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Editorial Open Access

Patient Specific Radiation Dose Tracking: Improving Quality Assurance in Radiology Practices

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Introduction

The issue of radiation exposure during medical procedures has become an important public health issue as the number of procedures increases. The primary concern is raised due to the fact that over a lifetime many individuals will have multiple scans, from a variety of radiation sources which are additive and potentially result in significant radiation exposure. Using Computed Tomography (CT) as an example, there has been a seven-fold increase in its use for the entire population in the past decade. The increase is not limited to adults, approximately two to three million CT examinations were performed on children. Brenner et al. [1] indicate the number of children taking the CT scans could reach four million annually, with 50% of the examinations being potentially unnecessary. The reasons for the increase in utilization are complex and could possibly be attributed to physicians who increasingly are practicing defensive medicine. Other contributing factors include the advancement in CT technology makes it capable to facilitate the evaluation of a greater number of diseases, and its growing utility in radiation therapy.

Any increase in dose is assumed to result in increased risk. The higher the dose is, the sooner the effects will appear and the higher the risk of morbidity. It is known that there exist several cancers associated with high-dose exposure, including leukemia, breast, lung, esophageal, ovarian and gastric cancers, multiple myeloma and skin damage [2-8]. This is why (1) Joint Commission lists peak skin dose level over 15 Gyas a sentinel event (The Joint Commission Sentinel Event Policy and Procedures, 2007) (2) Each individual state requires the maintenance of dose records for all patients undergoing fluoroscopy and active management of patients who receive high x-ray doses (3) Each hospital has a Quality Assurance Committee to review and monitor radiation of repeating exams such as CT. It is a noted fact that the overuse of diagnostic scanning contributes to skyrocketing health care costs as well. A government study found that Medicare spending on imaging has doubled since 2000 to about $14 billion a year (Scans save lives, but cost a lot, increase radiation exposure, March 9, 2009). There are also a number of recent studies, government reports and media articles accusing some doctors and hospitals of doing unnecessary scans to compensate for the diminished reimbursement. Apparently, there is an urgent need to develop national standards for the appropriate use of diagnostic imaging and one precursor of the standard is the integration of historical radiation exposure data (obtained from Digital Imaging and Communications in Medicine (DICOM) images) with a specific patient (health records). However, challenges exist such as:

- The sources of radiation are varied, including CT, Interventional Radiology, Nuclear SPECT/CT, Nuclear PET/CT, Mammography, Bone Mineral Density, Projection Radiography, Fluoroscopy, Diagnostic Catheterization, Interventional Catheterization, and Electrical Physiology. The technical differences which exist among the sources of radiation are large. Each of these has different radiation dose parameters listed as DICOM tags and different manufacturers differ in their implementation of these parameters. Even though DICOM standard is in place, the flexibility of the standard leads to mismatching among modalities despite the use of the standards.

- Secondly, although Picture Archival Communication Systems (PACS) has transformed the analog-based products (e.g., paper requisition, film, paper reports) to digital products, parsing and automatically analyzing the image-dose data require intensive cross-disciplinary efforts from both the radiation dosimetry domain and the information technology domain.

- Thirdly, the integration of imaging data and clinical data requires a level of communication between non-imaging systems (e.g., Hospital Information System (HIS), Radiology Information System (RIS)) and imaging systems (e.g., PACS) which is currently not available in most institutions mainly because of the lack of support for this level of integration by most vendors.

To address these challenges, Mayo Clinic is leading the efforts to develop and implement patient dose index tracking system (DIT©). This system has been the foundation for standardizing quality assurance practices in radiology world-wide. The impacts are not only from quality of patient care, but also from cost saving aspects.

Quality of Health Care Impact

It is understood that lower radiation will immediately improve the quality of patient care. The DIT© system is capable to (1) provide quantitative data that identifies opportunities to reduce radiation exposure; (2) enable standards of dose usage including the ability to follow guidelines of an episode of dose and the number of exams that should be ordered for a specific patient; (3) establish monitoring and quality metrics for Quality Assurance purposes (e.g., monitoring by patients, by imaging modality, by physicians, by types of equipment); (4) automatically identify patients who are at increased risk for adverse radiation effects and identify the best practices with respect to radiation; (5) provide an easy, consistent way to comply with state and federal radiation regulations; (6) demonstrate a comprehensive response to national concerns over the consequences of radiation misuse.

Cost Saving Impact

As noted in Brenner et al. [1], 50% of the CT scans performed on children and infants were potentially unnecessary. Having a

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comprehensive radiation dose information system, will ultimately reduce the numbers of these types of examinations. This system shall provide the physicians who order the examinations with the radiation dose information specific to their patients. For example, patients having a chronic disease will now have their accumulated radiation dose as part of their medical records. This added information will be known to the care providers. In this environment, the number of examinations ordered, particularly those with higher dose estimates will be reduced. The related Medicare expenses on imaging could be reduced.

In conclusion, as Sodickson, et al. [9] reviewed 22 years records of patients having CT examinations and concluded that "cumulative CT exposures added incrementally to the baseline cancer risk", a strong need exists for a patient specific information system for radiation dose tracking. The potential societal impacts are going to be enormous.

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