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The impact of image test bank construction on radiographic interpretation outcomes: A comparison study

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ABSTRACT

Introduction: Assessment of image interpretation competency is commonly undertaken through review of a defined image test bank. Content of these image banks has been criticised for the high percentage of abnormal examinations which contrasts with lower reported incidences of abnormal radiographs in clinical practice. As a result, questions have been raised regarding the influence of prevalence bias on the accuracy of interpretive decision making. This article describes a new and novel approach to the design of musculoskeletal image test banks.

Methods: Three manufactured image banks were compiled following a standard academic menu in keeping with previous studies. Three further image test banks were constructed to reflect local clinical workload within a single NHS Trust. Eighteen radiographers, blinded to the method of test bank composition, were randomly assigned 2 test banks to review (1 manufactured, 1 clinical workload). Comparison of interpretive accuracy was undertaken.

Results: Inter-rater agreement was moderate to good for all image banks (manufactured: range $k = 0.45-0.68$; clinical workload: $k = 0.49-0.62$). A significant difference in mean radiographer sensitivity was noted between test bank designs (manufactured 87.1%; clinical workload 78.5%; $p = 0.040$, 95% CI = 0.4–16.8; $t = 2.223$). Relative parity in radiographer specificity and overall accuracy was observed.

Conclusion: This study confirms the findings of previous research that high abnormality prevalence image banks over-estimate the ability of observers to identify abnormalities. Assessment of interpretive competency using an image bank that reflects local clinical practice is a better approach to accurately establish interpretive competency and the learning development needs of individual practitioners.

Background

The review and interpretation of musculoskeletal (MSK) trauma radiographic images by non-medical healthcare professionals is established practice in the UK.[1,2] Since its implementation, many studies have compared the skills of different professional groups to successfully interpret and report radiographic images.[2–9] A standard approach to the assessment of image interpretation competency is to review images from a defined test bank[2,3,7–9] considered to reflect the range of anatomical regions, pathological conditions and patient demographics that healthcare professionals might reasonably expect to encounter within their clinical practice. This approach has been widely adopted by Higher Education Institutions offering education in radiographic image interpretation to radiographers and other health professions (undergraduate, postgraduate and continuing professional development (CPD)). However, the content of these image banks has been criticised for the relatively high percentage of abnormal examinations, typically around 70%.[7,8] This contrasts with the lower reported incidence of abnormal radiographic images in clinical practice with, for example, the prevalence of MSK trauma being 20–30%.[5,10–13] As a result, authors have questioned the influence of prevalence bias on the accuracy of interpretive decision making (sensitivity and specificity)[14,15] and the assumption that interpretive competency, as determined through a high prevalence image bank assessment, reflects ability to accurately review and interpret (and/or report) radiographic examinations within the clinical environment.

An argument for the use of high prevalence image test banks is their association with increased interpretive sensitivity (ability to

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accurately identify an abnormality) of a variety of pathologies[14,15] and potential reduction in the risk of injuries or pathologies being overlooked. However, their use is acknowledged to be associated with a reduced interpretive specificity (ability to correctly discern a normal examination) with practitioners mistaking normal variations for pathology. This may result in over treatment of patients and inappropriate use of service resources. Consequently, while high exposure to abnormal radiographic examinations is a valuable learning strategy to improve confidence and increase interpretive sensitivity, in the assessment of clinical competency (preparedness of learner to practice within the clinical setting), image test banks should reflect disease prevalence within the general population.

This article describes a new and novel approach to the design and validation of MSK image test banks developed to reflect local clinical workloads. The interpretive outcomes from this approach are compared to those achieved from a traditional manufactured image bank.

Methods

Setting

The study was undertaken within a single NHS Trust in the north of England comprising 3 different hospital sites. Each hospital site provided an acute trauma service but patient referral patterns and volumes differed between sites (Table 1). At the time of developing the new clinical workload image test banks, computed radiography (CR) was installed at all 3 sites supplemented by direct digital radiography (DDR) equipment at 2 sites. The data presented in this paper are drawn from a larger study assessing an educational intervention to support preliminary clinical evaluation (commenting) of MSK trauma examinations. The larger study was reviewed by the Trust research department and considered service evaluation as the education package and interpretation role are standard within the organisation and wider NHS. Consequently, ethical approval was not required.

Design of manufactured high prevalence image banks

An experienced academic radiographer (MH) who had previously led courses at undergraduate and postgraduate level on preliminary clinical evaluation (commenting) and radiographic image interpretation shared an established ‘menu’ of anatomical requirements for an academic image bank focussing on musculoskeletal trauma (Table 2). In designing the test bank, 70–75% of cases were to be abnormal and 30–40% of cases to be related to the immature skeleton (children and young people) as changing skeletal appearances are known to cause interpretive confusion.[11,16]

While there is no nationally agreed standard for the development or content of image banks, the ratio of normal (including normal variants) to abnormal examinations was in keeping with previously published studies.[7,8]

Three manufactured image banks (M1–M3) were created using the defined menu. Each test bank was made up of 50 unique clinical cases identified from the picture archive and communication system (PACS) (IMPAX, Agfa Gevaert, Belgium) and saved as a separate teaching file (patient demographics and report details excluded). Each case was double reported by an experienced reporting radiographer to ensure expert interpretive agreement. Where interpretive agreement was not established, the case was excluded from the manufactured image bank. In all cases the images were of high technical quality and included all relevant anatomy. Cases were excluded where inappropriate or poor radiographic technique was evident or where relevant anatomy was missing. Minor variations within the manufactured image bank menus existed in relation to the number of paediatric cases and abnormality rates (Table 3).

Table 1
Overview of hospital radiographic activity (2012).

	Site A	Site B	Site C
Total ED referrals for radiography (all anatomy)	32,761	64,892	92,892
Proportion of MSKED referrals (%)	36.9	26.7	25.4

Table 2
Manufactured image bank anatomical menu.

Upper limb (22 cases)	*Lower limb (15 cases)*	*Axial skeleton (13 cases)*
• Shoulder (3)	• Knee (3)	• Face/mandible (3)
• Humerus (1)	• Tib/fib (2)	• Cervical spine (3)
• Elbow (6)	• Ankle (5)	• Thoracolumbar spine (2)
• Forearm (2)	• Foot (5)	• Pelvis/hip (5)
• Wrist (5)		
• Hand/fingers (3)		

Design of clinical workload image banks

To determine a representative clinical workload, the daily emergency department (ED) radiographic referrals across each of the hospital sites for the 2012 calendar year were extracted from the radiology information system (RIS) and exported into Excel (Microsoft Corporation, Redmond, WA).

The total number of musculoskeletal referrals was calculated and data were further stratified for patient age (paediatric (0–17 years); adult (18–64 years); older person (65+ years)) and anatomy (all musculoskeletal areas; upper limb; lower limb; axial skeleton). The mean number of daily referrals (+/−1 standard deviation (S.D.)) across the seven age and anatomical categories were calculated for each site (Table 4). For the purpose of identifying a representative clinical workload image bank, all days in the calendar year where the number of ED radiographic referrals were within 1 S.D. of the calculated mean value for every category were considered to represent local clinical workload.

As Site B operated a single imaging system (CR), this site was chosen to reflect local clinical workloads in order to reduce variation in image appearances between test banks. Using a random number table generated to represent the 73 eligible inclusion days, the MSK radiographic images for 3 unique days were extracted into separate teaching files on PACS to remove patient identifiable information and report data. Each day represented a clinical workload image bank (Table 2: C1–C3).

On review of each clinical image bank, repeat referrals following fracture manipulation or foreign body removal were excluded. Importantly, no exclusions were made based on image quality. All included cases were re-reported by an experienced reporting radiographer and agreement between original and final image report established. Any cases where image reports were not consistent were excluded. The resultant clinical workload image banks comprised 49, 49 and 48 unique MSK cases.

Comparison of image banks

As was expected, the abnormality prevalence was higher within the manufactured image banks (range 72.0–74.0%) compared to the clinical workload image banks (range 16.7–34.7%). Other key differences were the relatively small number of axial skeleton examinations and greater proportion of lower limb examinations and normal variants present within the clinical workload image banks (Table 3).