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Radiation Dose Optimization Approach at Dubai Health Authority Hospitals:

The Control of Patient CT Radiation Exposures during 2008-2010

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Overview

- **Introduction:** Why do we need to carry out projects to evaluate patient radiation doses?

- **Details on the Dubai Health Authority (DHA) Patient CT Dose Studies :** Dose Measurement using Phantoms AND Patient Dose Recording and Analysis over 3 years (2008-2010).

- **The Conclusions** on Dubai Hospital CT dose results.

Introduction

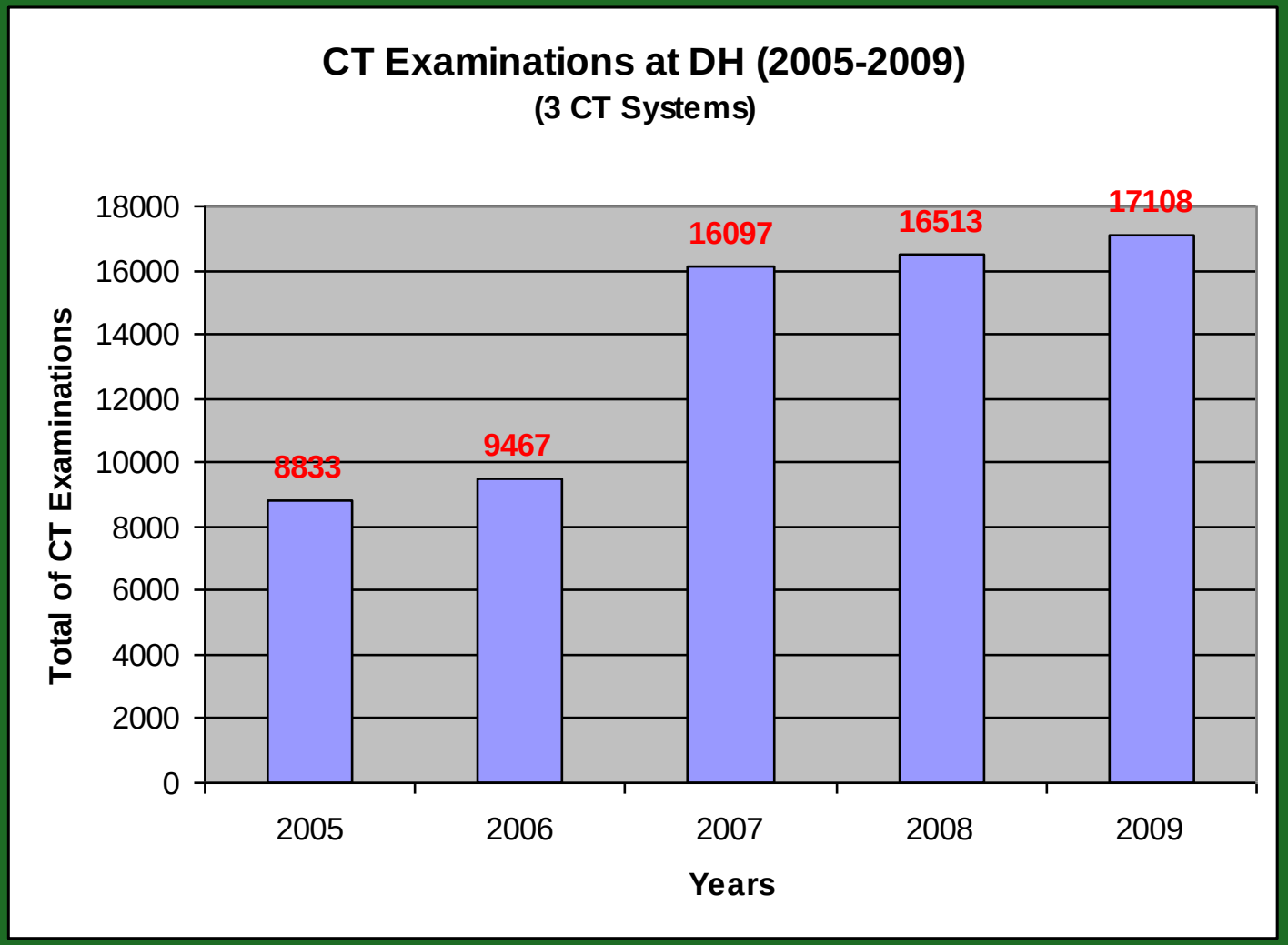
- This study is part of the IAEA Regional Project (RAS-9047/9055).

- Patient Radiation Dose Evaluation & Recording and the Establishment of DRLs (Diagnostic Reference Levels) are required by the UAE national law.

- The Radiation Exposure in the Medical Applications is increasing worldwide and the biological effects of these applications are evident.

CT Examinations at Dubai Health Authority (DHA)

CT examinations at the DHA were doubled in 5 years.



Introduction

- **Radiation Hazard & Overexposure incidents are reported internationally**

A Radiology CT Case

- **Estimates of potential cancer risk from diagnostic x-ray exposure have ranged from 0.6% to more than 3% in various developed countries where diagnostic CT scans are common.**

Study author Dr. Michael Kuefner, from the University of Erlangen-Nürnberg, and co-authors from the University of Colorado, Duke Medical Center, and the University of North Carolina.

- **More than 400 cases of CT scans in 8 hospitals were reported as overexposure (IAEA website: http://rpop.iaea.org/RPOP/RPoP/Content/News/new-era-ct-scanning.htm (Aug 2010)**

- **Over 68 minutes, the child (2 years) was exposed to 151 scans (happened in 2008).**
Within a few hours, the child developed a bright red ring around his head from the *massive radiation overdose.*

By Donna Domino
AuntMinnie.com contributing writer, ,May 24, 2010

Material and Method

(DHA QC, Dose Measurements & I.Q.)

- Through the DHA Quality Control program, we annually evaluated the radiation doses generated from the 4MDCT Ge Light-Speed unit at Dubai Hospital.

- Dose measurements in terms of weighted CT Dose Index CTDIw (mGy) were frequently monitored using Head (16 cm diameter) and Body (32 cm diameter) ACR Accredited Cylindrical PMMA CT phantoms and a 10 cm pencil ion chamber connected to Nero mAx 8000 meter.

- The Dubai Hospital radiologists took part in reviewing the images during the dose optimization procedures to make sure that image quality level was well maintained.

Material and Method

(Patient CT Dose Data Collection: Manual & PACS)

- Patient radiation doses in terms of Dose Length Product (DLP, mGy.cm) and volume CT Dose Index (CTDIvol, mGy) along with patient and imaging parameters (Age, weight, kVp, mA, pitch, slice width, No. of slices, IQ, … ect) were manually collected and recorded during 2008 for the common CT examinations: Head, Chest and Abdomen and Pelvis scans.

- In 2009-2010, these CT dose data were recorded within the Radiology Information System (RIS) and the Picture Archive and Communication System (PACS) at Dubai Hospital. Through the PACS tracking system, it is mandatory for the CT operator to manually fill CT patient doses in the RIS in order to finish the patient tracking.

- All patients' dosimetry data were collected from the RIS and viewed as PACS Dose Report by Cogonos statistical software. The PACS Dose Reports were presented in PDF and Excel sheet formats.

PACS Report on Patient Doses At Dubai Hospital

This Report indicates Radiation Dose delivered to patient in CT From: 1/1/2009 to: 12/31/2009 Count of patients 2178

seq	Date-time request	Exam Type	Output (mAs)	(DLP)	SEC	Voltage (kVp)	CTDIvol (mGy)	Age
			Total (DLP)					
1064	6/11/2009 11:21AM	CHEST	180	384.69	12.6	120	16.24	57
	6/11/2009 11:21AM	ABDOMEN AND PELVIS	180	733.77		120	16.24	57
	10/26/2009 12:15PM	CHEST	160	370.99		120	15.33	57
	10/26/2009 12:15PM	ABDOMEN AND PELVIS	150	731.34		120	15.33	57
			Total (DLP)	2220.79				
1072	3/26/2009 10:01AM	ABDOMEN AND PELVIS	200	778.11	27.8	120	19.94	55
			Total (DLP)	778.11				
1074	3/10/2009 01:21PM	HEAD	180	811.14	24	120	62.67	64
	3/23/2009 02:02PM	HEAD	141	630.89		120	63.71	64
			Total (DLP)	1442.03				
1078	2/19/2009 07:53AM	CHEST	180	433.31	17.1	120	18.03	70
	2/19/2009 08:17AM	NECK	200	393.63		120	20.04	70
	2/19/2009 07:54AM	ABDOMEN AND PELVIS	180	685.75		120	18.03	70
			Total (DLP)	1512.69				
1084	7/22/2009 08:30AM	HEAD	180	390.55	22	120	27.86	76
			Total (DLP)	390.55				
1086	11/15/2009 10:06AM	ABDOMEN AND PELVIS	150	762.98	30.2	120	17.94	59

Material and Method

(Number of patients: Adult & Paediatric)

- The total number of adult patients undergone common CT examinations in his study was 6528 (558, 2617 and 3353 in 2008, 2009 and 2010, respectively)

- Pediatric group was 404 (55, 184 and 165 in 2008, 2009 & 2010, respectively).

- The pediatric age was considered 15 years and below and were grouped based on the age as: 0- <1 year, 1-<5 years, 5-<10 years and 10-<=15 years.

- The dose results (DLP, CTDIvol and ED) in this study were analyzed as average and 3rd quartile for adult and pediatric patient groups and were compared to the initial Dose Reference Levels (DRLs) selected for the DHA hospitals.

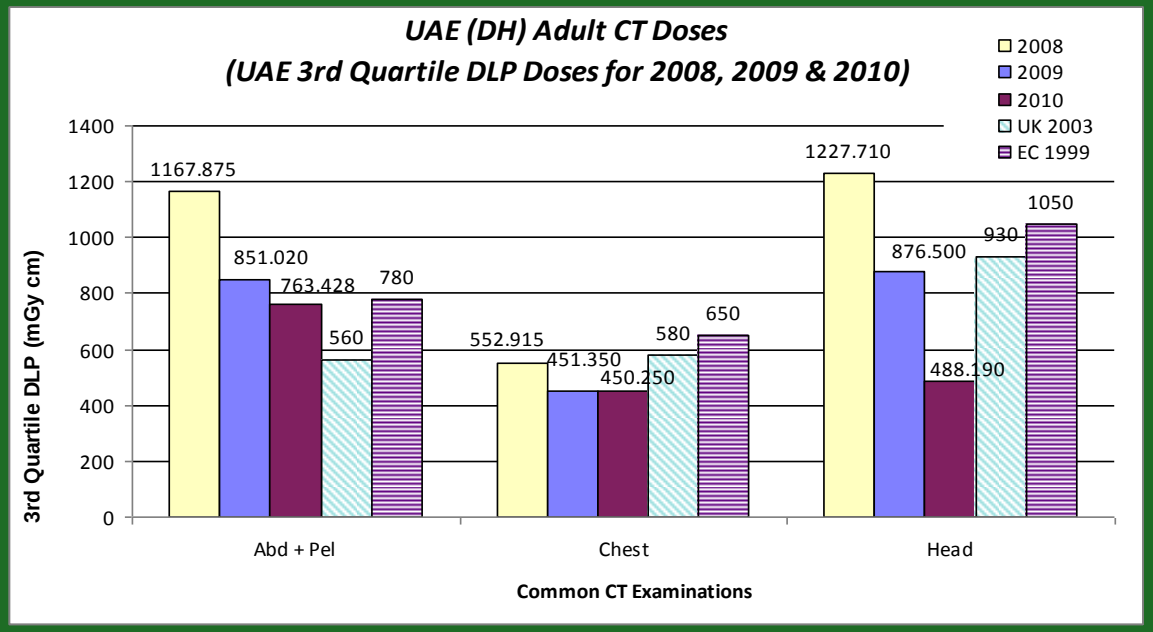
Material and Method

(The DHA Adopted DRLs for Adult & Paediatric CT Exams)

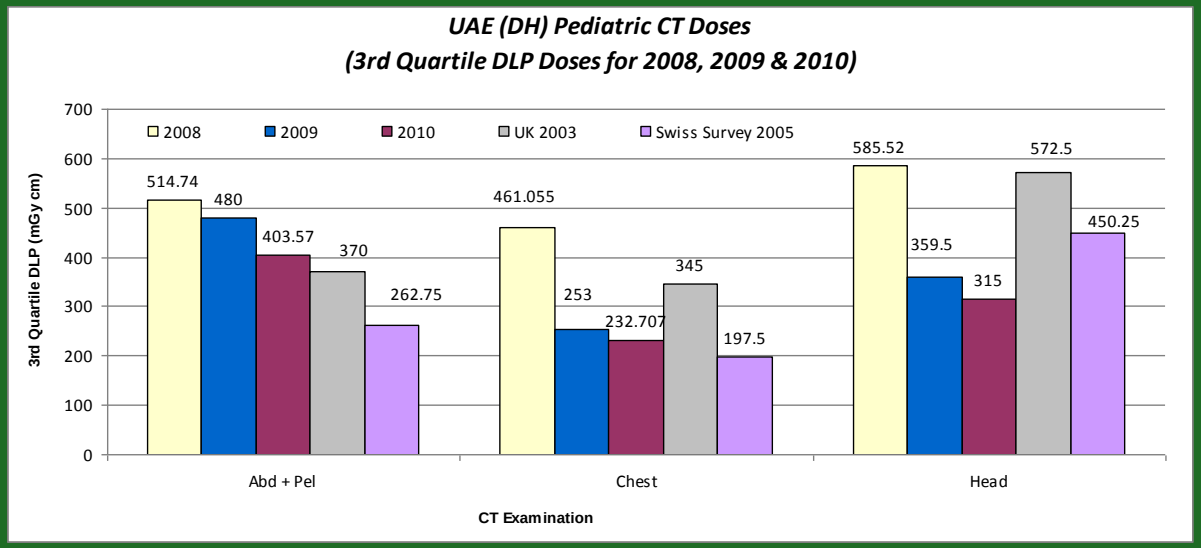
The DLP for both adult and pediatric patients adopted at DHA are shown in the below table:

CT Examination	DHA Adopted DLP (mGy.cm)	
	ADULT PATIENT	PEDIATRIC
Brain	1000	500
Chest	500	300
Abdomen & Pelvis	1000	500

The DH CT Dose Results

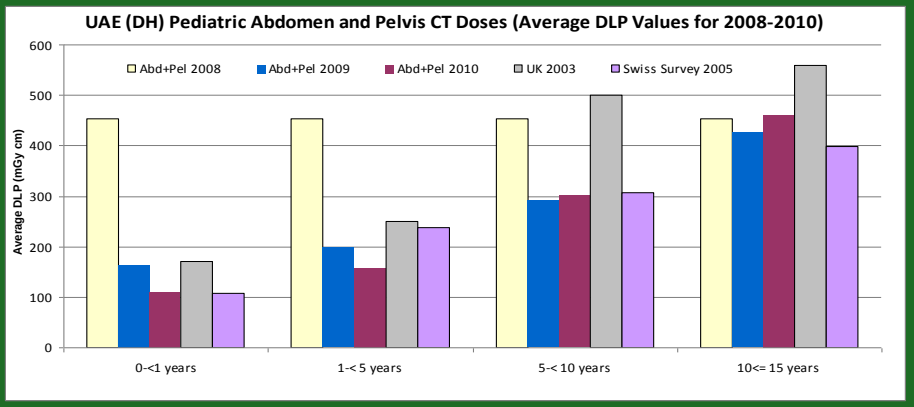


Third quartile values of Dose Length Product (DLP) for adult patient group

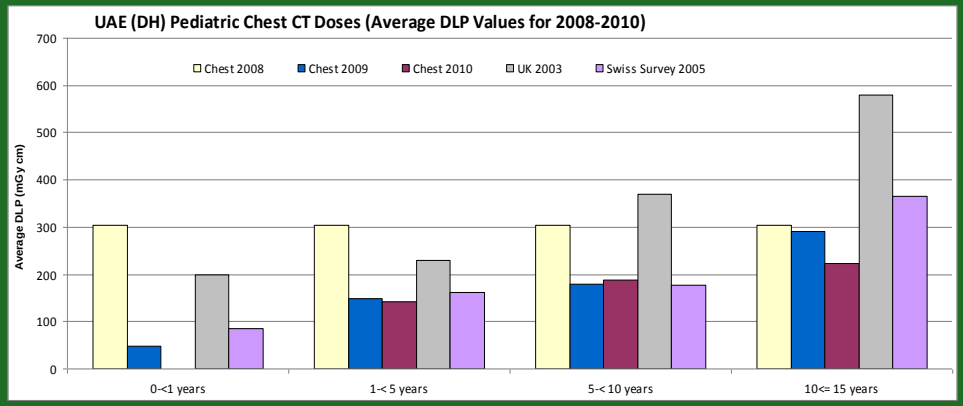


Third Quartile values of Dose Length Product for Paediatric Patients (All age groups)

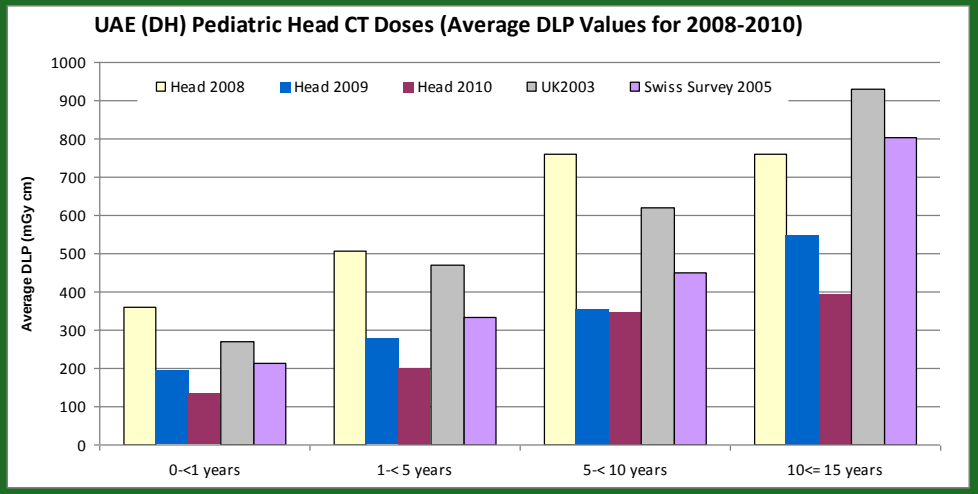
The DH CT Dose Results



Paediatric Abdomen and Pelvis CT Doses (DLP)



Paediatric Chest CT Doses (DLP)



Paediatric Head CT Doses (DLP)

Example of Dose Optimization In the Computed Tomography (CT)

CT Dose Optimization Techniques, at Dubai Hospital for Brain Scan Data

	kV	mA	GRT (S)	P	h (mm)	Ns	C (Collim)	A/ H	DLP (mGy cm)	CTDIv (mGy)	Total Time (S)	Date
CT Brain 2008	120	180	2	Axial	5	28	10	A	946.33	64.47	17	1/13/08
	120	200	2	Axial	5	28	20	A	1051.48	72.71	28	4/9/08
	120	220	2	Axial	5	28	10	A	1227.71	86.74	28	6/10/08
CT Brain 2010	120	AUTO	2 sec	Axial	5	26	10	A	498.19	37.24	26	5/4/10
	120	AUTO	2 sec	Axial	5	26	10	A	525.74	36.8	26	8/7/10
	120	AUTO	2 sec	Axial	10	26	20	A	488.19	34.82	26	22/7/10

H = Slice Thickness, Ns = Number of Slices or images

Conclusions

- The positive outcome of this patient radiation exposure study is manifested in the significant CT dose reduction for adult and paediatric patient groups with no noticeable drop in image quality.

- In compare to the initial DHA local DRLs, adult doses were reduced by about 52%, 17.5% and 31% for head, chest and abdomen and pelvis examinations, respectively.

- For the pediatric group, the doses were reduced by about 46%, 38.6% and 48.6% for head, chest and abdomen and pelvis examinations, respectively.

Conclusions

- CT effective doses were calculated for adult and paediatric groups and compared to the data published by the ICRP (Report 102, 2007). The Dubai Hospital results found to be comparable to the data published by the ICRP.

- The RIS/PACS approach to record patient doses is effective and provides advantage of obtaining evidence on patient individual cumulative doses and population exposures. Furthermore, PACS dose reporting may be utilized as a tool to facilitate dosimetry data for clinical auditing.

- Future plan to carry out same study on our new CT machine at Dubai Hospital and to set the pediatric DRLs according to age groups.

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