CMBES/SCGB

2016 CMBEC39 Conference
Calgary AB
May 24–27, 2016

AIM CT ACCREDITATION PROGRAM DEVELOPMENT FOR CT X-RAY SYSTEMS

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ADVANCEMENTS IN IMAGING (AIM) CT ACCREDITATION PROGRAM DEVELOPMENT

Abstract

The University Health Network (UHN) maintains 22 CT X-ray systems at five hospital locations. The problem that was addressed was how to develop and implement a CT Accreditation Program at the University Health Network.

This program was developed to satisfy the needs for a standardized annual testing of CT dose and image quality parameters [1]. Appropriate image quality test phantoms were selected and evaluated [3]. This topic deals with the problem of how to develop and implement a CT Accreditation Program for the CT systems at the University Health Network. The project will deal with the selection of image quality and dose phantoms, establishing baseline data derived from the phantoms and storing the data for future reference. Another challenge of the project was to develop a quality assurance program that will satisfy the corporate vision of the University Health Network. This vision is concerned with achieving global impact. The work done in this report will be relevant to Canadian standards and incorporate global standards as well.

A comprehensive CT Accreditation Program was then developed and implemented. The program was used to report on CT image quality and dose parameters. It is recommended that the AIM CT Accreditation Program be used at other hospitals to provide comprehensive image quality evaluation, dose monitoring and structured CT reporting.

Introduction

A comprehensive Accreditation program on computed tomography (CT) systems [1] should include:

- Daily testing of Hounsfield units
- Regular Air and Water Calibration of the CT systems
- Annual Image Quality Measurement

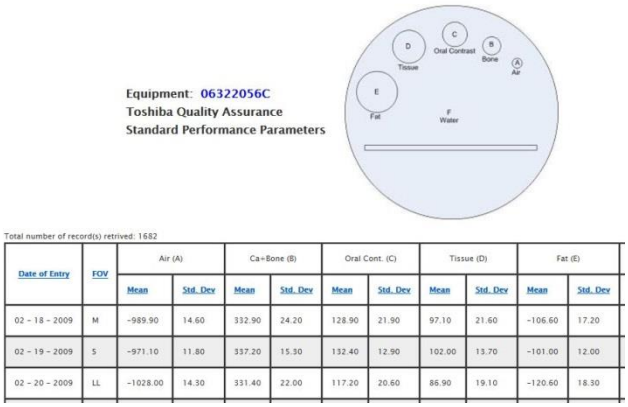
The University Health Network has developed a program, which we call "AIM" to perform and track all components of a CT QA program.

Methods

Development of the AIM interface

We worked with our hospital's technology department to setup a dedicated server which manages a daily CT QA SQL database. Portals on this interface connect to clinical and engineering Sharepoint sites. It also features educational presentations, an electronic CT Service logbook and AIM Accreditation Program (AAP) document storage and review.

Daily CT Density QA Database



Date of Entry	FOV	Air (A)		Ca+Bone (B)		Oral Cont. (C)		Tissue (D)		Fat (E)	
		Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
02 - 18 - 2009	M	-989.90	14.60	332.90	24.20	128.90	21.90	97.10	21.60	-106.60	17.20
02 - 19 - 2009	S	-971.10	11.80	337.20	15.30	132.40	12.90	102.00	13.70	-101.00	12.00
02 - 20 - 2009	LL	-1028.00	14.30	331.40	22.00	117.20	20.60	86.90	19.10	-120.60	18.30

Figure 1: Screenshot of QA database

A Toshiba TOS phantom [3] is used each morning to measure the Hounsfield unit and Standard Deviation values of six areas of interest. This data is then entered using the AIM application and stored on the AIM server database [1]. Please see "Figure 1: Screenshot of QA Database" for an example of this.

Annual Image Quality Measurements

Image Quality Phantom

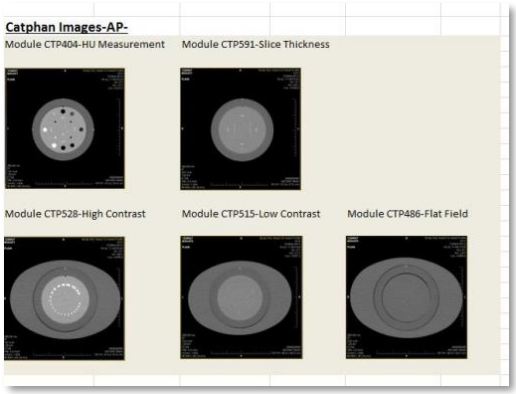


Figure 2: Catphan 600 Phantom images

We chose the Catphan 600 phantom [3] as our image quality reference because it is a current industry standard for measuring all the necessary imaging parameters. The high contrast module (21 line pairs) and the low contrast module (sub-slice and supra-slice objects) offer a wide range of testing for APP index calculations. It has features to measure the following parameters for image quality analysis; Hounsfield units (densities), slice thickness, high contract, and low contrast. Head and Body Annulus (CTP299/579) can be added to the phantom to simulate the attenuation of a 20 cm Head and 35 cm Body. Figure 2 gives examples of the images created by the Catphan 600.

Image Quality Reports

Reports have been developed for image quality and dose results that can easily be interpreted. Satisfactory results are highlighted in "green" and poor results in "red". Figure 3 is a sample of the AAP Image Quality report and. The imaging ranges are setup using acceptable levels of deviation as required for optimal image quality.

Figure 3: AAP Image Quality details

AAP Index

The AAP Index (1) was developed to provide an overall summary of the Image Quality measurements. The goal of the index was to evaluate and more accurately compare image quality on different CT systems by providing a complete single source evaluation that is clinically relevant. This relevance makes the AAP index unique to other forms of contrast evaluation.

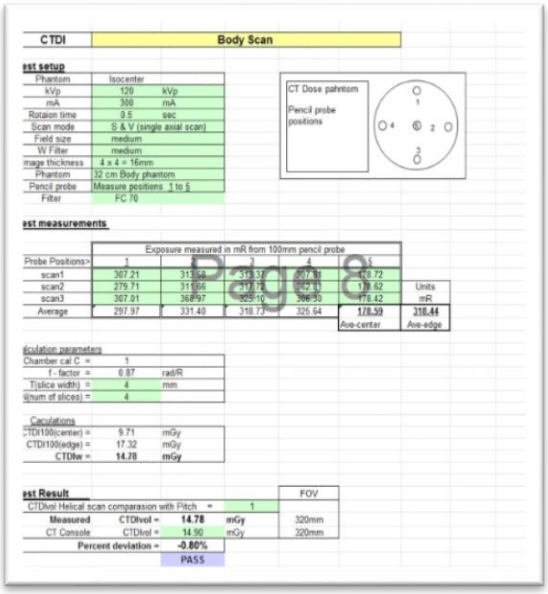
$$AAP\ Index = \left(\frac{Body\ IQ + Head\ IQ)}{(total\ IQ\ range)}\right) DRL \quad (1)$$

The AAP index is calculated using high and low contrast results from the Head and Body image quality measurements. This value is then rated using UHN Diagnostic Reference Levels (DRLs) with CTDI (vol) recorded values.

Annual Dose Measurement

CT dose index (CTDI) is a standardized measurement of radiation dose output of a CT scanner which allows the user to compare radiation output of different CT scanners. AAPM Summit reporting on CT dose indicates the use of standardized dose phantoms to measure average head and body dose values [4].

CTDI dose values are measured using routine Head and Body Clinical CT protocols with the CTP 553/554 16cm Head dose phantom and 32cm Body dose phantom. A RADCAL 9096 dose meter with a CT pencil probe is used to measure average dose values in the Head and Body phantoms. CTDI dose values are calculated and compared to console values. Figure 4 is a sample of the AAP Dose Report.



CTDI	Body Scan
est setup	
Phantom	Isocenter
kVp	120 kVp
mA	300 mA
Rotation time	0.5 sec
Scan mode	S & V (single axial scan)
Field size	medium
W Filter	medium
Image thickness	4 x 4 = 16mm
Phantom	32 cm Body phantom
Pencil probe	Measure positions 1 to 5
Filter	FC 70

CT Dose pahntom
Pencil probe positions

est measurements

Exposure measured in mR from 100mm pencil probe						
Probe Positions>	1	2	3	4	5	
scan1	307.21	311.58	319.37	307.91	475.72	
scan2	279.71	311.64	317.78	352.10	179.62	Units
scan3	307.91	368.97	305.10	316.90	478.42	mR
Average	297.97	331.40	318.77	325.64	178.59	318.44
					Ave-center	Ave-edge

iculation parameters		
Chamber cal C =	1	
f - factor =	0.87	rad/R
T(slice width) =	4	mm
N(num of slices) =	4	

Caculations		
CTDI100(center) =	9.71	mGy
CTDI100(edge) =	17.32	mGy
CTDIw =	14.78	mGy

est Result

CTDIvol Helical scan comparasion with Pitch =		1		FOV
Measured	CTDIvol =	14.78	mGy	320mm
CT Console	CTDIvol =	14.90	mGy	320mm
Percent deviation =		-0.80%		
		PASS		

Figure 4: AAP dose report

Clinical Evaluation

The Radiation Protection Office (RPO) provides an audit of our QA process and AAP reports. RPO review is necessary to maintain a complete CT Accreditation Program. The RPO can also conduct a clinical image review of standard protocols and Diagnostic Reference Levels.

Conclusion

The AIM CT Accreditation program has been operating for 8 years. We are continually improving it with clinical involvement and engineering enhancements. The clinical feedback has been very positive and the program is now considered a necessary tool to provide enhanced patient care.

AAP Future Development

AAP development includes setting new standards in AAP reporting, Clinical protocols and CT Diagnostic Reference Levels. The goal is to establish a network of partnership hospitals across Canada to share CT image quality and dose working based on a common standard. We have begun work with an image quality program software development team at UHN ("AQUA" of Acumyn) at UHN to further enhance database and dose measuring capabilities. This will enable our team to track image quality trends more closely and assist with scheduling annual testing.

Hospitals can work together to form a stronger knowledge base and share new ideas.

REFERENCES

[1] American College of Radiology, *CT Accreditation Program Requirements, pp. 1-16, Revised 10-4-11*

[2] Toshiba Medical Systems Corporation, *Installation Manual 2C201-175EN, vol. TSX-101A*, pp. 208-209, 2005.

[3] The Phantom Laboratory, *Catphan 500 and 600 Manual*, pp. 3-36, 2013.

[4] Michael McNitt-Gray, PhD, David Geffen School of Medicine at UCLA, pp. 2-55, AAPM 2011 Summit on CT Dose.