

## **Quality Use of Diagnostic Imaging (QUDI) Program**

Project: QS10.i:

A Survey of Current Scanning Procedures and Resulting Radiation Doses  
Associated with Common Paediatric MDCT in Australia

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#### NOTE:

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# 1. Executive Summary

A multidisciplinary group of medical physicists, radiographers and radiologists were funded by RANZCR QUDI program to investigate the range of various dose metrics for a generic 5 year old paediatric patient undergoing some common MDCT investigations at specialist paediatric CT practices across Australia. Data was to be collected through a paper based survey.

The project was to be delivered in 5 stages;

1. Work plan and survey development
2. Practice contact and survey distribution
3. Survey data collation and analysis
4. MDCT Optimisation workshop
5. Re-survey data collation and analysis
6. Data presentations and publications

The objective of the project was to deliver a national dosimetry survey of expert paediatric MDCT sites to determine;

1. dosimetry for generic scans using the dose metrics of dose length product (DLP – mGy.cm) and effective dose (ED - mSv) per scanning protocol
2. the impact of optimisation training on the initial dosimetry as determined by a follow up survey
3. the applicability of this program to be expanded into a national MDCT dosimetry survey to develop diagnostic reference levels (DRL) for MDCT practice in Australia.

The outcomes of this survey of Australian MDCT paediatric practice indicates that:

1. optimisation training can positively influence paediatric CT patient dosimetry,
2. there are no universal 'right' or 'target' dose answers,
3. appropriate optimisation application depends upon the technical expertise of users and scientific support staff,
4. practices should work towards development of local DRL and optimized dose-image quality relationships,
5. this survey technique could be expanded into a National survey to establish baseline DRL values for many common MDCT acquisition protocols, and
6. using the 2<sup>nd</sup> set of survey data as an indicative measure of DLP performance, these Australian sites compare favourably to internationally accepted DLP DRL recommendations.

## **2. Work plan and survey development and distribution**

A cohort of 8 specialist paediatric radiology practices was chosen across all states of Australia. Survey forms and an explanatory letter and invitation to submit multidetector CT (MDCT) acquisition data for 13 common MDCT protocols for 5 year old paediatric patients was sent to each practice. The survey forms included a data sheet requiring acquisition protocol parameters (kVp, mAs, pitch, beam width, reconstructed slice thickness, etc) and a phantom graphic sheet requiring the marking of the inferior and superior acquisition margins for each acquisition stage. Survey forms were supplied for each of the 13 common MDCT acquisitions to be tested.

The common protocols chosen for the 5 year old paediatric dosimetry survey were (i) chest - lung disease, (ii) chest - tumour/oncology, (iii) chest – trauma, (iv) abdomen - tumour/oncology, (v) abdomen - liver lesion, (vi) cervical spine – trauma, (vii) thoracic spine – trauma, (viii) lumbar spine – trauma, (ix) spine – scoliosis, (x) head – trauma, (xi) head - space occupying lesion, (xii) head - face/orbits – cellulitis and (xiii) head - internal auditory meatus - hearing loss.

Each of the 13 acquisition protocols had a separate data survey sheet. The responder was requested to provide, for each acquisition series within each defined protocol above, the following information (i) mode – axial or helical, (ii) IV contrast used, (iii) tube potential (kVp), (iv) tube current (mA) and rotation time or in lieu of these the tube current time product (mAs) or, the ratio of mAs to pitch, sometimes referred to as the effective mAs, (v) fixed or modulated tube current control, (vi) isocentric X-ray beam collimation, (vii) table increment per rotation, (viii) pitch and (ix) reconstructed slice thickness. The survey data form was loosely based on a previously used National Radiological Protection Board (NRPB) document (1). Additional to the data form was another anthropomorphic CT phantom graphic where the responder was asked to mark the inferior and superior margins for each acquisition series (2).

An example of the data survey sheet and phantom graphic is attached in appendix A.

## **3. Survey data collation and analysis**

A decision was made to survey at least one specialist paediatric MDCT practice in each State of Australia. Initially eight sites were surveyed and six responded. A further site requested involvement upon hearing of the survey and they were also included in the original survey data set. This additional site is also classified as a specialist paediatric MDCT practice. All sites use MDCT platforms although not every acquisition protocol is helical. In some instances, while still using multiple detector rows, the step and shoot, axial acquisition was the preferred technique. The range of MDCT platforms were 2× Philips Brilliance 64, 1× GE LightSpeed Plus 4, 1× GE LightSpeed Pro 16, 1× Siemens Sensation 16, 1× Siemens Sensation 64 and 1× Toshiba Aquilion 64.

The completed data sheets were collated and entered into CT-Expo version 1.5.1, a CT dose calculation engine developed by Stamm & Nagel (3). The dose metrics of DLP (mGy.cm) and effective dose (mSv) were the primary comparative results generated and used in the subsequent analysis.

## **4. MDCT Optimisation workshop**

The survey outcomes were then presented to the respondents at a one day workshop. Each site received a copy of their practice data and a copy of the de-identified total data set for comparison. The workshop also addressed the practicalities of MDCT dose and image quality optimisation. Topics included (i) kVp selection, (ii) use of X-ray tube current modulation technology (iii) beam collimation, (iv) over beaming and over ranging, (v) use of additional filtration, (vi) weight/size based technique charts. The participants were encouraged to question and or modify the manufacturer's default protocol parameters and were given an introduction to diagnostic reference level (DRL) theory and practice and

how these might be used as an indicative measure of dose and image quality efficiency across multiple practices.

Presentations can be reviewed at

<http://www.ranzcr.edu.au/qualityprograms/qudi/projects/documents/CT%20Dosimetry%20Overview.pdf>  
and <http://www.ranzcr.edu.au/qualityprograms/qudi/projects/documents/CT%20Optimization.pdf>.

## **5. Re-survey data collation and analysis**

Approximately six months following the workshop a second survey, requesting the same acquisition parameter information for each of the 13 protocols, was sent to each of the participant practices and an identical data analysis was undertaken. This was used to assess application, compliance and dose impact of the optimisation suggestions they had received at the workshop at the individual practice level.

## **6. Results, Data presentations and publications**

The final results were presented at RANZCR ASM 2007 and can be reviewed at <http://www.ranzcr.edu.au/qualityprograms/qudi/projects/documents/Paediatric%20CT%20Dose%20RANZCR%20ASM%202007.pdf>.

Further presentations have been given at

1. RANZCR QUDI Research Seminar, Melbourne 2007
2. Engineering & Physical Sciences in Medicine, Fremantle 2007
3. Australasian College of Physical Scientists & Engineers in Medicine, NZ branch meeting 2007
4. International Radiation Protection Association, Buenos Aires 2008

Manuscripts have been prepared and will be published in

1. International Radiation Protection Association, Buenos Aires 2008 conference proceedings
2. a refereed Radiology journal (AJR, Radiology, BJR).

## **7. Conclusion**

Initial survey data indicated a significant variation in acquisition protocols for diverse MDCT investigations across a range of system platforms and paediatric specialist practice sites. This project demonstrates that undertaking dose surveys, accompanied by appropriate optimisation education can have a significant positive impact on paediatric MDCT dosimetry for common scanning protocols. The implementation of a dose optimisation information program would also be of benefit as an information source for all CT practices in Australia. This survey technique could be expanded into a National survey to establish baseline DRL values for many common MDCT acquisition protocols.

## **8. Bibliography**

1. NRPB. NRPB-W67 : Doses from Computed Tomography (CT) Examinations in the UK - 2003 Review. In. Chilton: NRPB, 2005.
2. Nagel HN. Radiation Exposure in Computed Tomography. Frankfurt: COCIR - European Coordination Committee of the Radiological and Electromedical Industries, 2000.
3. Stamm G, Nagel HN. CT-Expo. In. 1.5.1 ed. Hannover, 2006.

# 9. Appendix A.

## DATA COLLECTION SHEET

Examination: Abdomen

Indication: Liver Lesion

Hospital/Institution:.....

Scanner Manufacturer:..... Model:.....

Person Completing Form:..... Contact Number:.....

	Series 1	Series 2	Series 3	Series 4
<b>Acquisition Mode</b> (Please Tick)	<input type="checkbox"/> Axial <input type="checkbox"/>	<input type="checkbox"/> Axial <input type="checkbox"/>	<input type="checkbox"/> Axial <input type="checkbox"/>	<input type="checkbox"/> Axial <input type="checkbox"/>
<b>IV Contrast used?</b> (Please tick)	<input type="checkbox"/> Y <input type="checkbox"/>	<input type="checkbox"/> Y <input type="checkbox"/>	<input type="checkbox"/> Y <input type="checkbox"/>	<input type="checkbox"/> Y <input type="checkbox"/>
<b>Tube voltage (kVp)</b>				
<b>Tube current (mA)</b> <b>Tube rotation time (s)/</b> <b>Displayed mAs</b>				
<b>Exposure Setting</b> (Please Tick)	<input type="checkbox"/> AEC <input type="checkbox"/>	<input type="checkbox"/> AEC <input type="checkbox"/>	<input type="checkbox"/> AEC <input type="checkbox"/>	<input type="checkbox"/> AEC <input type="checkbox"/>
<b>Beam collimation (mm)</b>				
<b>Table increment (mm)</b>				
<b>Pitch</b>				
<b>Recon. Slice thickness (mm)</b>	1..... 4..... 2..... 5..... 3..... 6.....			

**Additional Comments:**.....

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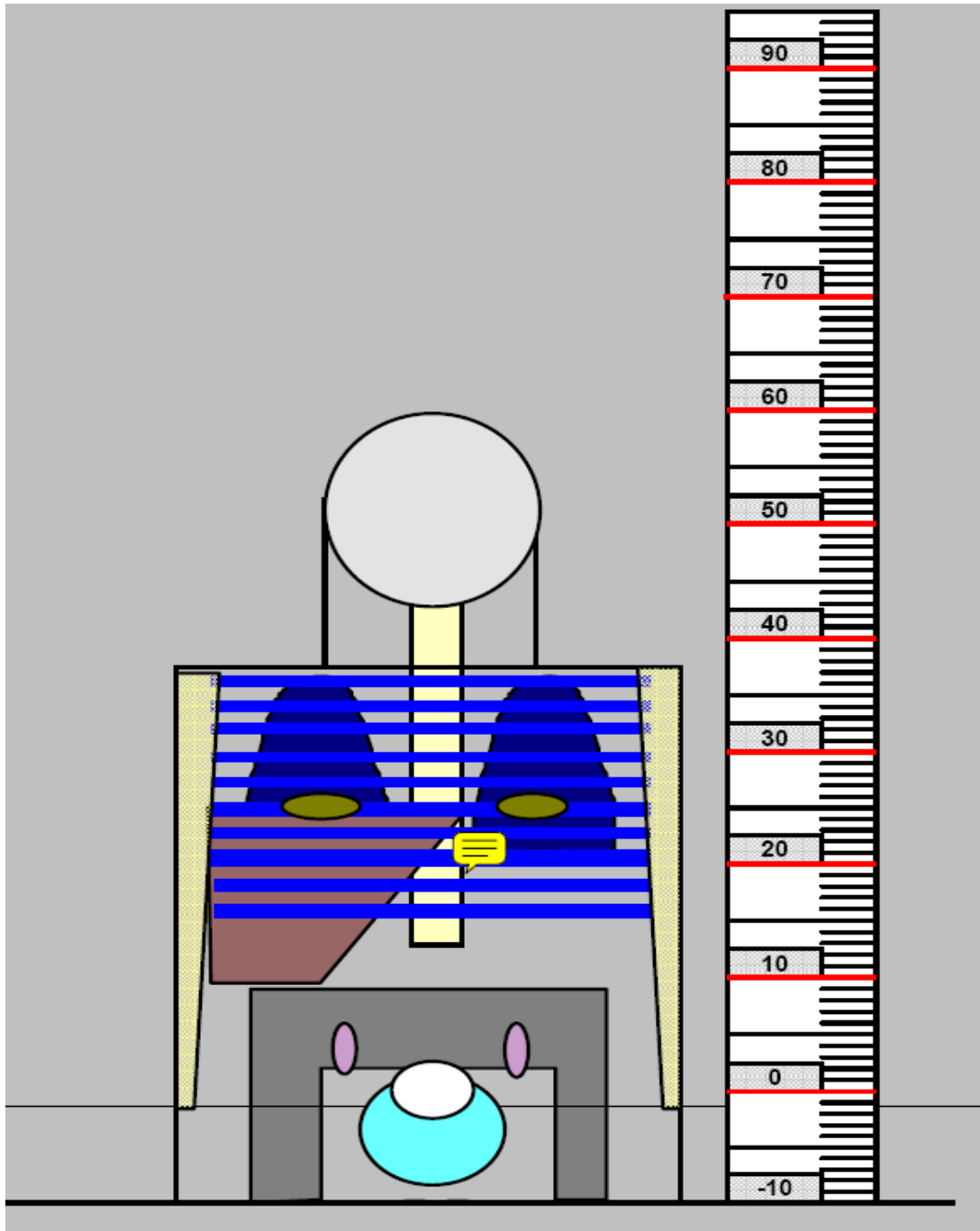
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# Anatomical Range Diagram

Please indicate the scan range for each sequence.



Explanation of the region scanned:

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