Using big-data analytics for CT radiation dose optimization

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Of all the imaging modalities, CT is the highest contributor to medical radiation exposure. This has raised a substantially growing, though debatable, concern of health risks associated with radiation (1). In general, patient safety is paramount and the basic principle in imaging vis-à-vis radiation rightfully remains to be 'as low as reasonably achievable'.

However, radiation doses from CT examinations vary within institutions, across the country and globally, even for the same clinical indication (2). The reasons are multifactorial and can be attributed to (I) *attitude*; theoretical knowledge not backed by practical application, unwillingness for a low dose culture (II) *technology*; differences in scanner technology or generation and practical techniques that curb radiation doses (III) *perception*; lack of tangible visualization of one's radiation numbers (3,4).

In an article published in the *Journal of the American Medical Association Internal Medicine* entitled "Optimizing Radiation Doses for Computed Tomography Across Institutions: Dose Auditing and Best Practices", Demb and colleagues sought to optimize radiation dose in three body regions across five medical centers (5). The authors created a three-month audit report of different dose metrics (effective dose, dose length product, volumetric CT dose index and size-specific dose estimate) for head, chest and abdomen examinations. The scans were performed at 12 facilities on 34 scanners from five different vendors. The different sites, makes of scanners and personnel all pose for factors that influence variation in practice in all the sites located within same state of California. The article highlighted the disparity in doses with 6–82% scans exceeding current benchmarks, depending on the anatomical area of interest (5).

The investigators then conducted webinars and an in-person meeting to share approaches for addressing their radiation doses. These approaches were practical and included suggestions like eliminating unnecessary phases in multi-phase examinations, optimizing doses for screening studies, and using iterative reconstruction. The personnel then implemented these approaches at their respective facilities and sub-specialties and efforts were measured after a 12-week period of implementation.

Demb *et al.* showed a significant reduction in the proportion of scans that exceed benchmark after optimization (5). These practical approaches are important and often crucial in addressing doses. With the availability of new dose-lowering technologies such as optimized kVp and iterative reconstruction, it is necessary to embrace and exploit them for creating dose-optimized protocols. The authors also included all relevant personnel—physicists, technologists and sub-specialty radiologists to address relevant concerns in different body regions without affecting diagnostic image quality.

Another factor, often neglected while addressing radiation doses is variation. Variations imply a deviation from expectation. Therefore, decreasing variations is important. It allows for consistency across different sites and reduces uncertainty in providing desired outcome. These variations occur as a consequence of different practices and/or technology (2,6). Demb *et al.* report a considerable standardization in radiation doses across sites and anatomy

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after optimization (5).

Though the paper addresses most of the issues associated with existing protocols, a few concerns remain. Radiation doses vary depending on the type of practice and available technology and the data in this investigation may be skewed. While their efforts may be applicable to academic centers equipped with newer technology, institutions without these techniques can also optimize protocols by judicious scanning for justified indications and proper positioning. Furthermore, accounting for body-size is a crucial factor when creating CT protocols (7). Significant optimization of radiation doses is possible by adapting a size-based protocol for clinical indications. Another factor that influences radiation dose significantly is clinical indication. While Demb *et al.* analysed and addressed protocol optimization for different body regions separately; for certain indications like in cancer staging, image quality is paramount and radiation dose may be of a lesser concern as opposed to for cancer screening.

Dose management softwares make the perception of one's doses more tangible. Institutions can now have a real-time overview of their doses rather than assuming their practice. These tools also highlight the importance of dose-optimization in an institution and provide the opportunity for meaningful benchmarking within the institution, nationally or internationally (2,3,8-11). The authors also used such a software for auditing doses. One caveat to bear in mind when using such softwares is to perform meaningful comparison as one cannot compare a low-dose stone protocol with an oncology examination.

In the recent years, different stakeholders have been investing in dose-optimizing strategies. Vendors are creating more robust techniques to reduce and track doses, referring physicians are using clinical decision support systems and radiologists along with technologists and physicists are optimizing protocols. Various radiological societies have also created campaigns (Image Wisely, Image Gently, Eurosafe) to address the anxiety among the lay- and medical-community.

As such radiation dose continues to remain a moving target and curtailment requires addressing multiple factors. All concerned personnel should ensure the safest and highest quality examination for an individual and the path to achieve it remains through better technology and attention to protocols.

In summary, the work by Demb *et al.* highlights feasibility of optimizing radiation doses by performing audits, continued education for improving protocols, keeping up with the state-of-the-art imaging techniques and most importantly of identifying dedicated individuals for successful implementation.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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