

## Background and Purpose

- Computed Tomography has a high standard for dose tracking and monitoring
- Accrediting bodies require each exam that exceeds the site specified value is investigated<sup>1</sup>
- There is no strict instruction or guidance on what this might look like for individual facilities and therefore is left to the discretion of the institution to implement and maintain a review process
- Sharing of individual facilities’ practices will help individual sites validate and fine tune their individual process and improve patient outcomes

## Methods

- Through the use of the dose tracking software, Radimetrics®, global exam alert settings were created for all protocols and all scanners. These were set to alert for the 99th percentile per water equivalent diameter (WED) ranges looking at the most current completed 12 month period (July– June) and separated into two patient cohorts, pediatric 0-18 year old and adult 18 + year old. The WED size ranges were modeled to match those set by Kanal et al for various body regions, extending in similar increments in either direction for larger or smaller sizes.<sup>2</sup>

Table 1. CTDIvol Body Global Alert Settings		
Age Group	99th%CTDIvol Body Limit	WED Range
Pediatric	40.86	37-41cm
	31.52	33-37cm
	30.86	29-33cm
	28.13	25-29cm
	26.68	21-25cm
	24.36	17-21cm
	20.36	13-17cm
	16.28	9-13cm
Adult	8.68	5-9cm
	77.78	45-50cm
	80.28	41-45cm
	45.38	37-41cm
	35.88	33-37cm
	30.27	29-33cm
	28.72	25-29cm
	27.07	21-25cm
	24.95	17-21cm
	25.9	13-17cm
	20.99	9-13cm
	13.48	5-9cm

Table 2. CTDIvol Head Global Alert Settings		
Age Group	99th%CTDIvol Head Limit	WED Range
Pediatric	78.49	20-25cm
	68.73	15-20cm
	38.7	10-15cm
	29.66	5-10cm
Adult	50.53	30-35cm
	70.51	25-30cm
	97.17	20-25cm
	69.01	15-20cm
	54.43	10-15cm

Table 2. Deviation Categories

Multiple Factors
Large Patient Habitus
Magnification in the Scout
Metal Dental Fillings
Neck Brace Present
Non-Event
Object in the Scan FOV
Old Exported Exam
Protocol Review Needed
Radimetrics Mis-Calculation
Slider Board Present
Unknown Cause

- For each exam that alerts, the exam is opened in our Philips® PACs system as well as in the Radimetrics® dose tracking system. The tube current modulation plot provided in Radimetrics is analyzed and the images and topogram for each exam is analyzed for possible causes for variation/increases in dose. (see Case Examples section)
- Once analyzed, a note is entered into Radimetrics® and one of our site specified deviation categories is selected (see Table 2 for list of categories) for classification purposes
- The typically alert rate is between 2.4-3.3% of all exams which for our site equates to around 100 -200 alerts in a single month.

## Case Examples

Case 1: Magnification in the Scout due to 4.5 cm Miscentering

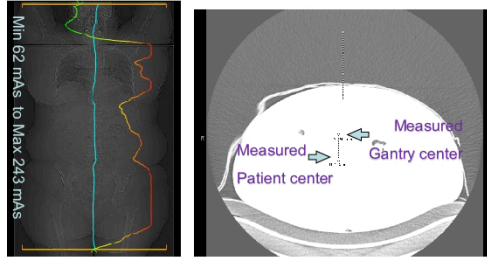


Image 1. Tube Current Plot Image 2. Cross-Section of thickest portion of patient

Looking at the scout and the axial section on the thickest portion of the patient, exam was found to be posteriorly shifted by 4.5cm (as seen in Image 1 and Image 2). Nuclear Medicine technologists have since been added to the annual CT department training titled “CT Scout Importance” as well as given an in-person training to answer questions real time pertaining to miscentering errors.

Examination dose reference level exceeded for CTDIvol Body.  
Max value = 30.27 mGy;  
Actual value = 30.96 mGy.  
Applies to age 18.0-150.0 years.

Case 2: Multiple Factors including the presence of a neck brace, slider board, and metal dental fillings

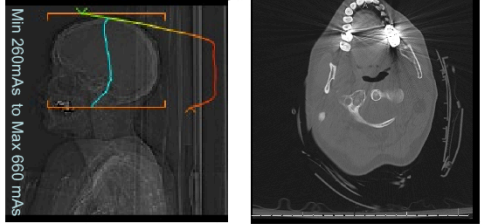


Image 3. Tube Current Plot Image 4. Cross-Section displaying neck brace, slider board, and metal dental fillings

Looking at the scout and the axial section the presence of a neck brace, slider board, and metal dental fillings are clearly seen (Image 3 and Image 4). These three items are the most common reasons for CTDIvol increase in the Emergency Department. The deviation category “Multiple Factors” accounts for 54% off exam alerts cleared indicating there is typical multiple factors playing into even a subtle exam alert overage.

Examination dose reference level exceeded for CTDIvol Head.  
Max value = 69.01 mGy  
Actual value = 70.02 mGy  
Applies to age 18.0-150.0 years

Case 3: Large Patient Habitus in a Coned in Field of View (FOV)

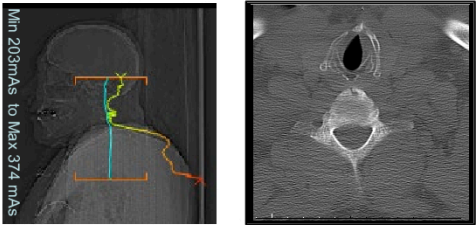


Image 5. Tube Current Plot Image 6. Cross-Sectional image in the shoulder region demonstrating a coned in FOV

Looking at the scout and the axial section you can see the patient has a very thick shoulder region (Image 5). This is not conveyed in the cross-sectional spine image which are purposefully coned into the spine region to exclude excess anatomy (Image 6). This results in Radimetrics® miscalculating the WED for the patient and therefore making an poor comparison for patient’s actual WED. Large patient habitus alone accounts for very few exam alerts unless paired with a coned in FOV. For this reason, protocol specific exam alerts have been set for all spine images that excludes patient WED ranges as they become non-sensical in these types of exams.

Alert: Examination dose reference level exceeded for CTDIvol

Max value = 28.72 mGy  
Actual value = 30.14 mGy  
Applies to age 18.0-150.0 years

## Results

- Setting the limits per WED range allows for the capture of alerts for a variety of patient sizes. There are a few typical causes for alerts and through diligent review, each exam above the dose level can be accounted for. Through the discovery of new positioning issues, correlation to technologists that consistently have issues, or just new issues cropping up, root cause analysis allows us to detect, educate, and correct issues. WED based alerts do not work for spine imaging, or any imaging with a coned in FOV so separate, protocol specific alerts should be set for those.

## Conclusion

- Reviewing dose alerts takes skill and effort that sometimes requires investigating in the clinic and often results in new education for the technologist. Through sharing results, perhaps this will become a slightly less cumbersome process and with a shared library of alert causes for reference.
- Improvement on exam alert settings are possible with setting specific protocol and scanner alerts within Radimetrics®

## References

- The Joint Commission. Diagnostic Imaging Requirements. Issued August 10, 2015
- Kanal, K. M., Butler, P. F., Sengupta, D., Bhargavan-Chatfield, M., Coombs, L. P., & Morin, R. L. (2017). U.S. Diagnostic Reference Levels and Achievable Doses for 10 Adult CT Examinations. Radiology, 284(1), 120–133. <https://doi.org/10.1148/radiol.2017161911>

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