The DICOM Index Tracker®-
An Automated Database of Patient Image Informatics

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ABSTRACT
An information system, “DICOM Index Tracker®” (DIT) is developed to transparently captures desired DICOM (Digital Imaging and Communications in Medicine) tags from x-ray CT, nuclear imaging equipments and other DICOM devices across an enterprise. Its uses include recording, monitoring and providing automatic alerts to medical professionals of excursions beyond internally determined trigger action levels of radiation, and to system administrators of unknown equipment. It incorporates a knowledge base to handle the varieties in data provision and a Dosimetry module to enable automatic calculation and retrieval of radiation dose information, including mammography breast organ dose, peak skin dose values from XA modalities, S# etc. upon receipt. The AAPM (American Association of Physicists in Medicine) recommended effective dose calculations are performed with CT units having DICOM Dose Structured Report (SR). Web interface reporting (customized by user needs) is provided for accessing the database in real time. Differences or summary findings of patient dose by age or gender and/or by equipment type or location, manufacturer, software version are easily accessible.

INTRODUCTION
Quality Assurance (QA) monitoring of ionizing radiation, with certain diagnostic uses, is required by state regulatory bodies and by The Joint Commission in the U.S. [1]. Of the eight U.S. National Quality Measures Clearinghouse [2] (federal) metrics specific to Radiology, two deal with radiation exposure: reducing CT dose and documentation of x-ray fluoroscopy duration. Recently public discussion in the U.S national news has expressed concerns regarding the use of CT [3]. These concerns drive medical facilities to provide enhanced monitoring of radiation use [4].

At this time, records of radiation use are commonly hand recorded into paper logbooks typically at the operator’s scanner console or are manually retrieved from Picture Archiving and Communication Systems (PACS). Neither way is economic. A standardized toolkit is needed to automatically capture dose records in real time. One precursor of such standardization is the integration of Structured Reporting (DICOM WG-06[B]) standards to exchange structured data during image acquisition or post examination.

In this research, DICOM Index Tracker® (DIT) is designed to serve as a patient centric, integrated DICOM information repository (including radiation dose index history) combined with continual monitoring and reporting tools. It is featured by:
- DICOM-based system to handle exams from different specialties, different vendors, different sites
- Modality and vendor specific analysis
- Ad hoc searchable information
- Real-time monitoring, alerting and reporting
- Applications include CT mSv Report, MR Efficiency Study, Peak Skin Dose, CT Perfusion Alert

METHOD

The system architecture of DIT, including the composite modules and the connection with other software, is shown as in the left figure.
- DICOM Receiver & Parser - receives images from DICOM complaint devices/systems, then extracts and stores the tag information.
- DIT Database - stores all exam harvested tags while avoiding redundancy, keeping balance storage efficiency and improving data access efficiency.
- Knowledge Base - describes known scanners with their hardware and software specifications as well as the standard and proprietary dose related data that are present with this equipment.
- Dosimetry Analyzer - computes radiation dose estimate for a single (and each) episode of care for each ionizing radiation modality, i.e. CT, CR, XA, PET, DX, etc.
- Alert Mechanism - monitors database in real time and sends out instant messages alerts via internal email, designated cell phone text messaging and internal pager text messages.
- Web Reporter - provides dynamic on-line reports and ad hoc search of dose information.

RESULTS AND CONCLUSIONS
The development of DIT has continued since January 2009. DIT (v1.0) was introduced into clinical use in September, 2009. The initial test database contained approximately 650 exams (~70 thousand image header) purposely chosen from different vendors and modalities to expand the Knowledge Base. Approximately 25 different devices at MCA are represented with additional devices being added from Mayo Clinic Florida (MCF) and Mayo Clinic Rochester (MCR). These include CT, Interventional Radiology, Computed Radiography, Digital Radiography, MRI, Cardiac Catheterization, Nuclear, PET, and Mammography.

Ongoing testing and reviewing enables the system to improve and be accepted for use in clinical service at MCA.

Two examples of applications are shown on the left – “General Search” Website for ad hoc information search, and “CT Effective Dose Report”.

In summary, this work provides an enterprise system solution for automated dose calculation in a multi-location, multi-modality and multi-device environment and forms a basis for evidence-based quality assurance and intelligent analysis regarding radiation dose estimates. Future advances with dosimetry analysis are predicated on greater availability of the DICOM Dose SR.

References:
5. DICOM Structured Report WG-08 and WG-15 Supplement 94, WG-21 CT Dose SR

ACCOMPLISHMENTS

- Presentation:
- Paper:

Figure: Ad Hoc Search –Filtering Fields

Figure: CT Effective Dose (mSv) Report
- Head vs Neck, on April 2010

Figure: CT Effective Dose (mSv) Report
- Head vs Neck, on April 2010

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