Radiography xxx (2016) 1–7

Contents lists available at ScienceDirect

Radiography

journal homepage: www.elsevier.com/locate/radi

Image interpretation performance: A longitudinal study from novice to professional

C. Wright [a, *], P. Reeves [b]

[a] London South Bank University, 103 Borough Road, London, SE1 0AA, UK
[b] Sheffield Hallam University, Sheffield, S10 2BP, UK

ARTICLE INFO

Article history:
Received 27 April 2016
Received in revised form
15 August 2016
Accepted 17 August 2016
Available online xxx

Keywords:
RadBench
Image interpretation
Red dot
Radiographer
PCE
Clinical governance

ABSTRACT

Purpose: Universities need to deliver educational programmes that create radiography graduates who are ready and able to participate in abnormality detection schemes, ultimately delivering safe and reliable performance because junior doctors are exposed to the risk of misdiagnosis if unsupported by other healthcare professionals. Radiographers are ideally suited to this role having the responsibility for conducting the actual X-ray examination.

Method: The image interpretation performance of one cohort of student radiographers was measured upon enrolment from UCAS in the first week of university education and then again prior to graduation using RadBench ($n = 23$).

Results: The results identified that novices have a range of natural image interpretation skills; accuracy 35–85%, sensitivity 45–100%, specificity 15–85%, mean ROC 0.691. Graduates presented a narrower range; accuracy 60–90%, sensitivity 40–100%, specificity 60–90%, mean ROC 0.841. The positive shift in graduate mean accuracy (+16%) was driven by increases in specificity (+27%) rather than sensitivity (+5%). No statistically significant differences (ANOVA) could be found between age group, gender and previous education however trends were identified. 56.5% of the population ($n = 13$) met a benchmark accurate standard of 80%, including one graduate who met 90%.

Conclusion: Image interpretation testing at the point of UCAS entry is a useful indicator of future performance and is a recommended factor for consideration as part of the selection process. Whilst image interpretation now forms an integral part of undergraduate radiography programmes, new graduates may not necessary possess the reliability in decision making to justify participation in abnormality detection schemes, highlighting the need for continuous professional development.

Introduction

This paper presents a longitudinal study of the image interpretation skills of student radiographers from enrolment to graduation and considers the implications for the profession and the NHS in terms of reliable abnormality detection to aid service improvement in Accident and Emergency (A&E) departments.

Traditional UK National Health Service (NHS) practice is for a patient presenting in A&E be seen by a doctor, referred for X-ray, and then return to the doctor for evaluation. Rotation through A&E presents an important potential learning and development opportunity for junior doctors. Their lack of radiological expertise and related knowledge, however, exposes them to the risk of misdiagnosis if unsupported by other healthcare professionals. One solution might be to increase the number of radiologists in order to provide immediate reporting of images. This presents two key challenges, firstly, the demand for diagnostic imaging services has grown faster than the supply and, secondly, the high fiscal cost. The potential for radiographers to deliver equivalent accuracy of reporting to radiologists[1] offers an alternative solution. The joint publication of the Royal College of Radiologists and the College of Radiographers[2] takes a team working approach to formal image reporting, recognising the value of radiographers in delivering timely decisions ('hot reporting') to support patient management. The 2008 scope of practice survey[3] identified that 53% of participating NHS sites employed reporting radiographers. Hot reporting is generally only available during the day but a few centres offer it at night.

* Corresponding author.
E-mail address: chris.wright@lsbu.ac.uk (C. Wright).

http://dx.doi.org/10.1016/j.radi.2016.08.006
1078-8174/© 2016 Published by Elsevier Ltd on behalf of The College of Radiographers.

Initial image interpretation may also be performed by the examining radiographer, with a formal report provided either by a radiologist or reporting radiographer at a later stage. Radiography abnormality detection schemes (RADS) have traditionally focussed around 'red dot' and have been used for over 25 years.[4] There has recently been a push towards to the use of preliminary clinical evaluation (PCE), also known as 'commenting'. A UK wide survey[4] identified that 93% of participating hospitals operated abnormality signalling systems, although only 25% considered this to be a mandatory function.

A proliferation of studies[5–9] have highlighted deficiencies in the image interpretation competence of medical students and attributed this to the lack of formal radiological tuition. Unlike medical degree programmes, which offer limited exposure to formal instruction in X-ray image interpretation as part of undergraduate education,[10] modern undergraduate diagnostic radiography degree programs have changed[11] to meet the College of Radiographer's[12] policy that expects graduates to be able to provide reliable preliminary clinical evaluation (PCE) based on the radiographic images that they produce. The aim of this is to provide the referring doctor with key information to underpin the diagnostic decision. Whilst 'red dot' has enabled radiographers to make contributions to A&E services for many years, the College of Radiographers[12] argued that this approach no longer aligned with current clinical governance processes and should be phased out and replaced by PCE such that junior doctors would be provided with more directed information on which to base their patient treatment decisions. The first step in scaffolding this transition is developing the ability of radiographers to make the correct image interpretation decision before increasing confidence and then learning to write the PCE.[13] With further development some of these radiographers would then form the pool of future reporters.

Novices enrolling on diagnostic degree programmes in principle all start from the same point and undergo the same opportunities for image interpretation education within the same university; however in practice this might not actually be the case. This research study aimed to measure the performance of one full cohort of radiography students from a single university at the point of enrolment onto the undergraduate course from UCAS and compare it to their exit performance upon graduation.

Method

The decision-making performance of a single cohort of student radiographers at one university was measured at the point of enrolment from UCAS in week one of the first year and again one month prior to graduation in year three using the abnormality signalling component of RadBench, a specifically developed software program for measuring image interpretation performance.[14] Cognisant that making the correct decision is a precursor to accurate written description,[13] the option to collect preliminary clinical evaluation (PCE) was disabled in order to focus directly on decision making. The research received ethical approval from the study university. Students were provided with a participant information sheet and gave their written consent (n = 36). Participation was voluntary.

The test bank contained twenty appendicular musculo-skeletal images (see Fig. 1) which had a fifty per cent incidence of abnormality, confirmed by prior blind double reporting. Images were selected such that abnormality was restricted to a single fracture per image, all clearly visible with satisfactory search. Respondents were asked to choose from five options per image that best described their decision making confidence (1 = Definitely Normal, 2 = Probably Normal, 3 = Possibly Abnormal, 4 = Probably Abnormal, 5 = Definitely Abnormal). This format enables identification of decision making confidence and also facilitates the calculation of ROC. For the calculation of sensitivity, specificity and accuracy this data is binarised into normal and abnormal decisions. The distribution of images is illustrated in Fig. 1.

	Cases	Normal	Fracture
Ankle	4	2	2
Foot	4	2	2
Knee	2	1	1
Hand	4	2	2
Wrist	2	1	1
Elbow	2	1	1
Shoulder	2	1	1
Total	20	10	10

Figure 1. Case mix.

An identical randomised image bank was used for both tests. Answers were not revealed after the enrolment test. Students were unaware that the graduation test was a randomised clone of the enrolment test.

The results from both tests were analysed in terms of accuracy, sensitivity, specificity to compare enrolment with graduation performance; analysis of variance (ANOVA) with previous education, gender and age group. The receiver operator characteristic (ROC) was calculated with the JROCFIT web based calculator.[15]

Results

Thirteen students elected not to complete the final assessment and were therefore excluded from the data analysis (n = 23). Their demographics are presented in Fig. 2.

Fig. 3 provides a box-plot to summarise performance.

Mean sensitivity at enrolment was 73% (std dev = 0.157) with a range from 45 to 100%. Mean sensitivity at graduation was 78% (std dev = 0.107) with a range from 40 to 100%.

Mean specificity at enrolment was 49% (std dev = 0.153) with a range from 15 to 85%. Mean specificity at graduation was 76% (std dev = 0.153) with a range from 40 to 100%.

Mean accuracy at enrolment was 61% (std dev = 0.113) with a range from 35 to 85%. Mean accuracy at graduation was 77% (std dev = 0.072) with a range from 60 to 90%.

ROC at enrolment was 0.691 increasing to 0.841 at graduation. See Fig. 4

Fig. 5 demonstrates the difference in accuracy between enrolment from UCAS and graduation by student. Supporting the evidence of the ROC, the accuracy of 91% (n = 21) of students improved, one stayed the same, and one decreased. Analysis of variance (ANOVA) demonstrated no significant differences at a 95% confidence level (p = 0.555).

The mean accuracy improvement was 16%, driven predominantly by the 27% increase in specificity relative to the sensitivity which increased by only 5%.

Unsurprisingly no student could meet a 90% benchmark standard upon enrolment from UCAS although 13% (n = 3) could achieve the 80% standard. At graduation 4% (n = 1) could meet a 90% standard and 52% (n = 12) an 80% standard.

Considering graduate performance, analysis of variance (ANOVA) demonstrated no significant differences at a 95%

Please cite this article in press as: Wright C, Reeves P, Image interpretation performance: A longitudinal study from novice to professional, Radiography (2016), http://dx.doi.org/10.1016/j.radi.2016.08.006