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Radiographer use of anatomical side markers and the latent conditions affecting their use in practice

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ABSTRACT

Background: Patient safety is a primary concern within the NHS. It has been reported that anatomical side marker (ASM) use in radiography does not meet the 'best practice' standard. Case reports suggest this may be a contributing factor to adverse events in healthcare.
Purpose: This study aimed to investigate the latent conditions contributing to poor ASM practice; communities of practice, time of image acquisition and competing priorities with collimation practice.
Method: Proxy variables of projection and laterality were used to measure communities of practice. ASM practice on 330 examinations (170 lumbar spine, 160 finger) was retrospectively observed using a data collection tool. Aggregate scores were calculated from the two images in each examination. Data was analysed using descriptive statistics, chi-square tests (projection) and Mann–Whitney *U* tests (laterality, time of acquisition and collimation practice).
Results: 'Best practice' ASM use was met on one examination. Correct ASM were observed within the primary collimation in 32.0% images. Projection, laterality and collimation practice were associated with ASM use. Time of acquisition was not found to be associated.
Discussion: Communities of practice and competing priorities impact on ASM use. Logistic regression to determine a primary latent condition was not possible. However, comparison with previous research suggests this is likely to be specific to each radiography department.
Conclusion: Latent conditions are associated with poor ASM practice. These must be identified and addressed in each individual radiography department, to improve patient safety and uphold NHS Constitutional standards.

Introduction

In radiography the correct use of anatomical side markers (ASM) is considered a 'best practice' which is vital to meeting the standards of the profession.[1] ASM are here defined as annotations of 'right' or 'left' on the image. Although the HCPC Standards of Proficiency[2] omit an explicit comment on ASM practice, educational textbooks and European professional guidelines strongly direct ASM practice.[3–7] Accordingly, the accepted 'best practice' standard necessitates that a correct radio-opaque ASM must be placed within the primary collimation when the image is acquired, ensuring its presence on the subsequent radiograph. The ASM is 'correct' if it corresponds to the anatomical side demonstrated. The primary collimation is set by the radiographer prior to exposure to limit the X-ray beam exclusively to the area of diagnostic interest (ADI). Image appraisal should include a check for a correct ASM within the collimation.[8]

Omission of ASM is seen as such a risk to the patient that a radiologist or reporting radiographer may refuse to give an opinion on an image without ASM, and can request another radiograph to be done.[9] Medico-legally, a repeat examination may be necessary in forensic cases if the image does not have an ASM present within the primary collimation.[10,11] Failure to annotate images correctly, therefore, may delay or diminish the standard of care received by the patient, and potentially require exposure to unnecessary radiation.

Radiographers have a duty of care to patients, and a professional responsibility to safeguard their wellbeing.[2,12,13] A radiographer may be held "legally responsible and accountable for the results of their professional actions caused by act, negligence [or] omission".[13] Reported cases of negligence show that absent ASM have contributed to serious adverse events. Within the NHS wrong-site surgery is considered a 'never event',[14] but in one reported case a

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patient died after his healthy left kidney was removed instead of his diseased right kidney. The patient's radiographic images may have been inverted when the surgeon viewed them, potentially informing the decision to operate on the incorrect side.[15] In another example, two premature babies were reported to have had wrong-sided treatment for pneumothorax, one fatally, due to clinical decisions based on images without ASM.[9]

Reason[16] determined that human error is inevitable and it is the underlying latent conditions which allow mistakes to occur unchecked which should be addressed. Latent conditions are the originators of error within the system. Strategic decisions, made by those unaware of the 'grass-root' consequences, have the potential for provoking error or removing existing checks and barriers. Reason provides examples such as: time pressure, understaffing, inadequate equipment, fatigue, inexperience, untrustworthy alarms and indicators, unworkable procedures, and equipment/estate design and construction deficiencies.

Reports[17] and government policy[18,19] regarding patient safety concur with this analysis, but the existence of an implementation gap has hindered the impact on practice.[20,21] Previous research into errors and omissions in ASM use has mostly focussed on erecting barriers between the source of error, the radiographer, and the victim, the patient.[18] These include the provision of further training, technology, automation and engineering safety features.[22,23] Platt and Strudwick[24] have previously discussed potential latent conditions contributing to the short-fall in 'best practice' ASM use, specifically in the context of implementation of storage phosphor technology.

Several potential latent conditions can be proposed. Neglect of ASM maybe inherent to the department through the learning and fostering of incorrect methods, Platt and Strudwick referred to this as an issue of 'communities of practice'.[24] This concurs with the conclusion of To Err is Human[17] which stated that standards of practice and safety are influenced by the values and norms of healthcare professionals. Thus, ASM may only be applied when they are perceived to be important by the radiographer. ASM may be seen as important to avoid confusion when orientating unilateral images (those which may appear as the contra-lateral side if inverted, e.g. Finger). ASM placement may not appear as important on lateral projections (where two sides are superimposed upon each other). However, ASM may be perceived as most important on anteroposteriorly projected images where two sides are present and may be inverted (termed bilateral).

Time of image acquisition may contribute to poor ASM practice. A review of night working in the NHS found safety and productivity to be significantly compromised, specifically between 10pm and 6am.[25] Additionally, shift work including nights, as common in radiography, was found to substantially increase the risk of accidents.[26] However, activities such as role extension, continued professional development and supervising students removes man-hours from the 9–5 working day.[24] Thus, when any temporal effect may be most error-provoking is debatable.

Radiographers have a conflict of priorities between 'best practice' ASM use and efficient collimation practice to optimise radiation exposure to the patient. It may not be possible to place an ASM within the ADI without obscuring anatomy. Consequently, to include an ASM within the primary beam, collimation has to be increased. The forced choice between these practice standards could be a latent condition of poor ASM practice.

The serious risks of poor ASM practice, as highlighted by case studies,[9,15] and the strong recommendations present in training material make the evidence of low compliance to best practice guidelines surprising.[24] This research therefore aimed to confirm or moderate this evidence, as well as explore some potential latent conditions mediating any short-fall by testing explicit hypotheses (Fig. 1).

H_1: Application of ASM is more likely on anteroposterior projections compared to lateral projections.

H_2: Application of ASM is more likely on unilateral examinations compared to bilateral examinations.

H_3: Application of ASM is associated with time of examination acquisition.

H_4: Collimation to the ADI is associated with application of ASM

Figure 1. Hypotheses derived from the literature.

Methodology

A quantitative, non-experimental, cross-sectional approach was taken through retrospective, structured observation of radiographs.

Research sample

A common unilateral examination (FINGER) and bilateral examination (LUMBAR SPINE) were selected. These examinations provided varying stimuli for the hypotheses (unilateral/bilateral and collimation). Selection of standard examinations allowed the elimination of co-variants and an increase in reliability of the findings. A non-probability, convenience sample was selected from an anonymised DICOM teaching library (DLT) held at an academic institute, applying inclusion and exclusion criteria (Table 1). The images in the DTL come from radiographic examinations conducted in 2009 and the specific subset used in this study are a contiguous sample of all storage phosphor radiographs from volunteer hospital DICOM archives for the collection time period. All images are as they were reported (the anonymised reports were also available for checking).[27]

The sample size was decided using a power calculation tool.[28] 172 examinations of both lumbar spine and fingers were required to reach 95% power (df = 3, $\alpha = .05$), giving a desired sample size of 344 examinations.

Instrumentation

A data collection tool was developed (Fig. 2), based on a previously published method for retrospective audit of ASM use.[24] Presence of ASM was noted and the ASM was judged to be 'correct' if it corresponded to the anatomical side demonstrated. Using a prescribed structure,[29] the potential latent conditions were operationalised into closed questions. Proxy variables were used as indicators to measure the impact of communities of practice on ASM practice.[30] A reference tool was prescribed from an educational textbook[5] for consistent judgement of collimation to area of

Q1. At what time of day was the examination completed (hh:mm)?	___:___	
Q2. Is there an indication of side on the radiograph?	Yes [1]	No [0]
Q3. Is there a visible anatomical side marker present, placed within the primary collimation?	Yes [1]	No [0]
Q4. Is there an anatomical side marker visible outside the primary collimation due to extra-focal/scattered radiation? Window the contrast of the image across the scale before establishing judgement.	Yes [1]	No [0]
Q5. Is there an anatomical side marker added post-processing?	Yes [1]	No [0]
Q6. Is the anatomical side marker indicating the correct anatomical side?	Yes [1]	No [0]
Q7. Has the collimation been increased outside the area of diagnostic interest? Draw area of diagnostic interest onto image using software tools before establishing judgement.	Yes [1]	No [0]

Figure 2. Data collection tool template, completed for each image within the examination.