CT Dose Notifications and Alerts

What are they, how do they work,
and important information for
successful implementation

April 16, 2014

Disclaimer

- The information contained herein is current as of the date shown on the title slide
  - Not all systems may behave the same, or as shown in these examples. Users must understand the specific behavior of their specific CT system.
  - Questions should be directed to the respective manufacturer.
- Modification of the content of these slides is allowed.
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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
  - Recommendations by the AAPM provide initial default values (for CTDIvol only)[1]
  - Values were set by AAPM so that notifications would be infrequent to ensure that operators pay attention to them
    - If they pop up all the time, they will be ignored
  - Target frequency was approximately 5%

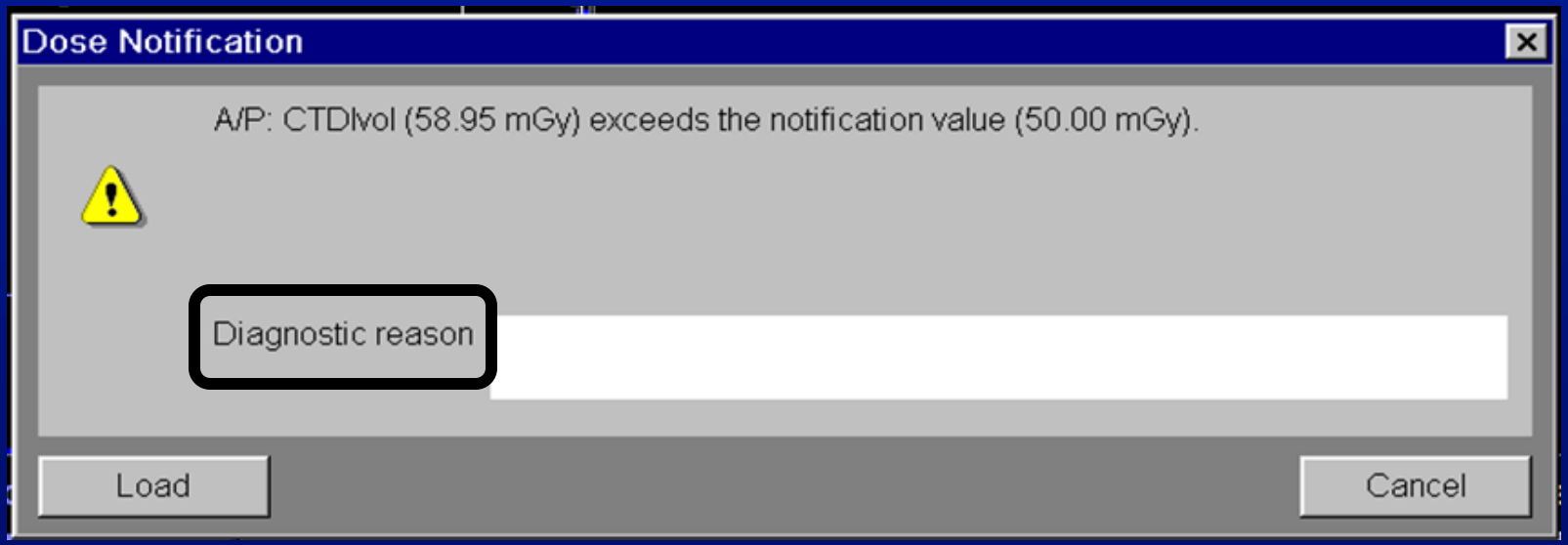
[1] http://www.aapm.org/pubs/CTProtocols/documents/NotificationLevelsStatement.pdf

CT Scan Region (associated with one scan series or scan phase)	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; GE, Hitachi, Toshiba)	25
<10 years old (32-cm phantom; Siemens, Philips)	10
Brain Perfusion (exam series that repeatedly scans same anatomic level to measure flow of contrast media through the anatomy)	600
Cardiac	
Retrospectively gated (spiral)	150
Prospectively gated (sequential)	50

Source: http://www.aapm.org/pubs/CTProtocols/documents/NotificationLevelsStatement.pdf

Dose Notification

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

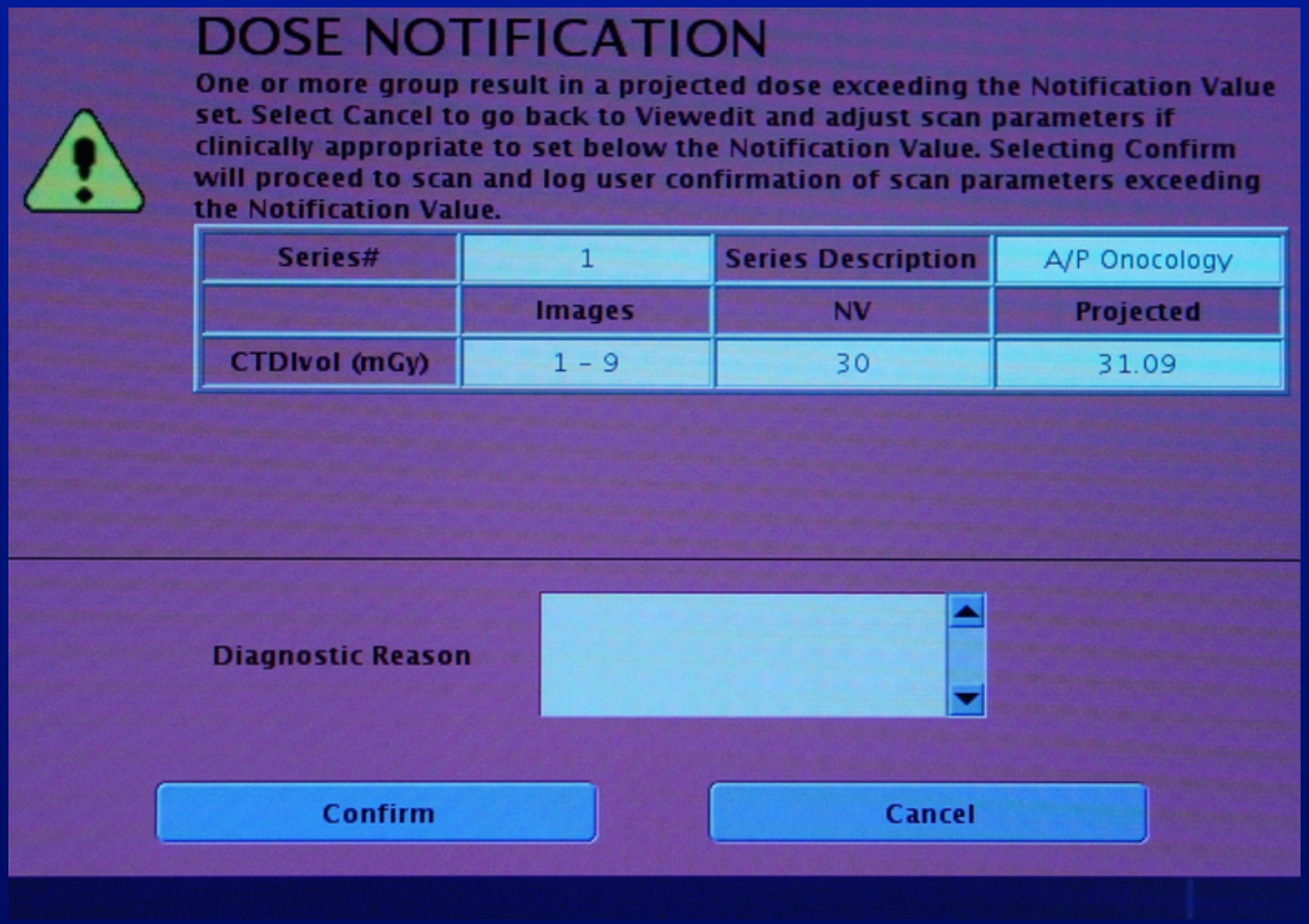


Example from Siemens scanner

- 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

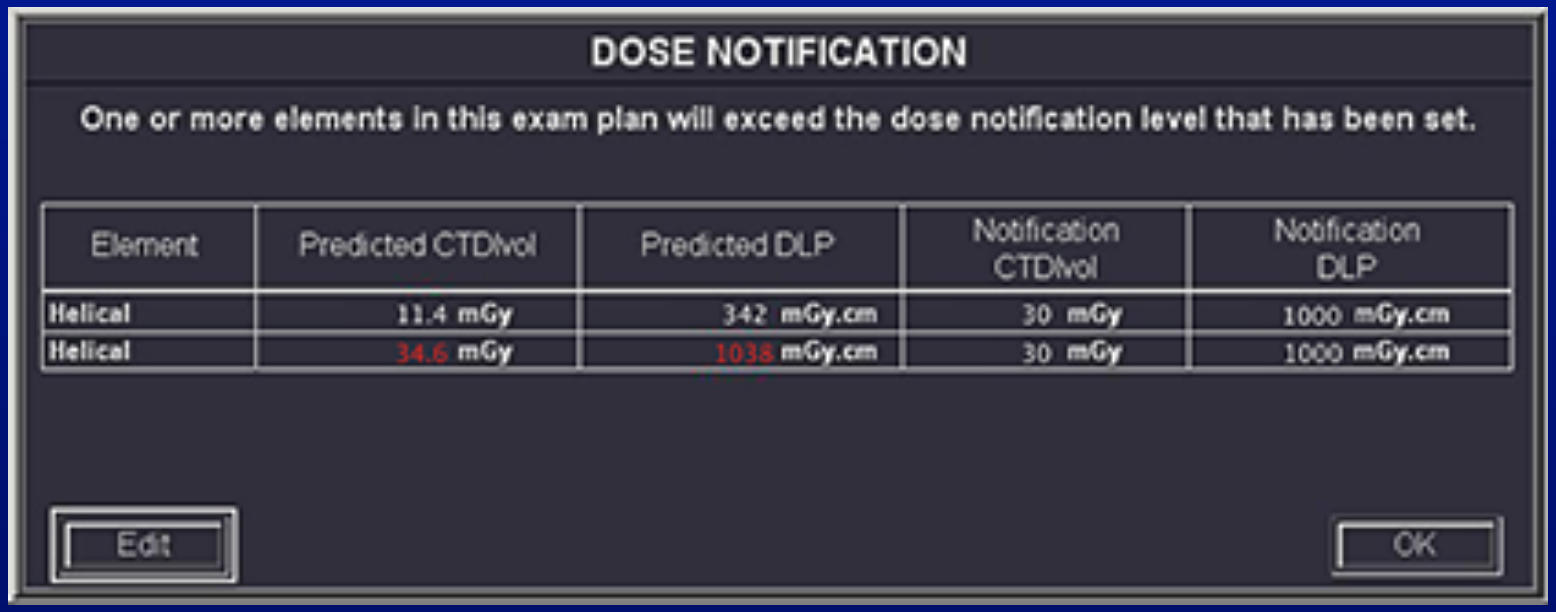
Dose Notification Pop-up Window Examples

- GE



Dose Notification Pop-up Window Examples

- Toshiba



Log files may include

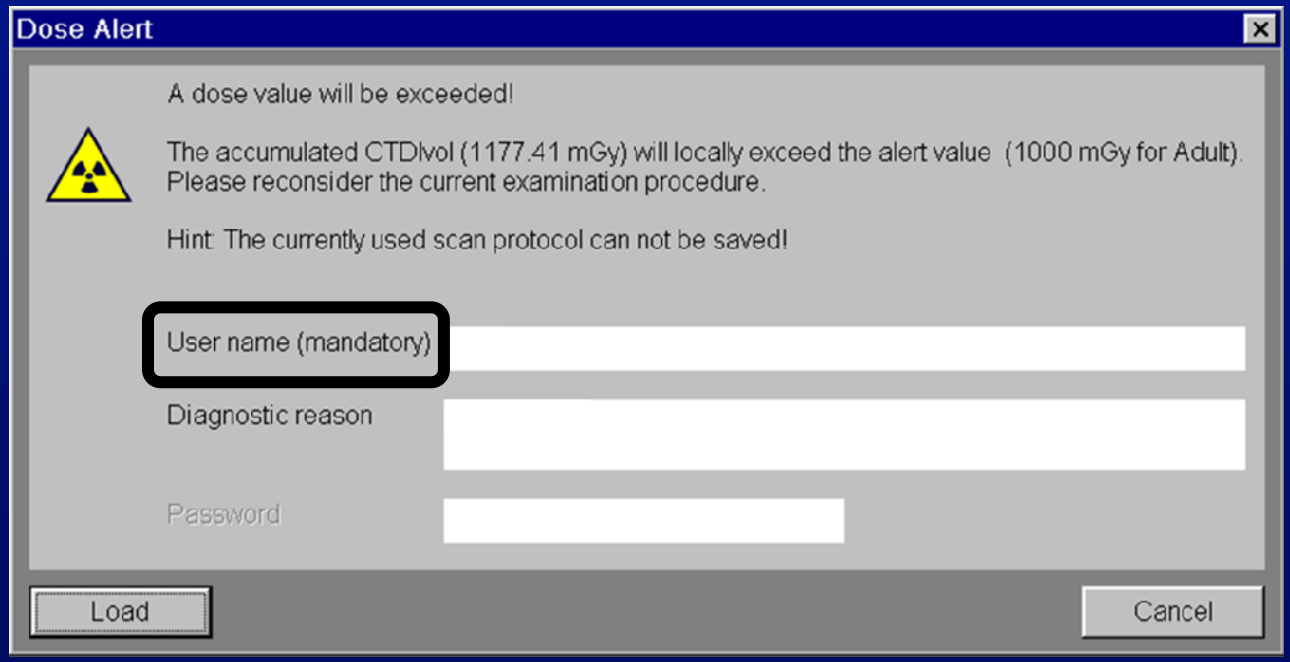
- time
- date
- patient ID
- study ID
- event type
- series description
- operator name
- operator-provided reason for event
- did operator use password
- CTDIvol value that triggered notification event
- programmed notification value (CTDIvol)
- DLP value that triggered notification event
- programmed notification value (DLP)

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 CTDIvol=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

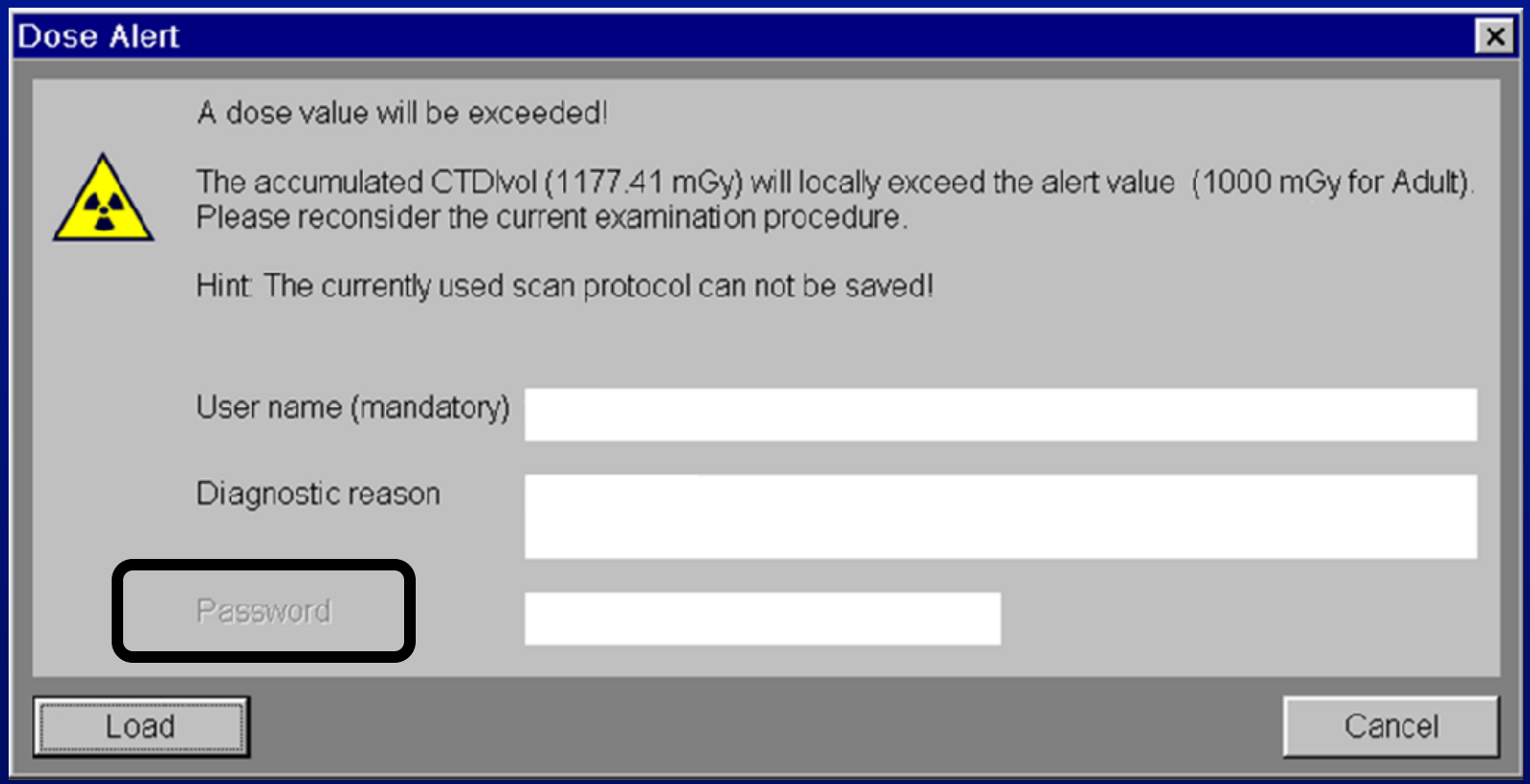


- User name is mandatory

Example from Siemens scanner

Dose Alert

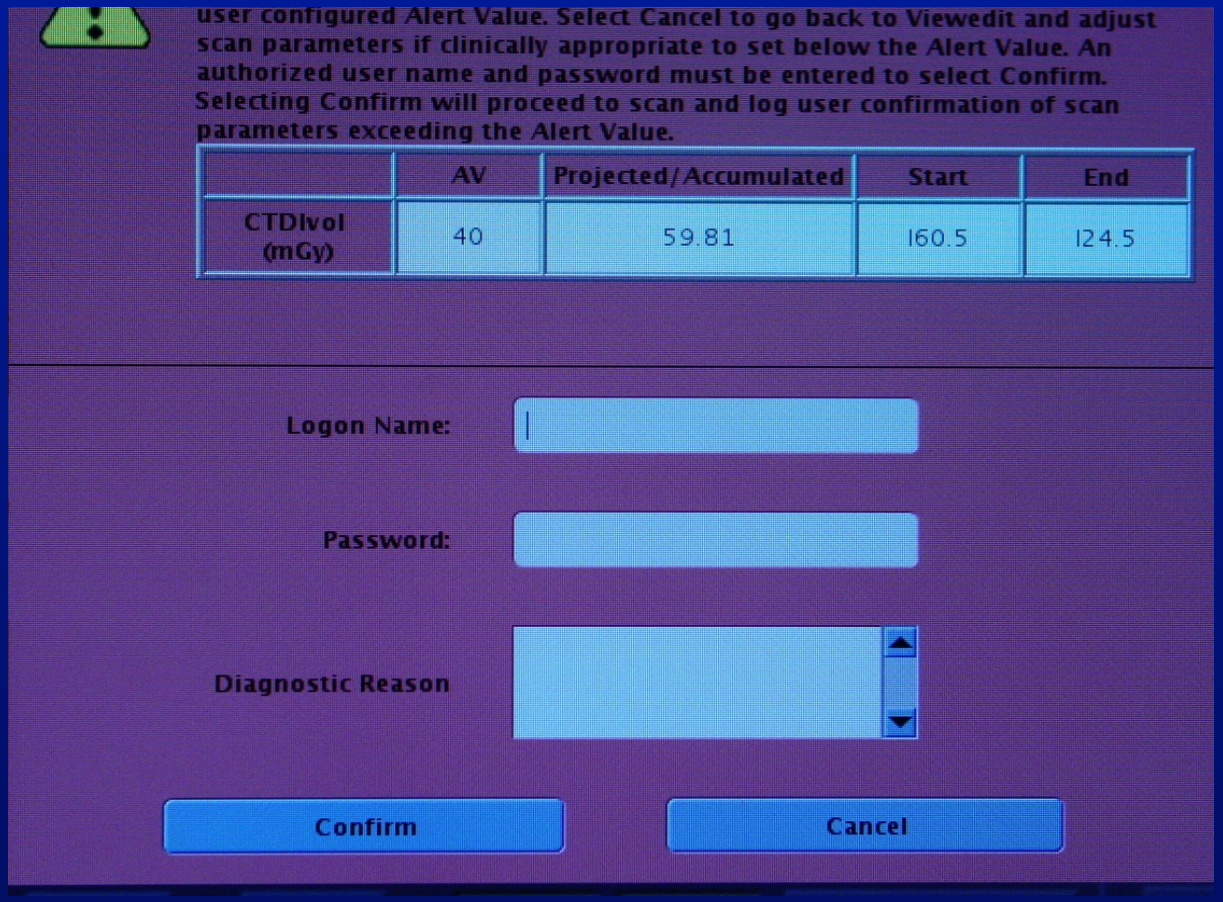
- Password protection can be set



Example from Siemens scanner

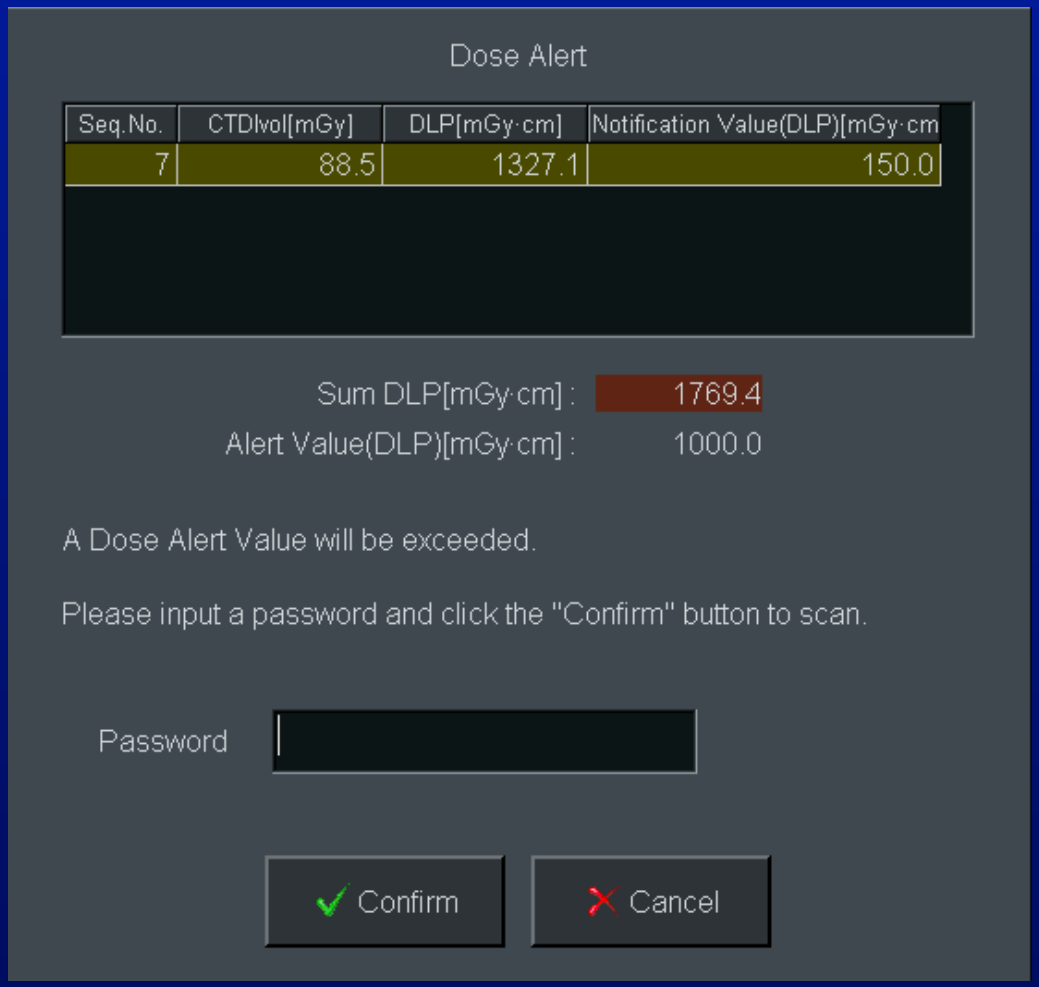
Dose Alert Pop-up Window Examples

- GE



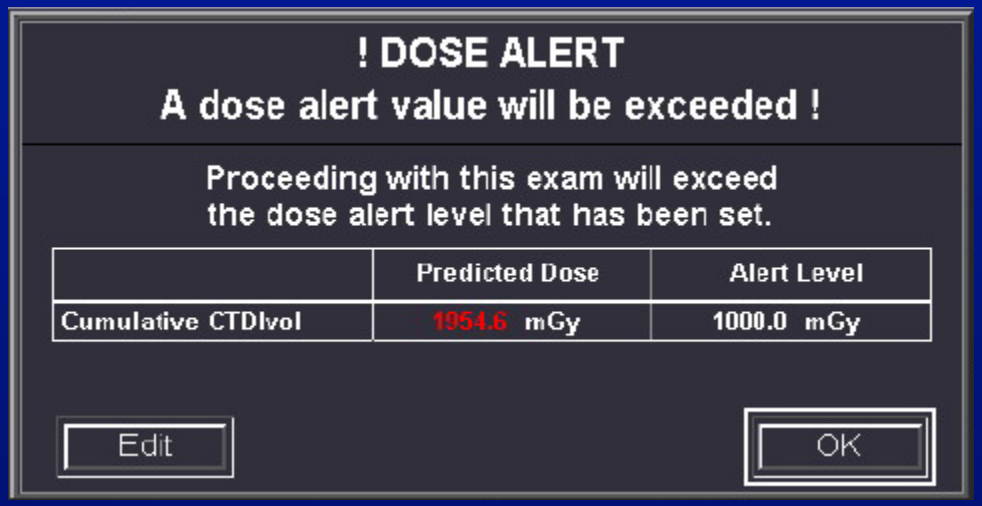
Dose Alert Pop-up Window Examples

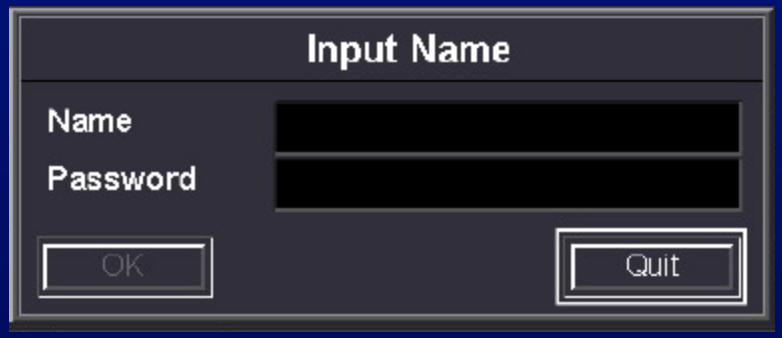
- Hitachi



Dose Alert Pop-up Window Examples

- Toshiba





Take Home Message

- Automated evaluation of CTDIvol and/or DLP before patient scanning using the "Dose Check" feature can help protect patients from inadvertent use of excessively high CTDIvol and/or DLP
  - Does not negatively impact clinical workflow*
  - It was designed to prevent egregious errors
  - It was not designed to "optimize" dose
- Sites must regularly monitor event logs
  - Use information to evaluate appropriateness of notification values and protocol parameters
  - Log monitoring is labor intensive
  - Tools from manufacturers are requested to facilitate log review

* Howard, ME et al., Use of CT Dose Notification and Alert Values in Routine Clinical Practice, JACR, March 2014

Important Operational Points

- Standard operating procedures need to be established by a practice to ensure that dose check features are used effectively
- Must have clear directions as to who is responsible for
  - Choosing and programming notification values
  - Log collection and evaluation
  - Modifying notification and alert values, as needed
  - Ensuring passwords are known only by chosen personnel
  - Giving approval to proceed with an exam after an alert

Important Operational Points

- Practices must establish
  - Frequency of log collection and evaluation
  - Procedures for reviewing log data with practice leadership
  - Clear instructions for how technologists are to respond to notification events
  - Clear instructions for how technologists are to respond to alert events
  - Clear instructions for how technologists are to deal with an alert event during an interventional procedure
  - Guidelines for minimizing the impact of dose notifications and alerts on workflow (e.g. limiting the programmed number of bolus tracking scans to a reasonable number)

Example: Dose Notification Procedure

1. If a dose notification box appears, the prescribed dose for that specific scan exceeds a programmed dose notification value
2. Compare scanning parameters (mAs, kV, detector configuration, etc.) against the prescribed protocol to ensure nothing has been inappropriately entered
3. If scanning parameters are correct:
   - If patient size (measured at level of the liver) is greater than 45 cm, then in the space provided for a diagnostic reason enter "patient size is ___ cm" and proceed with scan
   - If patient size is smaller than 45 cm, call the lead technologist for guidance before proceeding

Example: Dose Alert Procedure

1. If a dose alert box appears, the prescribed accumulated dose for the entire exam exceeds the programmed dose alert value
2. Compare scanning parameters (mAs, kV, detector configuration, etc.) against the prescribed protocol to ensure nothing has been inappropriately entered
3. If the scanning parameters all appear correct, and exam or procedure must be performed without delay, proceed with scan. Otherwise,
   - Call on-site physicist*, supervising radiologist and/or a lead technologist immediately for guidance
   - He/she/they will review scanning parameters and patient information, and will approve proceeding with the exam if parameters are appropriate for the specific patient, indication, and diagnostic question

*If applicable to practice

Practical Advice – Operator Education

- Operator education is ESSENTIAL
  - Be absolutely clear that these values are NOT limits.
  - If patient is large, the higher CTDIvol 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

Practical Advice – Operator Education

- 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*

Dose Alert and Interventional Procedures

- Interventional CT procedures often require repeated CT scans and may result in dose metrics that are substantially larger than those from diagnostic studies
- The reported cumulative CTDIvol and/or DLP from these studies may exceed the default or user-specified dose alert level

Dose Alert and Interventional Procedures

- When the cumulative CTDIvol for a study exceeds the dose alert level, the scan can not be performed until the alert is addressed
  - Operator must enter his/her name
  - Practices should determine whether a reason for proceeding should be entered. Using common terminology (e.g. obese patient, needed to repeat scan due to patient movement) will make log evaluations much more useful
  - Practices should determine if use of the password feature is desired, and if secondary approval is required (by whom)
  - If password is required, practice must have a fail-safe method of ensuring operator can obtain password when needed

Dose Alert and Interventional Procedures

- The time spent addressing the alert may have serious consequences if alert occurs during a critical portion of an interventional procedure
- Each scan confirmed after the initial alert may also need to be addressed, potentially causing multiple delays and impeding workflow
- Interruption of the procedure by the dose alert has the potential to negatively affect the procedure safety or success, especially in complex procedures

Dose Alert and Interventional Procedures

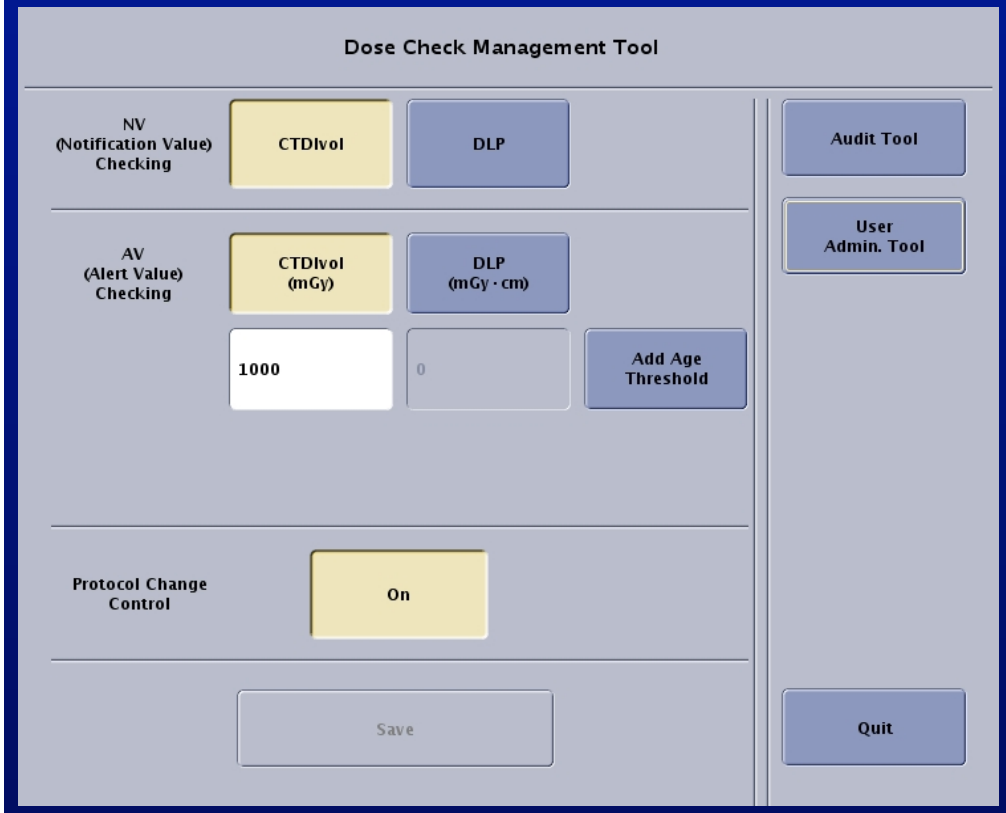
- If Dose Alert is enabled on a CT scanner that is used for interventional procedures, there are a number of steps an institution may take to ensure that the clinical workflow is not impeded
  - Ensure that the password to override the dose alert is available to all CT operators
  - Increase the Dose Alert level (e.g. to 2000 mGy)
    - 2000 mGy is the maximum value allowed, and this may not be high enough in extremely complex cases
  - Turn off Dose Alert during interventional procedures
  - Turn off the Dose Alert feature completely

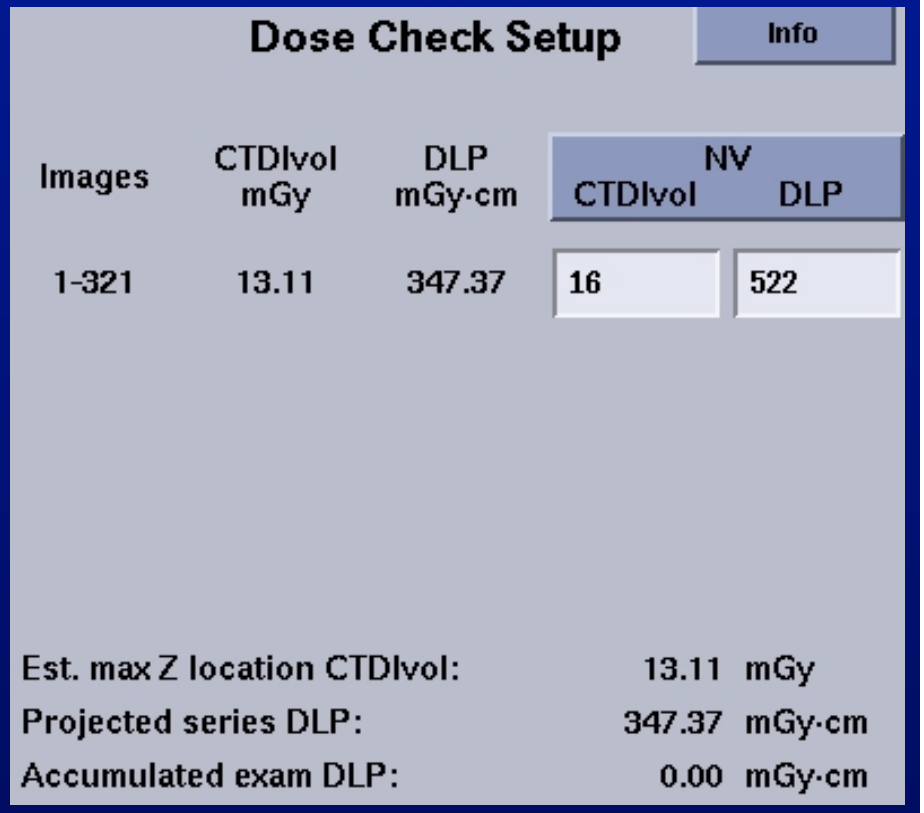
How to Turn Off Dose Alerts

- Find the place where the dose alert value can be configured. This is likely in a system configuration or dose management section of the user interface.
- Dose Alerts can be disabled by
  - Selecting the option to "Turn Dose Alert Off"
  - Deleting the numerical value (e.g. 1000 mGy) and leaving the box empty (the Dose Check standard does not require a system to display an alert if the alert value has not been set)
  - Replacing the numerical value (e.g. 1000 mGy) with 0 mGy (system response to a 0 value may be manufacturer dependent)
  - Manufacturers should specify the behavior of their systems
  - Users should also test and confirm this behavior

Configuration of Dose Check Values

- GE





Caution

- If a practice chooses to turn off Dose Alert only during interventional procedures, it is imperative a method to confirm the On or Off state is established and followed by all operators
  - Must remember to turn Dose Alert OFF before starting procedure
  - Must remember to turn Dose Alert ON after procedure is completed

CTDIvol vs. Skin Dose

- CTDIvol is not the same thing as skin dose
  - The relationship between CTDIvol and skin dose depends on patient size and scan mode
- Axial or helical scans (i.e. the table moves)
  - Head scans: Skin dose* is *approximately* equal to CTDIvol
  - Body scans: Skin dose* is *approximately* 20% greater than CTDIvol
- Biopsy, fluoroscopy or perfusion scans (i.e. the table does not move during scanning)
  - Head scans: Skin dose* is *approximately* 50% of CTDIvol
  - Body scans: Skin dose* is *approximately* 60% of CTDIvol

*From Bauhs et al., CT Dosimetry: Comparison of Measurement Techniques and Devices, RadioGraphics, 2008; 28:245-253

CTDIvol Values where Risk of Skin Injury Starts

- At skin doses of *approximately* 2000 mGy, transient skin erythema may begin to occur. This corresponds to …
- Axial or helical scans (i.e. the table moves)
  - Head scans: CTDIvol* a*pproximately* equal to 2000 mGy
  - Body scans: CTDIvol* a*pproximately* equal to 1670 mGy
- Biopsy, fluoroscopy or perfusion scans (i.e. the table dose not move during scanning)
  - Head scans: CTDIvol* a*pproximately* equal to 4000 mGy
  - Body scans: CTDIvol* a*pproximately* equal to 3330 mGy

*From Bauhs et al., CT Dosimetry: Comparison of Measurement Techniques and Devices, RadioGraphics, 2008; 28:245-253

Medical Context is Important

- In only a very few situations is a cumulative CTDIvol > 2000 mGy observed.
- Examples of important medical procedures where these high CTDIvol values are observed include:
  - Cryoablation and RF ablation procedures
  - Cementoplasty or multi-level blood patches for CSF leaks
- These procedures are often performed for oncological or other serious medical conditions, and offer important medical benefits that outweigh the low risk of transient skin erythema or hair loss
- Dose Alerts should not stop a needed procedure