

# THE RED DOT SYSTEM

## *Emergency Diagnosis Impact and Digital Radiology Implementation A Review*

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**Abstract:** Radiographer abnormality detection schemes (RADS) were introduced in the early 1980s to assist emergency departments. The development of PACS systems are affecting health professionals forcing them to evolve along, reviewing images on a computer monitor rather than on radiographic film. This article reviewed published articles that evaluated the impact of the use of a Red Dot System in patient outcome of emergency trauma patients and assessed the implementation of a Red Dot System in a Radiology Department with digital radiography and PACS. Few articles addressed the implementation issues and use of a Red Dot system in Computed Radiology. Radiographer skeletal red dot studies, had sensitivity and specificity of, respectively, 0.71 and 0.96 pre-training, and 0.81 and 0.95 post-training, compared with a reference standard. The use of radiographer abnormality detection schemes such as Red Dot and reporting has the potential to improve the diagnosis and outcome of emergency patients. The arrival of Information Technologies (IT) to healthcare and the introduction of Digital Radiography have limited the functionality of RADS due to incompatibility of new technology with the standard practice. New image technology solutions in Radiology should enhance the development and utilization of radiographer skills in RADS environments.

## 1 INTRODUCTION

Radiographer Abnormality Detection Schemes (RADS) were introduced in the early 1980s in UK where the radiographer marks a radiograph (usually a red dot sticker – thence the name) that he believes to show an acute abnormality to alert emergency doctors to the possible presence of an abnormality. If he is able to identify it correctly, then he can issue a comment or a report where he would describe the location, extent and type of the pathology, and its clinical importance. The aim is to assist emergency departments (ED) addressing the shortage of radiologists and is implemented in ED's where the radiologist is not always available to issue a radiography report, leaving the interpretation to the referring doctors.

The development of digital radiology and Picture

Archiving Systems (PACS) is affecting health professionals forcing them to evolve along, reviewing soft copy images on a computer monitor rather than on radiographic film. New questions have arisen about the best way to adapt and implement RADS with monitor image reviewing, abnormality signalling and transmission of the radiographer's report to the referring doctor becoming limited by Computed Radiography systems (Snaith and Hardy, 2008) and the paperless patient-management systems of today's hospitals.

The purpose of this article was to review published articles that evaluate the impact of the use of a Red Dot System in patient outcome of emergency trauma patients and assess the implementation of RADS in a Radiology Department with digital radiography and (PACS).

## 2 METHODS

A search of the literature was undertaken using the PubMed database with relevant keywords, in studies published since 1999, which resulted in 343 articles. The included studies addressed the use of Red Dot (or RADS) with digital radiology and its impact on emergency patient management. After a title/abstract analysis, 308 studies were excluded, remaining 35 studies with 11 overlapping resulting in 24 potential relevant studies. After a full text analysis 6 studies were found eligible to support this article.

## 3 RESULTS

The 6 eligible studies for this review assessed the accuracy of radiographers red dot or reporting, the costs and effects of introducing radiographer reporting in ED and the current practice of RADS. Only one of the eligible articles addressed the effects of Information Technologies, particularly Computed Radiology, on the implementation and use of Red Dot systems or RADS.

### 3.1 Accuracy of Radiographer's Red Dot of Emergency Radiographs

Radovanovic and Armfield, (2005) have found that the accuracy of untrained radiographers and ED doctors in identifying abnormal radiographs were quite similar: 87% and 89%, respectively.

Brealey, Scally, Hahn, Thomas, Godfrey and Crane (2006) registered a pooled sensitivity and specificity of radiographer's red dot for all body areas of, respectively, 0.88 (CI 0.88–0.90) and 0.91 (CI 0.90–0.92) (Bowman, 1991; Morrison, Hendry, Fell and Stothard, 1999). One study (Hargreaves and Mackay, 2003) assessed skeletal red dot without training with sensitivity and specificity, respectively, of 0.71 (CI 0.62–0.79) and 0.96 (CI 0.93–0.97); and with training was 0.81 (CI 0.72–0.87) and 0.95 (CI 0.93–0.97).

### 3.2 Accuracy of Radiographer's Reporting

Radovanovic and Armfield, (2005) found a correlation between the radiographer's experience or seniority, and the accuracy in their identifying abnormalities. The authors analysed the ability of radiographers to accurately identify the abnormality that was noticed and report it, without training, and

calculated it at 85% in one study (Orames, 1997) and 93% in another one (Smith and Younger, 2002) (Smith and Younger, 2002).

Brealey, Scally, Hahn, Thomas, Godfrey and Crane (2006) calculated the pooled sensitivity and specificity for radiographer reporting of the skeleton on emergency radiographies in five studies: 0.90 (CI 0.89 – 0.92) and specificity 0.94 (CI 0.93 – 0.94), respectively, using as reference standard radiologists of variable grades.

These authors had already published a review article (Brealey, Scally, Hahn, Thomas, Godfrey and Coomarasamy, 2005) to determine the accuracy of radiographer reporting in clinical practice with summary sensitivity estimate of 92.6% (CI 92.0 – 93.2) and specificity of 97.7% (CI 97.5 – 97.9).

### 3.3 Implementation of RDS / RADS and Digital Radiology

Snaith and Hardy (2008) sent a questionnaire to 456 UK sites (ED and minor injuries units), where they tried to find the main technologic issues regarding the use and implementation of RDS and RADS.

From the 306 (n=306/456; 74%) responses, a RADS was in operation in 284 sites (n=284/306; 92.8%), and of these, 221 sites (n=221/284; 77.8%) operated a red dot scheme; 7 sites (n=7/284; 2.5%) operated a radiographer comment system; and a further 54 sites (n=54/284; 19.0%) operated both a red dot and comment scheme. Two sites (n=2/284; 0.7%) indicated that a RAD system other than red dot or radiographer commenting was operated, but no more details were given about the kind of system used.

There were 275 sites from 306, with a red dot / reporting system with 21 different methods of abnormality flagging: the phrase "red dot" annotated on the computed radiography (CR) (n=83/275; 30.2%); a red dot sticker affixed to the printed radiograph (n=71/275; 25.8%); and an asterisk (\*) annotated on the CR image (n=43/275; 15.6%). Other annotation methods were registered.

There were identified 8 different methods of communicating radiographer findings in the 61 sites providing written comment on the radiographs (also operating a red dot system): use of a radiographer comment form (n=24/61; 41.4%); space for radiographers to annotate findings on the imaging request card (n=12/61; 20.7%); and verbal communication (n=7/61; 12.1%). Other methods included a note on the PACS system or the Radiology Information system (RIS); a hand written post-it note; and a stamp on the request card.

The implementation of PACS had limited the functionality of RADS due to incompatibility of new technology with standard RADS practice and, in many cases the radiographer's ability to detect abnormalities was being interfered by the monitor quality.

### 3.4 RADS Costs and Effects on Emergency Patient Management

The costs and effects of introducing selectively trained radiographers signalling and reporting on an ED were evaluated by Brealey, King, Hahn, Godfrey, Crowe, Bloor, Crane and Longsworth (2005) for the appendicular skeleton, using a retrospective controlled before and after design. They concluded that the "introduction of radiographer reporting did not have a negative effect on ED radiograph reporting accuracy, patient management or outcome" (Brealey, King, Hahn, Godfrey, Crowe, Bloor, Crane and Longsworth, 2005). This authors analysed a previous study (Piper, Paterson and Ryan, 1999) where the costs of introducing radiographer reporting in four UK National Health Service trusts ranged from nil to 15000£ (approx. 17.200€ ) per annum. Brealey's analysis showed that the cost of introducing radiographer reporting saved the Radiology Department 361£ (approx. 415€) and further cost savings could be made as radiographers acquire the same experience as radiologists and if secretaries typed the radiographer's reports.

## 4 DISCUSSION

The radiographer's role in trauma has been traditionally limited to image acquisition, but in some countries has changed dramatically to include responsibility for image interpretation. This evolution is related with the technological advances and the personnel shortages in some countries health systems like United Kingdom and Australia. In these countries radiographers have been taking on some responsibilities which were previously from the domain of radiologists. These additional responsibilities have been termed "role extension" or "skill-mixed" (Williams, 2006).

Red Dot is about image pattern recognition which requires a methodical visual analysis and effort, as opposed to reporting which is an analytical approach to the perceived image features, with consequent process of deduction and induction to understand the pathological basis of the

abnormalities shown and their medical significance (Brealey, Scally, Hahn, Thomas, Godfrey and Crane, 2006).

There is some evidence about the accuracy of radiographer's red dot and report of emergency radiographs in clinical practice. Radiographer's accuracy is affected by body area being the skeletal area the one with better accuracy results. Also, there is a similar accuracy in identifying radiographic abnormalities between untrained radiographers and ED doctors (Radovanovic and Armfield, 2005) (87% and 89%, respectively). The investment on a proper evidence based education and training, like post-graduated courses, improves the ability of radiographers to report on radiographs with accuracy comparable to radiologists (Brealey, Scally, Hahn, Thomas, Godfrey and Crane, 2006) (0,93 sensitivity and 0,98 specificity). This level of accuracy in clinical practice would only be maintained if a clinical audit were to be implemented periodically to assess possible divergences through time and maintain quality (Brealey, S., Scally A., Hahn S., Thomas N., Godfrey C. and Crane S., 2006).

The reviewed articles suggest that radiographers commenting on plain radiographs do not adversely affect patient management or outcome. A Red Dot or RADS can bring benefit to the patient reducing the risk of missed abnormalities, thus preventing misdiagnosis, particularly in ED with less experienced doctors. These schemes can speed up the patient care in a busy ED, with benefit to the patient, providing assistance to ED staff in departments where a radiologist may not always be available. The radiographer's contribution to emergency reporting has relieved the radiologist's workload and led to an increased job satisfaction for radiographers, enhancing their professional status and improving relations between them and ED staff. It has been stated also that when a radiographer has to provide a comment (diagnosis) from their own films the quality of their images improve (Radovanovic and Armfield, 2005).

Despite these advantages, flagging and reporting schemes may offer some limitations. Red Dot is limited by the fact that it is only possible to signal normal from abnormal giving no information about the characteristics and severity of the image. Thus this system can supplement a radiologist report but cannot replace it. There is concern about ED doctors may end up relying too heavily on the opinion of radiographers since the absence of a red dot on radiography does not exclude the possibility of an abnormality (Brealey, Scally, Hahn, Thomas, Godfrey and Crane, 2006). Other concerns are the

staffing shortages, financial issues and difficulties for radiographers to combine these extra duties with normal labour. Within the radiographer profession there are also some concerns: about the possibility of development of division between radiographers who report and those who don't; the fear of increased pressure is sometimes present; radiologists may feel threatened by radiographers advancing into areas previously considered their own (Radovanovic and Armfield, 2005).

The rapid technological evolution is affecting radiographers and other health professionals. The implementation of digital radiography has limited the functionality of Red Dot and RADS due to incompatibility of new technology with the standard practice of RADS (flagging and reporting). The arrival of Information Technologies (IT) to healthcare has brought new solutions to old problems but along with it came some new ones and limitations, such as need to compensate for the lack of films through the hospital with placement of a pc on each of emergency work rooms for ED doctors for radiography review. The use of high quality monitors in every place is not cost effective and, usually, the option is to go for less expensive and less quality monitors which sometimes hinder the correct image review.

The traditional red dot sticker to highlight abnormal images has been substituted, in Digital Radiology systems, with the use of image annotations (e. g. "RED DOT" or "\*", among others). Since there is no official support for a radiographer comment on RIS software, the reporting communication has been limited. The solution is going back to the paper form or putting a comment on PACS images.

## 5 CONCLUSIONS

The use of RADS schemes, such as Red Dot, does not adversely affect the emergency patient management and has the potential to improve the timely and cost-effective diagnosis, outcome and management of emergency patients. These systems have become a determinant factor to the contribution of radiographers to the trauma image review process and to the management of patients in the ED.

New image technology solutions in Radiology should enhance the development and utilization of radiographer skills in RADS environments. The challenge is to use the new IT solutions in Radiology and ED to maximize those skills and promote

flexible team work in a multiple disciplinary healthcare environment.

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