protocol	Criteria	Threshold
All except brain perfusion	Adults	DLP: 3000 mGy cm
All except brain perfusion	Pediatrics	DLP: 2000 mGy cm
Brain perfusion	-	DLP: 4000 mGy cm

# Sample expected dose index ranges

- Hospital 3

Protocol	Criteria	Threshold
Head	Adult	CTDI: 80 mGy DLP: 1500 mGy cm
Head	0-2 YO	CTDI: 50 mGy DLP: 750 mGy cm
Head	3-6 YO	CTDI: 60 mGy DLP 900 mGy cm
Abd Pel	Adult BMI<30	CTDI: 50 mGy DLP: 2000 mGy
Abd Pel	Adult BMI>30	CTDI: 75 mGy DLP: 3000 mGy cm
...		

Things can get very complicated

# Recommendations on expected dose index ranges

- Keep it simple
- Incorporate total DLP or number of irradiations
- Avoid alert fatigue

# Manually recorded high dose exams



# Using the ACR DIR to meet TJC standards

The screenshot displays the NRDR (National Radiology Data Registry) website interface. The header features the NRDR logo and the text "NATIONAL RADIOLOGY DATA REGISTRY" and "AMERICAN COLLEGE OF RADIOLOGY". The page title is "Dose Index". On the left, a navigation menu lists various options, with "Dose Information By Exam" highlighted in a red box. The main content area shows user information (User Name: Portland, User Type: Facility User, Facility ID, Facility Name) and a "Logout" link. Below this, the "DIR" section is visible, containing two paragraphs of text explaining the Dose Index Registry and its qualification by the American Board of Radiology.

# Using the ACR DIR to meet TJC standards

The screenshot displays the NRDR (National Radiology Data Registry) Dose Index web application. The header features the NRDR logo and the text "NATIONAL RADIOLOGY DATA REGISTRY" and "AMERICAN COLLEGE OF RADIOLOGY" on the left, and "Dose Index" on the right. Below the header is a navigation menu on the left with items like "DIR Registry", "About DIR", "Reports", "Summary Of Data Submitted", "Dose Information By Exam", "Summary of Irradiation Events", "CTDIvol Over Time", "CTDIvol Box Plots", "Exam Detail", "Standardized Dose Index Reports", "Aggregate Reports", "Registry Management", "Registration Information", "FAQ", "Data Dictionary in DIR Header and SR", "Exam Name Mapping", "Exam Name Mapping Tool User Guide", and "DIR Sample Report". The main content area shows the "Dose Information by Exam" section. At the top of this section, there are fields for "User Name: Portland", "User Type: Facility User", "Facility ID:", and "Facility Name:". A "Logout" link is visible in the top right. The "Dose Information by Exam" section contains a form with three rows: "DIR Facility Number" with a dropdown menu, "DIR Facility Name" with a dropdown menu, and "Submit Date range" with two date pickers set to "03/01/2017" and "04/30/2017", each followed by "(mm/dd/yyyy)". A "Submit" button is located below the form.

# Using the ACR DIR to meet TJC standards

The screenshot shows an Excel spreadsheet titled "DirDoseInformationByExamReport (3) - Excel". The spreadsheet contains a table with the following columns: Study, Submitter, Submitter, Study Description, Institution, Scans, Scans, Total CTDIvol (m), Total DLP (mGy), Study Date, Study Time, Dose Information By Exam, and Information By Exam. The data rows show various CT exams with their respective dates and doses. A "Filter" task pane is open, displaying a list of values to filter by, including "5", "60", "71", "78", "82", "86", "123", "133", and "137". The "Greater Than Or Equal To..." option is selected in the filter menu.

Study	Submitter	Submitter	Study Description	Institution	Scans	Scans	Total CTDIvol (m)	Total DLP (mGy)	Study Date	Study Time	Dose Information By Exam	Information By Exam
20170215			CT Abdomen w/ Contrast					17846				
20170228			CT Abdomen w/ WO Contrast					30855				
20170210			CT Abdomen w/ WO Contrast					16731				
20170216			CT Abdomen w/ WO Contrast					55819				
20170208			CT Abdomen/Pelvis w/ Contrast					26512				
20170216			CT Abdomen/Pelvis w/ Contrast					58178				
20170222			CT Abdomen/Pelvis w/ Contrast					15804				
20170203			CT Abdomen/Pelvis w/ Contrast					63116				
20170214			CT Abdomen/Pelvis w/ Contrast					4647				
20170203			CT Abdomen/Pelvis w/ Contrast					37742				
20170222			CT Abdomen/Pelvis w/ Contrast					10542				
20170205			CT Abdomen/Pelvis w/ Contrast					53005				
20170212			CT Abdomen/Pelvis w/ Contrast					22068				
20170224			CT Abdomen/Pelvis w/ Contrast					1507				
20170222			CT Abdomen/Pelvis w/ Contrast					44175				
20170220			CT Abdomen/Pelvis w/ Contrast					19724				
20170217			CT Abdomen/Pelvis w/ Contrast					78600				

# What is DoseCheck?

- DoseCheck is a scanner feature that is part of NEMA XR-29
- It supports prospective notifications and alerts at the CT console
- Events are saved to a log file that can be exported and reviewed to meet the TJC requirements

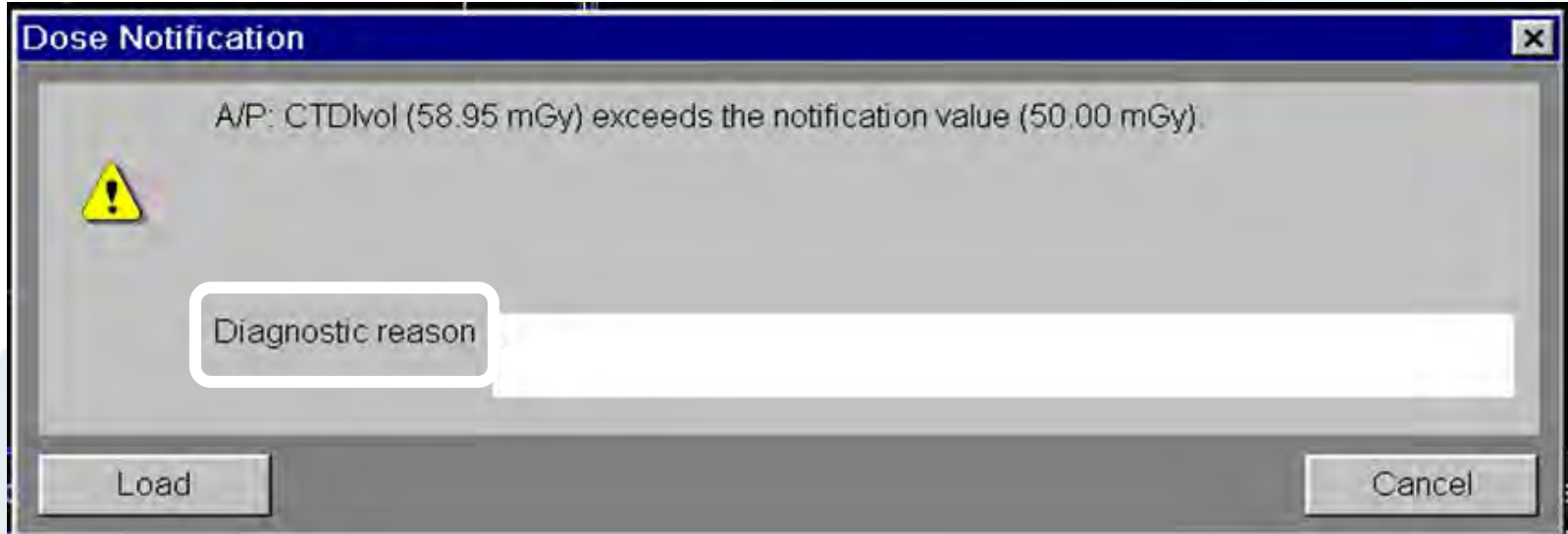


# Dose Notification Values

- Used to trigger a message when **a single planned and confirmed scan** is likely to exceed a pre-programmed value (CTDIvol and/or DLP).
  - Programmed value is set for each scan sequence in an exam
  - Values can be adjusted according to user preference

# Dose Notification

- When the scan protocol is confirmed (e.g. “go”, “load” or “confirm” buttons are selected), a message box will pop up:




Example from Siemens scanner

- Entering a reason is optional (e.g. very large patient)
- This information will be stored in a text file for site review
- Manufacturer should provide training on how to access these data

# Dose Notification Pop-up Window Examples

- GE

**DOSE NOTIFICATION**



One or more group result in a projected dose exceeding the Notification Value set. Select Cancel to go back to Viewedit and adjust scan parameters if clinically appropriate to set below the Notification Value. Selecting Confirm will proceed to scan and log user confirmation of scan parameters exceeding the Notification Value.

Series#	1	Series Description	A/P Onocology
	Images	NV	Projected
CTDIvol (mGy)	1 - 9	30	31.09

Diagnostic Reason

# Dose Notification Pop-up Window Examples

- Toshiba

**DOSE NOTIFICATION**

One or more elements in this exam plan will exceed the dose notification level that has been set.

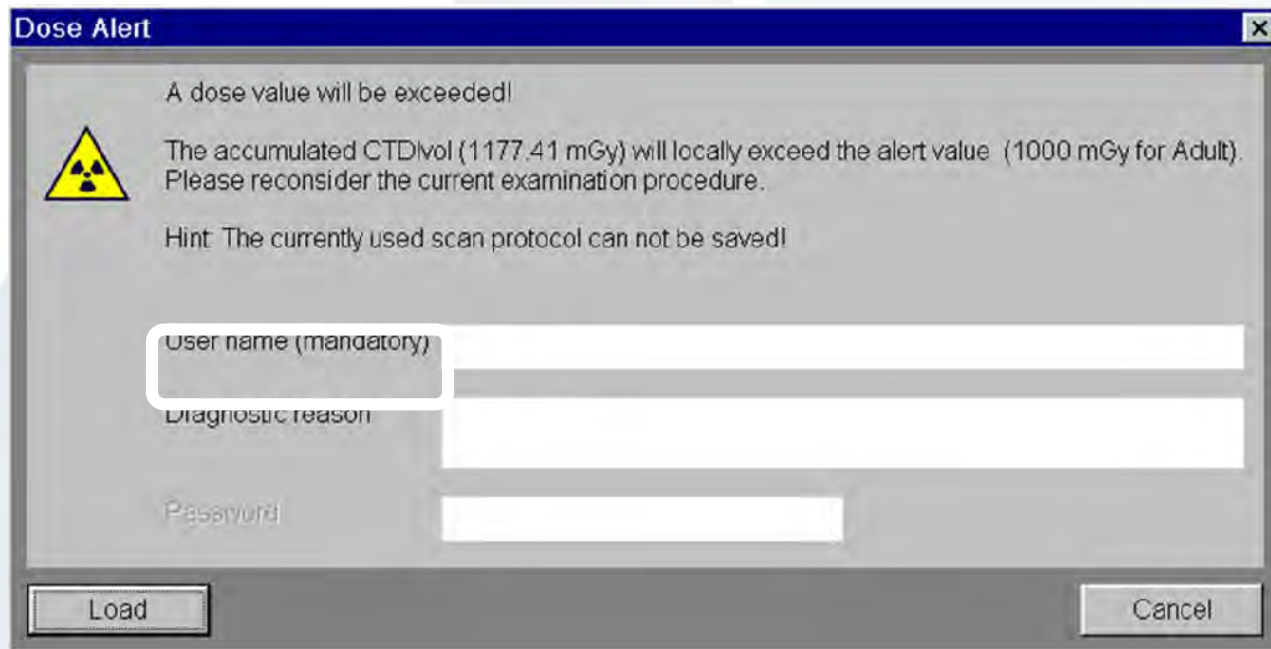
Element	Predicted CTDvol	Predicted DLP	Notification CTDvol	Notification DLP
Helical	11.4 mGy	342 mGy.cm	30 mGy	1000 mGy.cm
Helical	11.4 mGy	342 mGy.cm	30 mGy	1000 mGy.cm

# Dose Alert Values

- Used to trigger a message when **the cumulative dose at a location, plus the dose for the next planned and confirmed scan(s)**, is likely to exceed a pre-programmed value.
  - Programmed value is set once and applies to all exams (some systems may have adult and pediatric settings)
  - It is a scanner-wide parameter, not a protocol or sequence-specific parameter
  - FDA-recommend default value is  $CTDI_{vol}=1000$  mGy

# Dose Alert

- When a programmed scan(s) is confirmed (e.g. the go, load, or confirm button is pressed) that will result in the cumulative CTDIvol at any scan location exceeding the configured alert value (CTDIvol and/or DLP), a dose alert message box pops up




- User name is mandatory

# Dose Alert

- Password protection can be set

**Dose Alert** [X]

A dose value will be exceeded!

 The accumulated CTDIvol (1177.41 mGy) will locally exceed the alert value (1000 mGy for Adult). Please reconsider the current examination procedure.

Hint: The currently used scan protocol can not be saved!

User name (mandatory)

Diagnostic reason

# Dose Alert Pop-up Window Examples

- GE

user configured Alert Value. Select Cancel to go back to Viewedit and adjust scan parameters if clinically appropriate to set below the Alert Value. An authorized user name and password must be entered to select Confirm. Selecting Confirm will proceed to scan and log user confirmation of scan parameters exceeding the Alert Value.

	AV	Projected/Accumulated	Start	End
CTDIvol (mGy)	40	59.81	160.5	124.5

Logon Name:

Password:

Diagnostic Reason:

Confirm Cancel



# Dose Alert Pop-up Window Examples

- Hitachi

Dose Alert

Seq.No.	CTDIvol[mGy]	DLP[mGy·cm]	Notification Value(DLP)[mGy·cm]
7	88.5	1327.1	150.0

Sum DLP[mGy·cm] : 1769.4

Alert Value(DLP)[mGy·cm] : 1000.0

A Dose Alert Value will be exceeded.

Please input a password and click the "Confirm" button to scan.

Password

# Dose Alert Pop-up Window Examples

- Toshiba

**! DOSE ALERT**  
**A dose alert value will be exceeded !**

Proceeding with this exam will exceed the dose alert level that has been set.

	Predicted Dose	Alert Level
Cumulative CTDIvol	1054.6 mGy	1000.0 mGy

Edit OK

**Input Name**

Name

Password

OK Quit

**Input Diagnostic Reason**

Reason

- Large patient
- Exceptional image quality required
- Large number of series required
- Free text...

# Practical Advice – Operator Education

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- If password is set, it must be known by at least one readily available person at all times
  - Do not turn on the feature until all operators are educated on how to respond, especially how to override an Alert during an interventional procedure
  - *A medically critical scan must always be able to proceed*

# What about Dose Tracking Software (DTS)?

- DTS enables retrospective alerts and email notifications
- DTS alerts are often more flexible
  - Support more metrics like number of scans, SSDE, or cumulative patient dose
  - Can sometimes incorporate patient age and size
  - More robust protocol mapping
- Enhanced visibility through web portals

# Which dose tracking software should you get?

- All software can be used to meet the TJC standards
- Some software works better for certain approaches
- Things to look for:
  - How easy is it to configure the expected dose ranges
  - How easy is it for users to analyze alerts
  - Documentation for TJC survey
  - Summary data for managers/supervisors
- Other factors such as pricing and differentiating features may be a consideration

# Practical advice when using dose tracking software

- Ensure that you have a safety net for unmapped protocols
- Protocol mapping can be difficult to maintain with 100% accuracy
- Plan for the unexpected, like a PM breaking protocol mappings

# Which method should you use?

- Need a primary source for incidents where the dose index exceeded expected ranges
- All methods can be used to meet the TJC standards
- DoseCheck provides PROSPECTIVE notifications so should be considered regardless of how you plan to meet the TJC standards

# Sample expected dose index ranges

- Hospital 1

Protocol	Criteria	Threshold
All	-	DLP: 3000 mGy cm

Could use any method



# Sample expected dose index ranges

- Hospital 2

Protocol	Criteria	Threshold
All except brain perfusion	Adults	DLP: 3000 mGy cm
All except brain perfusion	Pediatrics	DLP: 2000 mGy cm
Brain perfusion	-	DLP: 4000 mGy cm

Could use any method except DoseCheck

# Sample expected dose index ranges

- Hospital 3

Protocol	Criteria	Threshold
Head	Adult	CTDI: 80 mGy DLP: 1500 mGy cm
Head	0-2 YO	CTDI: 50 mGy DLP: 750 mGy cm
Head	3-6 YO	CTDI: 60 mGy DLP 900 mGy cm
Abd Pel	Adult BMI<30	CTDI: 50 mGy DLP: 2000 mGy
Abd Pel	Adult BMI>30	CTDI: 75 mGy DLP: 3000 mGy cm
...		

Would need dose tracking software

# What to do when you get an alert

- Compare scanning parameters (mAs, kV, detector configuration, etc.) against the prescribed protocol
- Consider extenuating circumstances such as large patient size or repeats due to patient motion
- Document the reason for the elevated dose
- Discuss elevated dose levels with the Patient Dose Review Committee

# Closing thoughts

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- A variety of methods can meet the TJC standards
- Do incorporate total DLP or number of irradiation events into expected dose index ranges
- Keep your focus on improving to patient care