The ACR Computed Tomography Dose Index Registry: The 5 Million Examination Update

Mythreyi Bhargavan-Chatfield, PhD, Richard L. Morin, PhD

The ACR opened the Computed Tomography Dose Index Registry® (DIR) for general participation by all facilities in May 2011. Just over 2 years after its launch, the registry has more than 750 registered facilities, 465 of which were actively contributing data at the end of August 2013. The registry has dose index information on 5.5 million CT examinations, which in turn include 9.4 million irradiation events. Participating facilities receive semiannual reports that provide comparisons of dose indices for each procedure relative to all other facilities in the registry and to facilities similar by type and location. The purpose of the registry is to provide facilities a tool to allow them to compare their dose indices with those at peer facilities and make improvements where appropriate.

Data on dose indices for all CT examinations are collected and transmitted automatically from each facility to the DIR, after anonymization of data at the site. For each examination, dose indices are compared using volume CT dose index (CTDVol), dose-length product, and, for body examinations, size-specific dose estimate (SSDE). Fair and meaningful comparison required us to standardize data collection and estimation terminology [6]. SSDE calculation procedure names to RadLex standardization [7]. Participating facilities map their procedure nomenclature, and updated monthly [4].

Current State of the Registry

Of the 465 facilities actively contributing data to the DIR, 432 facilities received comparison reports on 1.5 million adult and almost 80,000 pediatric examinations performed from January through June 2013. The registry represents a broad range of CT practice in the United States (Figs. 1 and 2), including large multisite entities that submit and analyze data together and small hospitals and imaging centers with just one scanner. The large number of participating community hospitals and freestanding sites illustrates the ease of DIR implementation. Participation is voluntary, with a nominal annual fee. Facilities that agree to be publically listed are posted on the DIR website and updated monthly [4].

Data Collection and Transmission

Participating facilities register using an online form and sign a participation agreement. They then download TRIAD™, C-Store listener software that runs as a service in the background on any desktop or server at the facility, to transmit data to the DIR. The DIR accepts DICOM radiation dose structured reports (RDSRs) from scanners capable of producing them and dose screen secondary capture images from legacy scanners that do not produce RDSRs [5]. Facilities configure their scanners or PACS or third-party dose monitoring software to automatically send data to the TRIAD installation. TRIAD performs a number of functions: (1) it recognizes dose screens sent from scanners that do not produce RDSRs, processes them using optical character recognition, and converts them to RDSR format; (2) it anonymizes the data; (3) it discards data not required by the DIR but sent to TRIAD; and (4) it securely transfers the required information to the DIR. TRIAD can receive and process data from all major, and some of the smaller, scanner manufacturers. A list of scanners currently successfully transmitting data to the DIR is posted on the DIR website and updated monthly [4].

In addition to dose indices, facilities send localizer images to enable the calculation of patient width and SSDE. Once data have been transmitted for some interval of time, facilities map their procedure names to RadLex standard terminology [6]. SSDE calculation and procedure name mapping are described in greater detail below.

Reports

Participants access their semiannual reports via the DIR web portal. The separate adult and pediatric examination reports contain comparison tables and charts for the high-volume examinations (≥10,000 observations for each adult examination and ≥2,000 observations for each pediatric examination). Detailed spreadsheets supplement each report and contain data for examinations with at least 100 observations submitted by at least 10 facilities. The pediatric reports present data comparisons in 5 age-group subsets because of the size variability in this population.

Reports compare dose indices (CTDVol, dose-length product,
and SSDE) per scan across facilities, where the dose index per scan is calculated as the highest dose index for any irradiation event for the examination. For multiphase examinations for which different facilities may use different numbers of phases according to patient indication, the scan-level dose index allows a facility to focus on the technique and still be able to examine potential for improvement. Spreadsheet reports contain data on total dose index per examination as well as per scan.

STANDARDIZATION FOR COMPARISON

Size Adjustment
From January to June 2013, 61% of adult and 65% of pediatric body CT examinations in the DIR had localizers for the calculation of SSDE. Localizer images are automatically processed to calculate patient width [7]. The American Association of Physicists in Medicine methodology [8] is followed to estimate effective diameter for both anteroposterior and lateral localizer image submissions and single image submissions and to calculate the appropriate conversion factor for the estimation of SSDE for all body examinations from CTDIvol normalized to a 32-cm phantom.

Phantom Size
The CTDIvol for each scan is normalized to a 16-cm phantom for all head and face examinations (for which the target region is the head or neck), and to a 32-cm phantom for all other examinations (which are body examinations). This allows comparison of CTDIvol values across facilities regardless of scanner used. Normalization is performed by multiplying the CTDIvol by 2.3 to convert the value from a 32-cm to a 16-cm phantom and by dividing by the same factor to convert from a 16-cm to a 32-cm phantom. The normalization factor was derived from calculations performed on a range of scanners.

Timing Runs
RDSRs and dose reports include timing runs that report very high values for CTDIvol that are misleading because their dose indices do not represent the dose index associated with the scan. Therefore, timing runs are excluded from scan-level and examination-level dose
index estimates. Scans are excluded from estimates if the acquisition protocol was labeled “monitoring,” “premonitoring,” or “test bolus” or if dose-length product was less than CTDIvol (indicating multiple repeated scans over a very short length). This exclusion is particularly important for CT angiography.

Procedure Name Standardization

The degree of variability in procedure names within and across facilities and inaccuracies in what they represent are a significant challenge. The DIR provides a mapping tool to participants to help facilities map procedure names to the closest matching RadLex procedure names [6]. Study descriptions are captured from the DICOM headers of the dose records. (Some facilities opt to use their protocol names, if available, instead of study descriptions.) The mapping tool, which is accessible from the DIR login, displays the list of study descriptions and allows users to search available RadLex Playbook procedure names and RadLex Playbook IDs (RPIDs) to find the closest match. If no RPID is available, users can pick descriptors using the RadLex terminology (for body part, contrast use, modality modifiers, and other characteristics), and an RPID will be requested from RadLex.

This is a tedious task, especially at facilities with large numbers of procedure names. If study descriptions can be entered or modified as free text on the scanner, there are new examination names for a facility to map every few days. Some facilities use third-party commercial vendors to do their mapping for them or use dose-monitoring software to include the RPID for each procedure in the DICOM record for the DIR to use instead of the study description.

SUMMARY

Benefits

DIR data are most commonly used for protocol reviews; this is an approved Practice Quality Improvement project for the ABR’s Maintenance of Certification requirements. After each report, users have the opportunity to participate in webinars attended by DIR committee members, in which they learn to interpret reports and have the opportunity to discuss the use of DIR data with peer facilities. Annual registry users’ meetings allow participants to present on how they use DIR data in their practices. DIR performance is used as a marketing tool to advertise facilities’ commitment to quality improvement and patient safety.

Limitations

Procedure naming continues to be a challenge. No data are collected on indication unless it is specified in the
name of the examination (eg, “CT chest angiography pulmonary embolism”); this limits our ability to identify similar examinations precisely. Despite working closely with scanner manufacturer representatives on processing information received from scanners, challenges continue to exist in accurately processing all examinations from all scanners. The technical team at the ACR makes software modifications and improvements as problems are identified.

CONCLUSIONS
The implementation of DIR has raised awareness of the nuances of the variation in practice across facilities and the differences in the challenges that each facility faces. The standardized comparisons from the registry allow facilities to make meaningful comparisons and implement improvements that are customized to their own unique circumstances. What we have learned from CT will help us in implementing the dose index registries for Computed Radiography/Digital radiography (CRDR), fluoroscopy, and nuclear medicine over the next few years.

REFERENCES

Mythreyi Bhargavan-Chatfield, PhD, is from the American College of Radiology, Reston, VA. Richard L. Morin, PhD, is from Mayo Clinic, Jacksonville, FL.

Mythreyi Bhargavan-Chatfield, PhD, 1891 Preston White Drive Reston, VA 20191; e-mail: mchatfield@acr.org.