

Potential applications of dose-tracking and active dosimetry systems to encourage X-ray image optimisation and minimise staff dose

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Introduction

- UNSCEAR and other authorities have documented worldwide variability in doses to patients undergoing X-ray imaging procedures.
- The transition to digital radiology has broken the link between over-exposure of patients and image degradation, with dose creep reported.
- The continuing need for optimisation of diagnostic exposures requires knowledge of dose indices such as dose area product (DAP) for X-ray imaging procedures for typical patients.
- Provision of accurate, timely, easy-to-collect dose data facilitates understanding of doses received by patients and staff and can inform and drive dose-reduction programmes.
- Current small sample manual recording of patient dose indicators is time-consuming and susceptible to transcription errors.
- Digital radiology developments in recent years are laying the platform for automated collection and analysis of patient dose indices via 'big data' data-mining techniques.
- DICOM radiation dose structured reports and IHE radiation exposure monitoring standards are catalysts in the emergence of dose-tracking informatics tools.
- Dose monitoring software simplifies provision of data to develop local, national and international dose reference levels and facilitate comparisons against appropriate benchmarks.
- Recent personal dosimetry developments providing more timely dose / dose-rate information to staff can help minimise occupational exposures, particularly relevant to those involved in X-ray interventional procedures.
- By providing better dose data to staff undertaking medical exposures they will be more empowered to apply their skills to achieving fit-for-purpose diagnostic imaging, with minimal dose to patients and themselves.

Methods

Audit

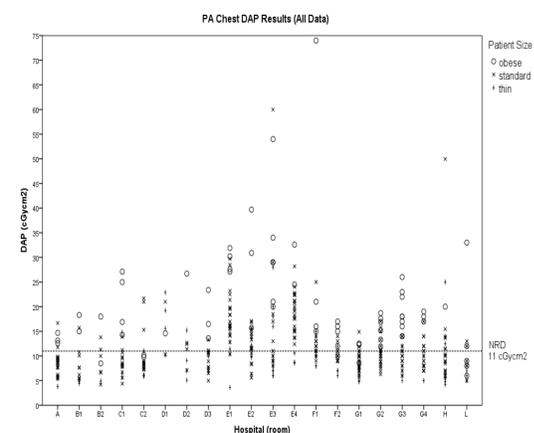
- A dose audit was conducted in 29 computed radiography X-ray rooms in 11 UK hospitals using traditional manual data collection.
- Exposure factors and DAP readings were recorded for four common X-ray procedures (PA chest, AP & Lateral lumbar spine, AP abdomen).
- Radiographers were also asked to observe and record patient size in three broad categories (thin / standard / obese).
- DAP values were analysed and compared with the relevant UK national reference dose (NRD).

Dose-tracking, data-mining informatics

- Dose tracking via large scale data collection and data-mining tools is a faster, more reliable and logistically simpler method to collect such data for subsequent analysis and comparison.
- Such technology facilitates opportunities for feedback to operators, departments, hospitals, commissioners, regulators and national registries.

Results

- This representative graph from a 2010 multi-centre dose audit shows the distribution of DAP values for 469 patients undergoing PA Chest radiography in 20 X-ray rooms in 9 UK hospitals.



- Large variations in patient doses were demonstrated, with dose patterns suggesting participating hospitals are at different stages in the journey towards optimisation.
- The PA Chest DAP readings ranged from 3.6 to 74 cGy*cm² (compared with the national reference dose of 11 cGy*cm²).
- In hospital A only 13% of patients had doses exceeding the NRD, whilst in hospital E (Room 1) 90% exceeded the NRD.

Conclusions

- Wide divergence in doses demonstrates the need for optimisation.
- Current manual dose audits tend to be small sample sizes, intensive on staff time and requiring lengthy analysis.
- These are limiting factors in undertaking such audits and completing the audit cycle aimed at X-ray dose optimisation.
- Informatics data-mining tools automate data collection and facilitate more comprehensive analysis.
- They enable better understanding of factors affecting patient doses and derivation / implementation of diagnostic reference levels.
- They support analysis of other data stored in image files to review impact of dose-related factors, possibly capturing patient size data from separate electronic patient records.
- These tools can help to raise operator awareness of dose issues through timely feedback and performance reviews, nudging staff towards image optimisation and limitation of dose creep.
- Identification and sharing of good practices is facilitated.
- Dose tracking can provide dose data for national registries, in keeping with current IAEA activities*.
- X-ray dose audits using data-mining informatics tools are likely to become part of future routine governance relating to patient safety.
- Concurrent technological developments in personal monitoring provide real-time dose-rate data and other rapid dose feedback which can encourage actions to minimise staff doses.

* Rehani MM, Frush DP, Berris T, Einstein AJ. Patient radiation exposure tracking: worldwide programs and needs – results from the first IAEA survey. Eur J Radiol. 2012 Oct 81(10): e968-76/jejr.2012.07.004. Epub 2012 Jul 25. A more complete set of references is contained in the conference papers (Session 7, Wilkins & Knapp, Potential applications of dose-tracking and active dosimetry systems to encourage X-ray image optimization and minimize staff dose.)