Adjustment of CT scan start location for CT organ dose calculations using a commercial dose monitoring software

A. Shankar*, I. Barreto, L. Rill

University of Florida, Gainesville, Florida

AAPM SPRING CLINICAL MEETING 2021 April 17–20 | VIRTUAL

Purpose

To investigate and demonstrate potential pitfalls in implementation of CT organ dose calculations in clinical settings.

Introduction

Our hospital system uses a commercial radiation dose monitoring software to collect clinical radiation dose data from all CT and fluoroscopically-guided interventional procedures. The software acquires and stores radiation dose data from DICOM-compliant radiation dose structured reports (RDSRs) and provides customizable dose reports, high-dose alerts, and many data analysis tools. The software also includes an NCICT Organ Dose calculator, which estimates organ dose and effective dose resulting from patient CT studies, given such details as patient size, CTDIvol and scan region, while matching patient height and weight to a digital phantom in the NCICT phantom library.

Figure 1. Calculated Effective Dose for a female patient (165 cm, 50 kg) and scan parameters.

The patient shown above had undergone an unenhanced C-Spine study. The spiral acquisition shown in the Fig. 1 is the helical scan acquisition and its associated effective dose.

NCICT Phantom	Adult Male (170cm 100kg)
NCICT Status	COMPLETE
Phantom	HEAD16
Pitch	0.64
Protocol	TRAUMA HEAD / C SPINE FF*
Revolution Time	1000 ms
Scan Length	291 mm
SSDE	30 mGy
SSDE Factor	HEAD16 Eff=26.66cm cf=0.66

Figure 2. Details including scan length and the digital phantom used for calculation is shown here.

The scan region and length are retrieved from the RDSR file. The assigned body part for organ dose calculation was procured from the acquisition target region in RDSR. The effective dose above in Fig. 1 was calculated assuming a scan length of 29.1 cm and scan region with C-Spine. This method of using body part from acquisition target region from RDSR had a pronounced effect on the organ dose calculations for protocols with multiple scans in different regions of body, as the assigned body part did not always indicate the correct scan region. For example, when "chest" was the indicated body part for a cardiac CT study the scan range was displaced approximately 10 cm superiorly and included different organs in the primary beam. This would result in incorrect effective doses in system.

Introduction (Cont.)

Materials and Methods

A simple change was made in the software to use the configurable body part associated with the Study Common Name. This change would also designate the scan start location and reflect in subsequent dose calculations. Organ doses were recalculated after this configuration change with large dose differences in some instances. An audit of the four most common studies was performed, accuracy of scan region was evaluated, and organ doses were recalculated.

Figure 3. The incorrect body part with Head selected for unenhanced C-Spine scan is shown. The scan range is 291 mm.

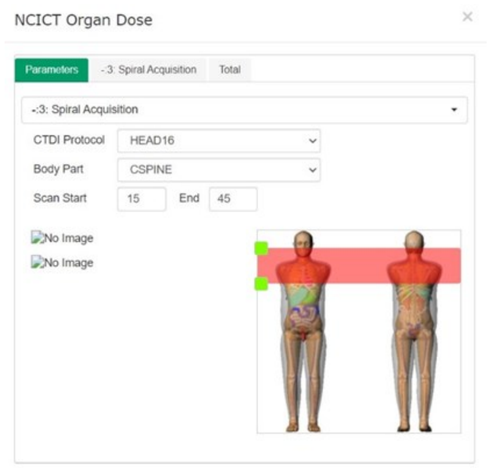

Figure 4. Correct descriptor of C-Spine for a C-Spine protocol based on common name. The scan range of 291 mm is taken from the RDSR.

Results

For each Study Common Name, acquisition target region varied drastically with scanner and workflow. Protocols that spanned multiple body parts had high variability in target regions, where scan regions were only correctly identified in 33% for Body/Trauma and 66% for Abdomen/Pelvis. The configurable body part improved consistency of organ dose calculations. All C-Spine protocols initially had acquisition target regions of neck or head. After adjustment of body part from head to c-spine, the effective dose increased from 3.8 mSv to 6.89 mSv.

Body Part	New Value (mGy)	Orig Value (mGy)
Brain	3.330423811176	32.042256753737995
Pituitary gland	2.722911336222	28.655216642051997
Lens	2.2917751718400003	43.740097025394014
Eye balls	2.449279901837999	41.25992378877601
Salivary glands	39.17034603312601	40.79093802814801
Oral cavity	39.282705062831994	40.130801570243996
Spinal cord	14.711806822020002	13.068643939890002
Thyroid	37.70923670052001	33.450923249898004
Esophagus	15.052617012510005	7.544875713929399
Trachea	22.766611966560003	13.615472365110001
Thymus	21.118615619640007	7.530173690886
Lungs	15.244234721562	2.8746572544689997
Breast	6.207516574644001	0.3170727000672
Heart wall	13.541761423344001	1.3424171296998
Stomach wall	1.4125825694442002	0.13806010800582
Liver	1.8532318514094004	0.18865995123360002
Gall bladder	0.9554649400758001	0.09672837577326002
Adrenals	1.3727205391746002	0.16087324066044004
Spleen	1.3360367559000002	0.16240950597102
Pancreas	0.6207665810346	0.06803038447128001
Kidney	0.5960256587208	0.07659368294886
Small intestine	0.15475198061862003	0.01978472826792
Colon	0.16018188140262002	0.0197505551628
Rectosigmoid	0.02666474411832	0.0062362411511400016
Urinary bladder	0.01715713191192	0.004624345053174001
Prostate	0.009117696079338	0.0028648895524326008
Testes	0.0060027117714564	0.0029049658864564805
Skin	5.359677712620001	4.19000496222
Muscle	0.6440399564214	0.19654509615510005
Blood vessel	5.271742351722	4.577612970546
Active marrow	5.9894035277999995	3.9882864178079993
Shallow marrow	6.322540722960001	7.272550676159999
Effective Dose (mSv)	6.892894908900001	3.7991729127659997

Conclusions

In our efforts to track patient doses accrued with multiple procedures in various x-ray imaging modalities, third party software can be helpful. Pitfalls in organ dose calculations can stem from improperly defining scan start location and range based on protocol nomenclature. Organ dose calculations and effective doses for CT can be improved and made accurate by properly defining scan region based on Study Common Name body part rather than acquisition target region.