A clinical self-audit evaluating the dose area product from PA chest examinations against established diagnostic reference levels

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INTRODUCTION

Since the introduction of digital imaging and its wide exposure latitude, evidence suggests exposure settings have gradually increased over time, resulting in increased radiation dose to patients (Gibson & Davidson, 2012). This compromises the fundamental principle of radiography, to keep radiation dose "as low as reasonably practicable" as required by The Ionising Radiation (Medical Exposure) Regulations (IR(ME)R) (2000). In order to regulate radiation dose, IR(ME)R (2000) implemented national diagnostic reference levels (DRL's) to provide a practical guide detailing the appropriate dose area product (DAP) for standard X-ray examinations (Gov.UK, 2016).

All Radiology units are required to adopt the national DRL's or establish their own local DRL's, dependant on their equipment and the patient demographics within their district. All DRL's must be justified and reviewed at appropriate intervals (Gov.UK, 2016). The national DRL's were reviewed in 2016 and with regards to the posterior-anterior (PA) chest examinations, a reduced limit was re-established. The current advised DAP limit for a standard adult PA chest x-ray is set at 0.1 Gy*cm2 DAP per radiograph (Gov.UK, 2016), the local DRL for the CR room used is 0.12 Gy*cm2 and the local DRL for the DR room used is 0.07 Gy*cm2 (The Christie NHS Foundation Trust, 2013).

AIMS & OBJECTIVES

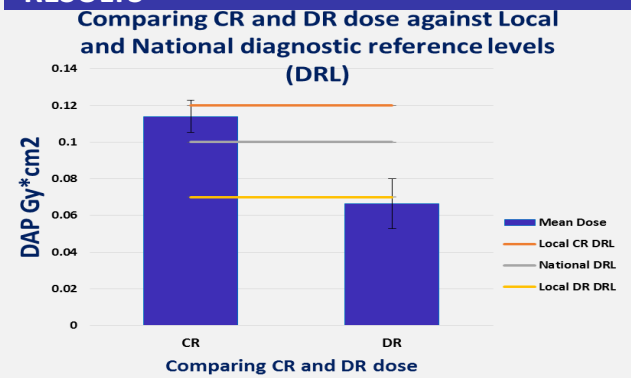
- To compare the DAP from PA chest X-ray examinations on standard sized adult patients against the national and local DRL'S using CR and DR systems.
- To evaluate any differences between DAP obtained from CR and DR systems

Audit Standard	Target
For patient radiation doses to be below the National or Local DRL	100%

METHOD

Prior to commencing this audit, quality control testing confirmed all equipment and systems were functioning within acceptable ranges to ensure the reliability of the study. The equipment used included a Kodak DirectView 850 CR system, 35x43cm intensifying cassettes and a PTW-Diamentor MZ dosimeter. Also a Phillips DigitalDiagnost LXRDD3 DR system with a DR image receptor (IR), anti-scatter grid and automatic exposure control (AEC's) and a data collection tool to collate the data. The audit was performed using DAP readings from 60 controlled selected average sized patients (30 female/30 male) equally divided between CR and DR undergoing a PA chest x-ray (The Christie NHS Foundation Trust, 2013). The X-ray tubes were aligned 180cm perpendicular to the vertical cassette /IR. The CR X-rays were taken without an anti-scatter grid or AEC's and the exposures were manually set according to local protocols. The DR systems were used with a grid and high kVp technique in conjunction with the AEC's. All patients were positioned for a PA chest according to Sloane, Holmes, Anderson, & Whitley (2010) and the primary beam collimated to include the left and right apices, both costophrenic angles and lateral skin margins. Following the exposure, all of the data and correlating DAP readings were documented and later analysed and compared to observe any trends or anomalies.

RESULTS



RESULTS CONTINUED

The audit data clearly demonstrates a significant increase in DAP from CR compared to DR, although the standard deviations (StDev) were larger for DR.

System	Mean DAP Gy*cm²	StDev
CR	0.114	0.0089
DR	0.066	0.0136

When comparing doses against the national and local DRL's, all CR readings exceeded the NDRL's however, 100% of these were below the CR LDRL whereas with DR, some examinations exceeded the DR LDRL but 100% were below the NDRL.

DISCUSSION & CONCLUSION

On reflection, the lower DR doses could be attributed to the use of a high kVp technique and the AEC cut off therefore, specifically tailoring the exposures to the requirements of each individual patient (Hertrich, 2005). These automatic exposures will prevent operator variations caused by manual selection of exposure settings as found in CR (Gibson & Davidson, 2012). However, the patient specific DR exposures have created larger standard deviations between doses compared with those of CR. This could be due to the dense breast tissue in female patients, thus prolonging the AEC cut-off and also a radiographers tendency to under-collimate the primary beam on a gowned patient (Debess et al., 2015).

In conclusion, DR has demonstrated to produce lower DAP readings and operates significantly below the established NDRL whereas CR was constantly above. Therefore in alignment with ALARP, DR would be the system of choice for these examinations.

RECOMMENDATIONS / ACTION PLAN

- Refer chest requests to the DR operating rooms.
- Optimize CR doses by reducing exposure settings whilst maintaining diagnostically acceptable image quality and improve collimation in female patients.
- Perform a re-audit in 6months to compare the doses and compare differences between male and females.

References

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Abstract

Keywords: **Posterior-anterior, chest, X-ray, DAP, DRL, DR, CR**

Introduction: Since the development of DR X-ray systems, different radiographic techniques and exposure settings are now used in DR compared to CR for chest examinations, thus leading to variations between patient doses. This poses an issue relating to the IR(ME)R (2000) principles of "ALARP" keeping doses as low as reasonably practicable. To ensure radiographic doses are maintained below a proportionate level, IR(ME)R (2000) devised the national diagnostic reference levels (NDRL's) as a guide for standard examinations.

Objectives: This audit will compare the Dose area product (DAP) readings from CR and DR systems for PA chest examinations and identify any differences between the systems. The readings will also be compared against the national and Local DRL's.

Method: A total of 60 average sized adult patients fitting the criteria of the study were selected (30 male/30 female) and equally split between both systems. The high kVp technique was used for DR using 125kV with an anti-scatter grid and AEC'S whereas for CR, the exposures were manually selected, without the anti-scatter grid or AEC'S. The data was analysed against the established DRL's and comparisons were made between DR and CR.

Results: All readings were below either the NDRL or LDRL, however, CR produced the highest DAPs overall consistently exceeding the NDRL. The DR DAPs were significantly lower than the NDRL, although, higher standard deviations were observed.

Conclusion: DR creates the lowest doses beneath the NDRL therefore being the preferred system for this examination.

Word Count: 248