AAPM Computed Tomography Radiation Dose Education Slides: Neusoft Version

Many of the terms used in these slides can be found in the CT Terminology Lexicon


Last updated: 18 November 2013
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• Screen captures are examples of a common (or latest) software version only and all software versions are not represented
• The information contained herein is current as of the date shown on the title slide
• The master version of these slides is located at:
• Modification of the content of these slides is not allowed.
Vendor Specific Slide Details

- The presence of a vendor name in the title of the slide indicates that the slide is vendor specific slide
- White text is used throughout to indicate vendor specific language
- An example of a vendor specific slide follows
Vendor: *Generic Parameter/Topic Name*

Vendor Specific Name

Vendor screen capture of how the acquisition parameter is set or how information on the topic is displayed

Text describing acquisition parameter or topic
**Motivation**

- These slides are provided to aid in understanding the factors that affect radiation dose in CT studies
- Image patients wisely and gently
  - A CT study should use as little radiation as possible, while still meeting the image quality needs of the exam
  - A CT study that is non-diagnostic because the radiation dose is too low may require rescanning the patient – increasing the total patient dose

imagegently.org

imagewisely.org
Outline

• What is Dose?
• Acquisition Parameter Settings
• Dose Modulation and Reduction
• Dose Display
What Is Dose?


How is $CTD_{vol}$ related to patient dose?

- $CTD_{vol}$ is not patient dose
- The relationship between the two depends on many factors, including patient size and composition
- AAPM Report 204 introduces a parameter known as the Size Specific Dose Estimate (SSDE) to allow estimation of patient dose based on $CTD_{vol}$ and patient size
- For the same $CTD_{vol}$, a smaller patient will tend to have a higher patient dose than a larger patient

http://www.aapm.org/pubs/reports/RPT_204.pdf
**How is CTDI\textsubscript{vol} related to patient dose?**

- **120 kVp at 200 mAs**
  - 32 cm Phantom
  - $\text{CTDI}_{\text{vol}} = 20 \text{ mGy}$

- **120 kVp at 200 mAs**
  - 32 cm Phantom
  - $\text{CTDI}_{\text{vol}} = 20 \text{ mGy}$

**Both patients scanned with the same CTDI\textsubscript{vol}**

**Patient dose will be higher for the smaller patient**

*What is Dose?*
How is $CTD_{vol}$ related to patient dose?

120 kVp at 100 mAs

120 kVp at 200 mAs

32 cm Phantom

$CTD_{vol} = 10 \text{ mGy}$

$CTD_{vol} = 20 \text{ mGy}$

Smaller patient scanned with a lower $CTD_{vol}$

Patient doses will be approximately equal

What is Dose?
Size Specific Dose Estimate (SSDE)

- AAPM report 204 describes a method to calculate SSDE using CTDI\textsubscript{vol}
- Conversion factors based on patient size (e.g., AP or lateral width, effective diameter) are provided to estimate patient dose for a patient of that size
- However, SSDE is still not the exact patient dose, as factors such as scan length and patient composition may differ from the assumptions used to calculate SSDE
- SSDE is not dose to any specific organ, but rather the mean dose in the center of the scanned volume

What is Dose?
**How is $CTD_I_{vol}$ related to patient dose?**

120 kVp at 100 mAs

- 9 cm
- 32 cm Phantom
- $CTD_I_{vol} = 10 \text{ mGy}$
- SSDE = 13.2 mGy

120 kVp at 200 mAs

- 27 cm
- 32 cm Phantom
- $CTD_I_{vol} = 20 \text{ mGy}$
- SSDE = 13.2 mGy

*Patients have equivalent SSDE*

*What is Dose?*
Why Use $CTD_{vol}$?

- $CTD_{vol}$ provides information about the amount of radiation used to perform the study
- $CTD_{vol}$ is a useful index to track across patients and protocols for quality assurance purposes
- $CTD_{vol}$ can be used as a metric to compare protocols across different practices and scanners when related variables, such as resultant image quality, are also taken in account
- The ACR Dose Index Registry (DIR) allows comparison across institutions of $CTD_{vol}$ for similar exam types (e.g., routine head exam)

What is Dose?

**Dose Length Product**

- The Dose Length Product (DLP) is also calculated by the scanner.
- DLP is the product of the length of the irradiated scan volume and the average $\text{CTDI}_{vol}$ over that distance.
- DLP has units of $\text{mGy} \cdot \text{cm}$.
Useful Concepts/Terms

- The relationships between acquisition parameters and CTDI\textsubscript{vol} described in the following slides assume all other parameters are held constant.

- The relationship between a parameter and CTDI\textsubscript{vol} is often described as \textit{proportional} in some way:
  - The symbol $\propto$ is used to indicate “proportional to”.

- Directly proportional means that a change in the parameter results in the same change in CTDI\textsubscript{vol}:
  - Example: Doubling the rotation time from 0.5 to 1.0 seconds will double the CTDI\textsubscript{vol}.

- Inversely proportional means that a change in a parameter has the opposite effect on CTDI\textsubscript{vol}:
  - Example: Doubling the pitch from 1 to 2 will reduce the CTDI\textsubscript{vol} by half.
**Acquisition Parameter Settings**

- Acquisition Parameters define the technique that will be used and how the scan will proceed.
- Acquisition Parameters are set in the user interface where scans are prescribed.
- Changing a single Acquisition Parameter while holding everything else constant will typically affect the CTDI_{vol} for that scan.
- The following slides describe what that affect is for each parameter.
Scan Mode

- CT Scanners offer a variety of Scan Modes which describe how the table moves during an exam
- Scan Modes include
  - Axial
  - Helical or Spiral
  - Dynamic

The Acquisition Parameters that affect CTDIvol may change amongst different Scan Modes

Acquisition Parameter Settings
Dynamic Scan Mode Notes

- In the Dynamic Scan Mode multiple acquisitions covering the same body region are acquired. Examples of these study types include:
  - Perfusion Studies
  - Bolus Tracking Studies
  - Test Bolus Studies
- Dynamic Scans often have large CTDI$_{vol}$ values because the scanner reports the sum of the CTDI$_{vol}$ values from each rotation
- The reported CTDI$_{vol}$ is NOT skin dose or organ dose

Neusoft: Scan Mode

Scan Type

- All protocols can be edited/modified during scan set up or via the "service" menu button. In either case, the pictured screen will be made available to the user so that parameters can be viewed and/or modified.
- The "Scan Mode", as well as other scan parameters, is preprogrammed and assigned to an anatomical region. Select this tab, and the pictured screen will be displayed.
- The scan parameters for a "Dynamic Scan" are pictured and the menu would be very similar for helical and axial scans.
- The "Scan Type" area is where the desired scan is selected. Note the drop down menu that gives the user access to the available Dynamic Scan Types.
- The anticipated Patient Dose is displayed in this location, regardless of the Scan Type.
**Table Feed/Increment**

- Is the movement of the table through the bore of the scanner over a full 360 degree rotation
- Units: millimeters/rotation or millimeters/second
- The parameter is known both as *Table Feed* (helical/spiral acquisition) & *Table Increment* (axial acquisition)

**Table Feed may affect CTDI\textsubscript{vol} through its inclusion in Pitch (discussed later)**
**Neusoft: Table Feed/Increment**

Increment

- Using the same screen for consistency, the “table increment” can be observed/modified in this box. As the pictured sequence is for a Brain Perfusion study, the increment is zero.
- The verbage “Increment” is used for both AXIAL and HELICAL scans.
**Detector Configuration**

- Is the combination of the number of data channels and the width of the detector associated with each data channel.
- The Detector Configuration determines the Beam Width or Beam Collimation (nT), which is the number of channels (n) times the detector width associated with each data channel (T).
- For a selected detector width per data channel, a smaller total Beam Collimation usually has a higher CTDI\textsubscript{vol} than a larger Beam Collimation.
  
  **Example:** On a 16 slice scanner with a detector width per channel of 1.25 mm, a collimation of 4x1.25mm is generally less dose efficient than a collimation of 16x1.25mm.

**Users should monitor CTDI\textsubscript{vol} values when changing detector configuration.**

Acquisition Parameter Settings
Detector Configuration

Acquisition Parameter Settings
**Neusoft: Detector Configuration**

**Collimation**

- By selecting this tab the details of the detector configuration can be observed and modified.
- By selecting “Collimation” a drop down menu will be displayed that lists all of the collimation choices available for a given protocol.
**Pitch**

- Is the Table Feed per gantry rotation divided by the beam width/collimation
- Pitch is the ratio of two distances and therefore has no units
- Users should monitor other parameters when changing Pitch. The scanner may or may not automatically compensate for changes in Pitch (for example, by changing the tube current) to maintain the planned $\text{CTDI}_{\text{vol}}$.

\[
\text{CTDI}_{\text{vol}} \propto \frac{1}{\text{Pitch}}:
\]

**Hitachi, Toshiba (no AEC)**

**CTDI$_{\text{vol}}$ independent of Pitch:**

**GE, Siemens, Philips, Neusoft, Toshiba (AEC)**

 Acquisition Parameter Settings
Pitch

- $\text{CTD}_{\text{vol}}$ may not change in the expected manner if the scanner automatically adjust other parameters when the pitch is changed.
- The relationships between $\text{CTD}_{\text{vol}}$ and pitch for the different vendors are described below:
  - $\text{CTD}_{\text{vol}}$ inversely proportional to change in pitch: Hitachi, NeuroLogica
  - $\text{CTD}_{\text{vol}}$ constant when pitch is changed due to changes to other parameters: GE, Neusoft, Philips and Siemens
  - The relationship between $\text{CTD}_{\text{vol}}$ and pitch depends on scan mode or Software version: Toshiba
**Pitch**

- **Pitch < 1**
  Beam Width has some overlap at each view angle from rotation to rotation

- **Pitch = 1**
  No overlap of Beam Width at each view angle and no view angles not covered at certain table positions

- **Pitch > 1**
  Some view angles are not covered by the beam width at certain table positions

Acquisition Parameter Settings
Neusoft: **Pitch**

Pitch

- By selecting this tab, the Pitch can be observed and modified.
- The Pitch value is displayed and can be modified via the drop down menu.
**Exposure Time per Rotation**

- Is the length of time, in seconds, that the X-ray beam is “on” during a gantry rotation
  - It takes into account the gantry rotation time and angular acquisition range
- Units: seconds
- Users should monitor other parameters when changing Exposure Time per Rotation. The scanner may or may not automatically compensate for changes in Exposure Time per Rotation (for example, by changing the tube current)

\[ \text{CTD}_\text{vol} \propto \text{Exposure Time per Rotation} \]

**Hitachi, NeuroLogica, Toshiba (no AEC)**

**CTD}_\text{vol} \text{ independent of Exposure Time per Rotation:**

**GE, Siemens, Philips, Neusoft, Toshiba (AEC)**

*Acquisition Parameter Settings*
Exposure Time per Rotation

- CTDI_{vol} may not change in the expected manner if the scanner automatically adjust other parameters when the exposure time per rotation is changed.
- The relationships between CTDI_{vol} and exposure time per rotation for the different vendors are described below:
  - CTDI_{vol} proportional to change in parameter: Hitachi and NeuroLogica
  - CTDI_{vol} constant when the parameter is changed due to changes to other parameters: GE, Neusoft, Philips and Siemens
  - The relationship between CTDI_{vol} and the parameter depends on scan mode or Software version: Toshiba
**Neusoft: Exposure Time per Rotation**

**Rotation Time**

- By selecting this tab, the Rotation Time can be observed and modified.
- The Rotation Time is displayed and can be modified via the drop down menu.

* Acquisition Parameter Settings

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AAPM Working Group on Standardization of CT Nomenclature and Protocols
**Tube Current**

- Determines the number of electrons accelerated across the x-ray tube per unit time
- Units: milliAmperes (mA)
- $\text{CTDI}_{\text{vol}}$ is directly proportional to Tube Current

\[ \text{CTDI}_{\text{vol}} \propto \text{Tube Current} \]
Neusoft: Tube Current

mA

- By selecting this tab, the Tube Current can be observed and modified.
- The Tube Current value is displayed to the right of the Tube Current Time Product drop down menu.
- Tube Current Time Product is used to indirectly select the Tube Current. The Tube Current can be adjusted by selecting and adjusting the Tube Current Time Product drop down menu.

Acquisition Parameter Settings
**Tube Potential**

- Is the electrical potential applied across the x-ray tube to accelerate electrons toward the target material.
- Units: kiloVolts (kV or kVp).
- CTDI$_{vol}$ is approximately proportional to the square of the percentage change in Tube Potential.

\[ \text{CTDI}_{vol} \propto \left( \frac{kV_{new}}{kV_{old}} \right)^n \]

\[ n \approx 2 \text{ to } 3 \]
Neusoft: Tube Potential

kV

- By selecting this tab, the Tube Potential can be observed and modified.
- The Tube Potential value is displayed and can be modified via the drop down menu.
Effective Tube Current Time Product

- Is the product of the Tube Current and the Exposure Time per Rotation divided by the Pitch
- Units: milliAmpere-Seconds (mAs)
- $\text{CTDI}_{vol}$ is directly proportional to Effective Tube Current Time Product

$\text{CTDI}_{vol} \propto \text{Effective Tube Current Time Product}$

Acquisition Parameter Settings
Neusoft: **Effective Tube Current Time Product**

mAs/Slice

- By selecting this tab, the Tube Current Time Product can be observed and modified.
- The Tube Current Time Product value is displayed and can be modified via the drop down menu.
Field Of Measurement

- Is the diameter of the primary beam in the axial plane at the gantry iso-center
- Units: millimeters (mm)
- $\text{CTDI}_{\text{vol}}$ may decrease with a decrease in the Field of Measurement
  - The relationship is vendor specific

Users should monitor the $\text{CTDI}_{\text{vol}}$ values when changing the Field of Measurement

Acquisition Parameter Settings
Neusoft: Field of Measurement

FOV

- By selecting this tab, the Field Of Measurement can be observed and modified.
- The Field Of Measurement value is displayed and can be modified via the drop down menu.
Beam Shaping Filter

- Is the scanner component that modifies the energy spectrum and spatial distribution of the primary beam
- Beam Shaping may include a bow tie filter and/or flat filters
- CTDI_{vol} is affected by a change in Beam Shaping Filters
  - The relationship is vendor and filter specific

Users should monitor CTDI_{vol} values when changing the Beam Shaping Filter
Dose Modulation and Reduction

- Many CT scanners automatically adjust the technique parameters (and as a result the CTDI_{vol}) to achieve a desired level of image quality and/or to reduce dose.
- Dose Modulation and Reduction techniques vary by scanner manufacturer, model and software version.
### Acquisition Parameter Settings Summary

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Relationship to CTDI&lt;sub&gt;vol&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scan Mode</td>
<td>Changes in the Scan Mode may affect CTDI&lt;sub&gt;vol&lt;/sub&gt;</td>
</tr>
<tr>
<td>Table Feed/Increment</td>
<td>Table Feed affects CTDI&lt;sub&gt;vol&lt;/sub&gt; through its inclusion in Pitch</td>
</tr>
<tr>
<td>Detector Configuration</td>
<td>Decreasing the Beam Collimation typically, but not always, increases the CTDI&lt;sub&gt;vol&lt;/sub&gt;</td>
</tr>
<tr>
<td>Pitch</td>
<td>CTDI&lt;sub&gt;vol&lt;/sub&gt; relationship to pitch is vendor dependent</td>
</tr>
<tr>
<td>Exposure Time Per Rotation</td>
<td>CTDI&lt;sub&gt;vol&lt;/sub&gt; relationship to exposure time per rotation is vendor dependent</td>
</tr>
<tr>
<td>Tube Current</td>
<td>CTDI&lt;sub&gt;vol&lt;/sub&gt; ∝ Tube Current</td>
</tr>
<tr>
<td>Tube Potential</td>
<td>CTDI&lt;sub&gt;vol&lt;/sub&gt; ∝ (kVp&lt;sub&gt;1&lt;/sub&gt;/kVp&lt;sub&gt;2&lt;/sub&gt;)&lt;sup&gt;n&lt;/sup&gt; n ~ 2 to 3</td>
</tr>
<tr>
<td>Tube Current Time Product</td>
<td>CTDI&lt;sub&gt;vol&lt;/sub&gt; ∝ Tube Current Time Product</td>
</tr>
<tr>
<td>Effective Tube Current Time Product</td>
<td>CTDI&lt;sub&gt;vol&lt;/sub&gt; ∝ Effective Tube Current Time Product</td>
</tr>
<tr>
<td>Field of Measurement</td>
<td>Changes in the Field of Measurement may affect CTDI&lt;sub&gt;vol&lt;/sub&gt;</td>
</tr>
<tr>
<td>Beam Shaping Filter</td>
<td>Changes in the Beam Shaping Filter may affect CTDI&lt;sub&gt;vol&lt;/sub&gt;</td>
</tr>
</tbody>
</table>
Automatic Exposure Control (AEC)

- Automatically adapts the Tube Current or Tube Potential according to patient attenuation to achieve a specified image quality
  - Automatic adjustment of Tube Current may not occur when Tube Potential is changed
  - Centering the patient in the gantry is VITAL for most AEC systems
- AEC aims to deliver a specified image quality across a range of patient sizes. It tends to increase CTDI$_{vol}$ for large patients and decrease it for small patients relative to a reference patient size

The use of Automatic Exposure Control may decrease or increase CTDI$_{vol}$ depending on the patient size and body area imaged and image quality requested

Dose Modulation and Reduction
**Neusoft: Automatic Exposure Control (AEC)**

**DoseRight Mode**

- By selecting this tab, the Automatic Exposure Control configuration can be observed and modified.
- The Automatic Exposure Control configuration is displayed and can be modified via the drop down menu.

_Dose Modulation and Reduction_
Image Quality Reference Parameter

- Is the AEC parameter that is set by the user to define the desired level of image quality
- Changing the Image Quality Reference Parameter will affect the CTDI$_{vol}$

The effect on CTDI$_{vol}$ when changing the Image Quality Reference Parameter is vendor dependent

Dose Modulation and Reduction
**Neusoft: Image Quality Reference Parameter**

**DoseSave Level**

- By selecting this tab, the Image Quality Reference Parameter can be observed and modified.
- As the DoseSave level is decreased (i.e., changing from 1.7 to 0.3) the noise will increase (i.e., go from “low noise” to “low dose,” where low dose images typically have higher noise levels). A lower DoseSave setting means a lower dose compared to a higher setting, but also means a higher noise level.
**Image Quality Reference Parameter**

- A change in the Image Quality Reference Parameter will affect the CTDI$_{vol}$
- Setting the parameter for "increased" image quality (e.g., lower noise) will result in more dose
  - Increasing the DoseSave Level will result in an increase in the CTDI$_{vol}$
- Setting the parameter for "decreased" image quality (e.g., more noise) will result in less dose
  - Decreasing the DoseSave Level will result in a decrease in the CTDI$_{vol}$
Angular Tube Current Modulation

- Is an AEC feature that adjusts the Tube Current as the x-ray tube rotates around the patient to compensate for attenuation changes with view angle
- Angular Tube Current Modulation is used to adjust the Tube Current to attempt to deliver similar dose to the detector at all view angles

The use of Angular Tube Current Modulation may decrease or increase CTDI_{vol} depending on the patient size and body area imaged and image quality requested

Dose Modulation and Reduction
Neusoft: Angular Tube Current Modulation

- Angular Tube Current Modulation (DOM) uses information from
  - A combination of the scout anatomical profile and the noise level of the previous rotation to control DOM
Neusoft: Angular Tube Current Modulation

DOM (DOse Modulation)

- By selecting this tab, the state of the Angular Tube Current Modulation can be observed and modified.
- The Neusoft Angular Tube Current Modulation name is “DOM”.
- “DOM” has two components, “Z-DOM” & “D-DOM”. These components modulate the tube current in the X/Y and Z orientations, respectively. They cannot be run separately. When “DOM” is selected, both Z-DOM and D-DOM are active.
- The state of DOM is displayed and can be modified via the drop down menu.
Longitudinal Tube Current Modulation

- Is an AEC feature that adjusts the Tube Current as patient attenuation changes in the longitudinal direction
- The CT Localizer Radiograph is used to estimate patient attenuation

The use of Longitudinal Tube Current Modulation may decrease or increase CTDI_{vol} depending on the patient size and body area imaged and image quality requested

Dose Modulation and Reduction
**Neusoft: Longitudinal Tube Current Modulation**

- Longitudinal Tube Current Modulation (ACS) uses information from
  - A single view localizer is used for ACS
Neusoft: Longitudinal Tube Current Modulation

ACS (Automatic Current Selection)

- By selecting this tab, the state of Longitudinal Tube Current Modulation can be observed and modified.
- The Neusoft Longitudinal Tube Current Modulation is known as “Automatic Current Selection” or “ACS”.
- The state of the Longitudinal Tube Current Modulation is displayed and can be modified via the drop down menu.
Angular and Longitudinal Tube Current Modulation

- Is an AEC feature that incorporates the properties of both Angular and Longitudinal Tube Current Modulation to
  - Adjust the Tube Current based on the patient’s overall attenuation
  - Modulate the Tube Current in the angular (X-Y) and longitudinal (Z) dimensions to adapt to the patient’s shape

The use of Angular and Longitudinal Tube Current Modulation may decrease or increase $\text{CTDI}_{\text{vol}}$ depending on the patient size and body area imaged and image quality requested

Dose Modulation and Reduction
Angular and Longitudinal Tube Current Modulation

Angular Modulation
mA during 1 rotation
1 2 3 4
Tube Angle

Longitudinal (z) Modulation
Average mA per rotation
Thorax (Low Attenuation)
Liver (Moderate Attenuation)
Shoulder (High Attenuation)
Scan Distance (z)

Longitudinal (z) and Angular Modulation
mA
Scan Distance (z)

Dose Modulation and Reduction
**Neusoft: Angular and Longitudinal Tube Current Modulation**

**ACS + DOM**

- ACS and DOM can be run together or separately.
- DOM has an X, Y and Z component, which run simultaneously when DOM is selected.
- AEC can be disabled entirely by selecting the “NONE” option in the drop down menu.
Dose Display

- Information about the CTDI$_{vol}$ planned for each scan is typically displayed before the exam on the user console.
- Information about the CTDI$_{vol}$ delivered by each scan is typically reported in a data page or DICOM structured dose report.
- Dose information provided after the exam typically also includes the DLP and the CTDI phantom size. These may also be included in information displayed before the scan.
Display of Planned CTDI$_{vol}$

- CTDI$_{vol}$ is displayed before a study is performed based on the selected technique parameters.
- It is important to check CTDI$_{vol}$ before a study is performed to ensure that the output of the scanner is appropriate for the specific patient and diagnostic task.

**CTDI$_{vol}$ is displayed for each planned acquisition**

Dose Display
Neusoft: Display of Planned $\text{CTDI}_{\text{vol}}$

**Planned CTDI$_{\text{vol}}$**

- By selecting this tab, the Display of Planned CTDI$_{\text{vol}}$ values can be observed.
- The Planned CTDI$_{\text{vol}}$ is displayed.

Dose Display  Neusoft
Post Study Data Page

• Following the completion of a study, a Post Study Data Page is created that includes information on the delivered CTDI$_{vol}$ and DLP and the phantom size used to calculate these values
• Information is displayed for each series
Post Study Data Page - $CTD_{vol}$

- $CTD_{vol}$ is displayed for each series after a study is performed and is calculated based on the technique factors used to acquire the data.
- It is useful to check $CTD_{vol}$ after a study is performed to ensure that the output of the scanner was as expected.

$CTD_{vol}$ is displayed for each completed acquisition

Dose Display
Post Study Data Page - DLP

- DLP is displayed for each series after a study is performed and is calculated based on the technique factors and scan length used

DLP is displayed for each completed acquisition and is typically summed for all of the acquisitions

Dose Display
Post Study Data Page – CTDI Phantom

• The CTDI Phantom used for each acquisition in the study is typically displayed

• Different phantoms may be used to calculate the CTDI_{vol} for different acquisitions in the same study (and may vary by vendor)
  – Head and C-Spine Example
    • Body Phantom used to report CTDI_{vol} for C-Spine portion of exam
    • Head Phantom used to report CTDI_{vol} for Head portion of exam

Dose Display
Neusoft: Post Study Data Page

Dose Info

<table>
<thead>
<tr>
<th>Dose Information</th>
<th>L/DR/DRs</th>
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<td>Time</td>
<td>May 16, 2012, 7:57:51 PM</td>
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<td>Total DLP</td>
<td>1,172,633 mGy*cm</td>
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<td>Estimated Dose savings</td>
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<table>
<thead>
<tr>
<th>Series Description</th>
<th>Scan Mode</th>
<th>mA</th>
<th>kVp</th>
<th>NPS</th>
<th>CTDose</th>
<th>DLP</th>
<th>Dose/CLR</th>
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<tbody>
<tr>
<td>1 50% AEC</td>
<td>Head</td>
<td>50</td>
<td>120</td>
<td>166.75</td>
<td>4.46</td>
<td>31.52</td>
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</tr>
<tr>
<td>2 100% AEC</td>
<td>Head</td>
<td>100</td>
<td>120</td>
<td>166.75</td>
<td>6.70</td>
<td>64.45</td>
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<td>3 200% AEC</td>
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<td>159</td>
<td>120</td>
<td>166.75</td>
<td>12.82</td>
<td>127.90</td>
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<td>4 300% AEC</td>
<td>Head</td>
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<td>252</td>
<td>120</td>
<td>166.75</td>
<td>3.71</td>
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<tr>
<td>6 500% AEC</td>
<td>Head</td>
<td>252</td>
<td>120</td>
<td>166.75</td>
<td>3.71</td>
<td>258.03</td>
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<tr>
<td>7 600% AEC</td>
<td>Head</td>
<td>256</td>
<td>120</td>
<td>166.75</td>
<td>3.71</td>
<td>258.03</td>
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<tr>
<td>8 Total</td>
<td>256</td>
<td>120</td>
<td>266.75</td>
<td>62.41</td>
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<tr>
<td>9 Total</td>
<td>128</td>
<td>120</td>
<td>266.75</td>
<td>26.48</td>
<td>8.32</td>
<td>BODY 32</td>
<td></td>
</tr>
<tr>
<td>10 Total</td>
<td>128</td>
<td>120</td>
<td>266.75</td>
<td>10.06</td>
<td>1.18</td>
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<tr>
<td>11 Total</td>
<td>50</td>
<td>120</td>
<td>266.75</td>
<td>5.50</td>
<td>0.65</td>
<td>BODY 32</td>
<td></td>
</tr>
<tr>
<td>12 Total</td>
<td>50</td>
<td>90</td>
<td>266.75</td>
<td>6.82</td>
<td>0.50</td>
<td>BODY 32</td>
<td></td>
</tr>
</tbody>
</table>

- This screen is displayed at the end of each patient exam and is included as part of the patient record.
- The estimated dose savings realized by using AEC is listed here as well. This example displays the reading when the AEC is turned off.
- Patient dose levels are displayed per series and the reference phantom type for that series is also listed.
**Summing Dose Report Values**

- CTDI<sub>vol</sub> values for separate series are NOT to be summed to give a “total” CTDI<sub>vol</sub> for a study
  - This is especially true if the series cover different anatomic regions

- DLP is typically summed over all series in the Post Study Data Page to provide an estimate of the total patient exposure
  - Extreme care should be taken when considering summed DLPs because different phantoms may have been used to calculate the CTDI<sub>vol</sub> values used to determine DLP

- A medical physicist should be contacted if patient specific dose estimates are required
Dose Notification Levels

- Notification Levels may be set on a CT scanner for each series within an exam protocol.
- If the planned CTDI$_{vol}$ is above the Notification Level and triggers the notification, the user has the opportunity to edit or confirm the technique settings.
- Notification Levels may be exceeded when appropriate for a specific patient or diagnostic task (e.g., in very large patients or contrast bolus monitoring scans).

Dose Display
Neusoft: Dose Notification Levels

Warning CTDIvol

- The NOTIFICATION LEVEL can be set via this screen.

The Dose Notification feature complies with the NEMA XR-25 standard.
Dose Alert Levels

- Dose Alert Levels require specific action by the operator to continue scanning
- Dose Alert Levels are typically much higher than Notification Levels and take into account all series within the exam
- Triggering a Dose Alert requires that the operator confirm the protocol and settings are correct by entering in his or her name. Optionally, sites may require that the operator provide a brief explanation in the provided field
**Neusoft: Dose Alert Levels**

Maximum CTDIvol

- The DOSE ALERT level can be set via this screen.

The Dose Alert feature complies with the NEMA XR-25 standard.
**Questions**

- Please contact the medical physicist providing support for your CT practice, your lead technologist, supervising radiologist or manufacturer’s application specialist with questions regarding these important topics and concepts.
A special thank you to Dr. Mark Supanich for his considerable efforts in leading the working group in developing these slides.
Acknowledgements

- GE
  - John Jaechle
- Hitachi
  - Mark Silverman
- Philips
  - Amar Dhanantwari
- Neusoft
  - Keith Mildenberger
- NeuroLogica
  - Donald Fickett

- Siemens
  - Christianne Liedecker
- Toshiba
  - Kristen Boedecker
- MITA
  - Brian Abraham