2026 JULY 19–22 VANCOUVER, BC
JOINT AAPM | COMP MEETING

Leveraging Longitudinal ACR CT Dose Index Registry Data to Improve Interpretation of Institutional CT Dose Performance

Azmul H. Siddique, M.S.[1]; Mike Weaver, PhD [1]; Gary Ge, Ph.D. [1]; Leslie Anaskevich, MHS [1]; Jie Zhang, Ph.D. [1]
[1]Department of Radiology, University of Kentucky

ABSTRACT

Background: The American College of Radiology CT Dose Index Registry (DIR) is a national benchmarking program that enables institutions to compare CT dose metrics with aggregated reference distributions to support CT radiation dose optimization and quality assurance. In practice, benchmarking is typically reviewed at discrete reporting intervals, which can be limited by benchmark shifts, transient variation, or incomplete reference data.

Purpose: This study evaluates how longitudinal DIR analysis improves interpretation of institutional CT dose performance and supports protocol optimizations.

Methods: Longitudinal DIR data from 2020-2025 were analyzed for 10 common CT exam across 21 reporting quarters for both adult and pediatric. CTDIvol, DLP, and SSDE distributions (25th, 50th, 75th percentiles) were compared with exam-specific DIR reference percentiles. Exams with n≥30 per reporting interval were included for analysis.. Exceedance rates, defined as median value of facility metric exceeding the DIR 75th percentile (Diagnostic Reference Level [DRL]), were evaluated across exams and reporting intervals. Linear mixed-effects (LME) regression was used to evaluate longitudinal trends and identify exams demonstrating statistically significant dose drift. Coefficient of variation (CV) and F-test were performed to assess year-to-year variability.

Results: Four of ten adult exams remained within DRL across all intervals for both CTDIvol and DLP. CT Neck with IV contrast exceeded the CTDIvol and DLP DRLs in 19/21 intervals, and CT C-spine without IV contrast exceeded the DLP DRL in 19/21 intervals. Pediatric data demonstrated exceedance rates greater than 50% for both CTDIvol and DLP in those same exams. For adult exams with seven available DIR SSDE benchmarks, five remained within the SSDE DRL across all intervals. LME analysis identified a significant increase in institutional dose metrics in 2025 (β_2 = 0.139; p=0.001), with CT C-Spine contributing largest positive shift (30.56%) for adults. Facility median variability (CV) ranged from 4.6%-127%, whereas, DIR 75th percentile variability ranged from 2.8%-21.9%.

Conclusion: Longitudinal analysis of ACR DIR executive summary data extends isolated quarterly review by contextualizing exceedances over time, accounting for benchmark variability, and distinguishing persistent exam behavior from transient effects. This supports improved interpretation of institutional CT dose performance and targeted exam triage.

CONTACT

[Azmul Siddique]
[University of Kentucky]
[Lexington, KY]
[ahsi223@uky.edu]

INTRODUCTION

The American College of Radiology (ACR) CT Dose Index Registry (DIR) is a national benchmarking program that enables facilities to compare institutional CT dose metrics with aggregated reference distributions to support radiation dose optimization and quality improvement. In routine practice, institutional performance is primarily evaluated using quarterly executive summary reports that compare facility dose metrics with national diagnostic reference levels (DRLs). Although these reports provide valuable benchmarking information, interpretation based on isolated quarterly reviews may be influenced by transient variation, changing national benchmarks, or incomplete reference data, making it difficult to distinguish persistent dose issues from normal variability. Longitudinal evaluation of DIR data across multiple quarters may provide additional context by identifying sustained dose trends, persistent DRL exceedance, and exams most likely to benefit from optimization. This study evaluates a longitudinal framework for analyzing adult and pediatric DIR data using CTDIvol, DLP, and SSDE to improve interpretation of institutional CT dose performance and support targeted exam triage.

METHODS AND MATERIALS

Data Source: Longitudinal data from ACR CT Dose Index Registry (DIR) executive summary reports were collected from 2020-2025, encompassing 21 quarters. The ten most common adult and pediatric CT examinations (Table 1) were evaluated using CTDIvol, DLP, and SSDE benchmark data.
Data Analysis: Facility median dose metrics were compared with the DIR 25th, 50th, and 75th percentile benchmarks. Examinations with ≥30 studies per quarter were included. Diagnostic reference level (DRL) exceedance was defined as a facility median exceeding the DIR 75th percentile, and exceedance frequency was evaluated across all reporting intervals.
Longitudinal and Statistical Analysis: Longitudinal visualization was used to evaluate benchmark movement and persistent dose performance over time. Linear mixed-effects (LME) regression assessed institutional dose trends and estimated exam-specific 2025 shifts relative to historical performance. Coefficient of variation (CV) and F-tests were used to quantify year-to-year variability in facility and DIR benchmark dose metrics.

Table 1: Top 10 common exams listed for the adult and pediatric group. Pediatric data were further stratified in five DIR defined age groups. WO=without, W=with, IVCON=Intravenous Contrast.

Adult	Pediatric
CT Abdomen Pelvis Kidney WO IVCON	CT Lower Extremity (LE) WO IVCON
CT Abdomen Pelvis W IVCON	CT Abdomen Pelvis W IVCON
CT Abdomen Pelvis WO IVCON	CT Abdomen Pelvis WO IVCON
CT C-Spine WO IVCON	CT C Spine WO IVCON
CT Chest Abdomen Pelvis W IVCON	CT Chest Abdomen Pelvis W IVCON
CT Chest Pulmonary Arteries W IVCON	CT Head Paranasal Sinuses WO IVCON
CT Chest W IVCON	CT Chest W IVCON
CT Chest WO IVCON	CT Chest WO IVCON
CT Head Brain WO IVCON	CT Head Brain WO IVCON
CT Neck W IVCON	CT Neck W IVCON

RESULTS

Adult Longitudinal Analysis: Longitudinal analysis identified persistent dose elevation, intermittent exceedance, benchmark drift, and gradual upward dose trends. As listed in Table 2, persistent DRL exceedance were limited to a small subset of examinations. Figure 1 demonstrates one example of sustained CT C-Spine WO IVCON dose elevation.
Pediatric Longitudinal Analysis: Similar longitudinal patterns were observed in the pediatric cohort. The greatest CTDIvol and DLP exceedance occurred in CT C-Spine WO IVCON (0-2 years) and CT Neck W IVCON (15-18 years), while most remaining exam-age group combinations demonstrated minimal or no persistent exceedance.
Statistical Analysis: LME regression identified a significant 14.9% increase in institutional CTDIvol during 2025 (p = 0.001). CT C-Spine WO IVCON demonstrated the largest estimated 2025 shift (30.56%), followed by CT Chest W IVCON (21.35%), CT Chest Abdomen Pelvis W IVCON (19.90%), and CT Head Brain WO IVCON (19.90%). Facility dose variability exceeded DIR benchmark variability throughout the study period.

Table 2: List of adult exceedance rates for the dose metrics evaluated throughout the study period.

Exams	$CTDI_{vol}$ (%)	DLP (%)	SSDE (%)
CT ABDOMEN PELVIS KIDNEY WO IVCON	0.00% (0/21)	0.00% (0/21)	0.00% (0/21)
CT ABDOMEN PELVIS W IVCON	4.76% (1/21)	9.52% (2/21)	0.00% (0/21)
CT ABDOMEN PELVIS WO IVCON	0.00% (0/21)	0.00% (0/21)	0.00% (0/21)
CT C SPINE WO IVCON	52.38% (11/21)	90.48% (19/21)	N/A
CT CHEST ABDOMEN PELVIS W IVCON	0.00% (0/21)	0.00% (0/21)	5.26% (1/19)
CT CHEST PULMONARY ARTERIES W IVCON	33.33% (7/21)	71.43% (15/21)	9.52% (2/21)
CT CHEST W IVCON	9.52% (2/21)	80.95% (17/21)	0.00% (0/21)
CT CHEST WO IVCON	0.00% (0/21)	0.00% (0/21)	0.00% (0/21)
CT HEAD BRAIN WO IVCON	28.57% (6/21)	38.10% (8/21)	N/A
CT NECK W IVCON	90.48% (19/21)	90.48% (19/21)	N/A

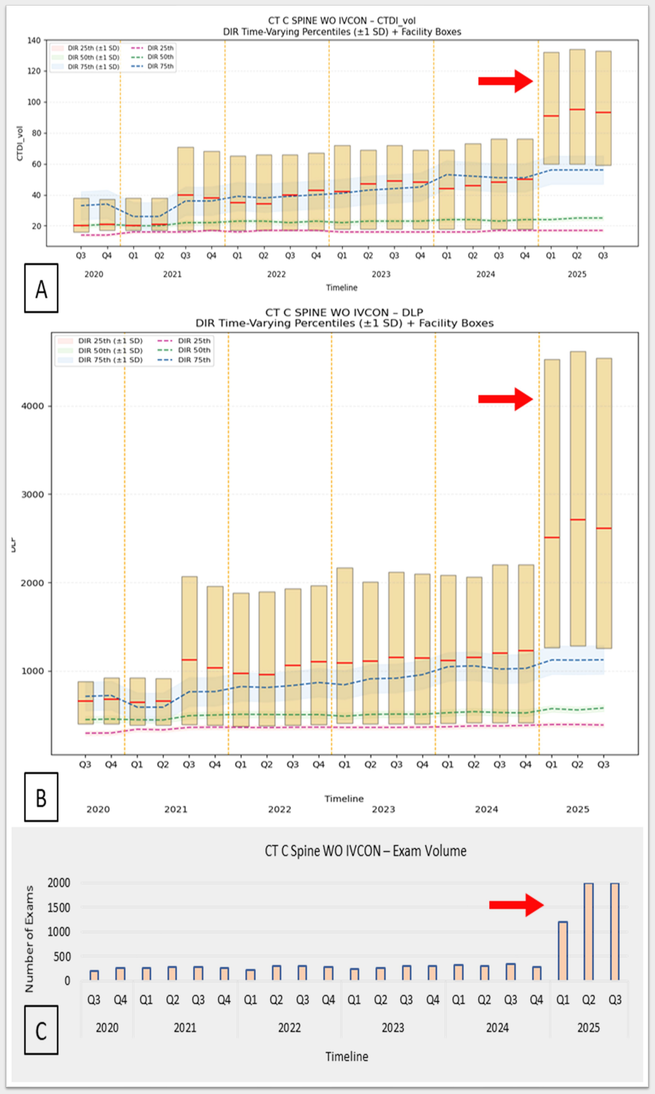

Figure 1: Adult CT C-Spine WO IVCON CTDIvol (A), DLP (B), and exam volume (C) longitudinal plots. CTDIvol and DLP demonstrated progressive increases over time, with sustained DIR threshold exceedance and increased exam volume observed during 2025 (red arrow).

DISCUSSION

Isolated quarterly DIR review may overemphasize single-threshold exceedance while obscuring temporal variability, benchmark movement, and exam-specific behavior. Longitudinal analysis provides greater context by identifying sustained and reproducible patterns rather than isolated outliers.

Repeated DRL exceedance was concentrated within a small subset of exams, supporting targeted optimization efforts. Evaluation across CTDIvol, DLP, and SSDE provided complementary information, as differences between CTDIvol and DLP may indicate scan coverage or protocol implementation issues, while SSDE helps account for patient-size effects when available.

Longitudinal visualization also helped distinguish true optimization opportunities from benchmark drift, transient variation, or data classification issues. In this study, the apparent CT C-Spine dose increase was ultimately attributed to a registry classification artifact rather than true protocol performance.

LME regression complemented longitudinal visualization by quantifying recent dose shifts and ranking examinations relative to historical performance, providing an objective framework for protocol triage and quality assurance prioritization.

CONCLUSIONS

Longitudinal analysis of ACR DIR executive summary data offers a meaningful extension beyond isolated quarterly review by characterizing exceedance behavior over time, accounting for benchmark variability, and distinguishing persistent exam behavior from transient changes. Using exceedance rates, longitudinal trends, and complementary statistical analyses, this framework improves interpretation of institutional CT dose performance, enables targeted exam triage, and provides a defensible structure for ongoing quality assurance and accreditation support. As participation in DIR continues to expand, longitudinal review represents a practical and scalable approach for institutions seeking to derive greater value from registry-based dose benchmarking.

REFERENCES

1. American College of Radiology. National Radiology Data Registry (NRDR): CT Dose Index Registry (DIR). Available at: https://nrdr.acr.org/Portal/DIR. Accessed October 2025.
2. American College of Radiology. ACR CT Dose Index Registry (DIR) executive summary reports. ACR National Radiology Data Registry; reporting periods 2020-2025. Accessed October 2025.

© Poster Template by Genigraphics® 1.800.790.4001 www.genigraphics.com