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Agreement between expert thoracic radiologists and the chest radiograph reports provided by consultant radiologists and reporting radiographers in clinical practice: Review of a single clinical site

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ABSTRACT

Introduction: To compare the clinical chest radiograph (CXR) reports provided by consultant radiologists and reporting radiographers with expert thoracic radiologists.
Methods: Adult CXRs (n = 193) from a single site were included; 83% randomly selected from CXRs performed over one year, and 17% selected from the discrepancy meeting. Chest radiographs were independently interpreted by two expert thoracic radiologists (CTR1/2).Clinical history, previous and follow-up imaging was available, but not the original clinical report. Two arbiters compared expert and clinical reports independently. Kappa (K), Chi Square (χ^2) and McNemar tests were performed to determine inter-observer agreement.
Results: CTR1 interpreted 187 (97%) and CTR2 186 (96%) CXRs, with 180 CXRs interpreted by both experts. Radiologists and radiographers provided 93 and 87 of the original clinical reports respectively. Consensus between both expert thoracic radiologists and the radiographer clinical report was 70 (CTR1; K = 0.59) and 70 (CTR2; K = 0.62), and comparable to agreement between expert thoracic radiologists and the radiologist clinical report (CTR1 = 76, K = 0.60; CTR2 = 75, K = 0.62). Expert thoracic radiologists agreed in 131 cases (K = 0.48). There was no difference in agreement between either expert thoracic radiologist, when the clinical report was provided by radiographers or radiologists (CTR1 χ = 0.056, p = 0.813; CTR2 χ = 0.014, p = 0.906), or when stratified by inter-expert agreement; radiographer McNemar p = 0.629 and radiologist p = 0.701.
Conclusion: Even when weighted with chest radiographs reviewed at discrepancy meetings, content of CXR reports from trained radiographers were indistinguishable from content of reports issued by radiologists and expert thoracic radiologists.

Introduction

Clinical imaging is fundamental to modern medicine and worldwide there has been a sustained increase in demand for all radiological investigations.[1–4] The chest radiograph is integrated into many patient pathways, and is the most frequent radiology examination in England with approximately 6.7 million performed in 2015–16.[5] The rise in demand for imaging has not been matched with increased diagnostic capacity.[6] The Royal College of Radiologists (RCR) has found that more than 230,000 imaging examinations across all modalities are waiting more than 30 days to be reported,[7] of which 170,00 are plain imaging investigations. Further, the volume of non-radiology clinicians who interpret their own examinations is increasing.[8] Clinical reporting by trained radiographers is established in the UK, and used by many departments to meet rising demand.[8–10] Recent work by Milner et al. suggests that this is concentrated on musculoskeletal radiograph reporting (255 of 259 respondents, 98.5%) with only 39 individual radiographers (15.1%) indicating that they currently report CXRs in

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practice.[11] There is definitive evidence that reporting radiographers interpret skeletal radiographs with high accuracy.[12,13] Evidence regarding chest radiograph reporting by trained radiographers is more limited.[14,15] Several earlier studies have examined the performance of radiographers in identifying normal and abnormal CXRs with promising results.[16–18] However, the radiographers had not completed accredited postgraduate CXR reporting training.

The aim of this study was to compare the content of clinical CXR reports, which had been provided by consultant radiologists and reporting radiographers with expert thoracic radiologists during the construction of a standard reference bank of CXRs.

Methods

Design, setting and ethical approval

This retrospective study, mirroring a case–control design, was conducted in an acute district general hospital that performed approximately 20,000 hospital based CXRs per year. The purpose of the study was to establish an image bank with a robust reference standard diagnosis to examine diagnostic accuracy. Ethical approval was obtained from City Road & Hampstead research ethics committee (13/LO/0639 21 May 2013) prior to the study commencing.

Case selection

A sample of anonymised adult (>16 years) CXRs performed over a consecutive twelve month (April 2010–March 2011) period at a single London acute district general hospital was used. A total of 106 CXRs (normal n = 53, 50%) were required for the image bank. An estimated 176 cases were required to be reviewed to generate a test bank of 106 CXRs with agreed reports assuming 61% agreement between experts.[19] Sim and Wright estimate that for a disease prevalence of 50% and Kappa (K) of 0.5 a total of 43 cases would give 90% power to detect a significant difference at p = 0.05.[20] All CXRs were acquired using computed radiography (CR) or direct digital radiography (DR) systems. The time frame was chosen to enable all clinical or radiological follow up to be performed in order to provide maximum clinical information to the expert thoracic radiologists so that a robust reference standard diagnosis could be formed. Comparison of case mix and the use of follow-up images and CT scans has not changed substantially between data collection (2010) and publication (2018; local audit data). Inclusion criteria were patients referred by a hospital based clinician; emergency department, outpatient and inpatient examinations. Chest radiographs of patients under 16 years of age, referrals from general practice and multiple CXRs from a single patient were excluded. Referrals from general practice were excluded due to logistical difficulties in obtaining case notes for review as part of the reference standard diagnosis.

Cases were also drawn from the monthly radiology discrepancy meeting (32, 17%). Reports were provided by both consultant radiologists (n = 8) and reporting radiographers (n = 2). Selection of difficult cases from the discrepancy meeting ensured that the resultant image bank included a range of subtle cases (difficult normal and abnormal) to ensure that it would be discriminatory for small differences in observer performance for the study of diagnostic accuracy.

To ensure that a representative sample of normal and abnormal cases and a range of pathologies were included in the image bank that was to be formed, cases were stratified for a normal:abnormal ratio of 1:1 and, for abnormal cases, a disease category (infection: cardiopulmonary: malignancy: other) ratio of 3:3:1:3. Examples of cardiopulmonary pathology included pulmonary oedema, congestive cardiac failure and pericardial effusion. The percentage of cases within each broad disease category was based on the proportions found at audit of most frequent discharge diagnoses associated with CXRs performed at the study site. These proportions were matched against national disease datasets, and found to be similar.[21] Stratification of the cases (normal and for each disease category) was performed, based on the clinical report provided by the reporting practitioner at time of clinical interpretation. Stratification of CXRs was consistent for reporting radiographer and consultant radiologist reports.

Reporting

Chest radiograph reports were provided by reporting radiographers (post accredited education experience 1 and 3 years) and consultant radiologists (n = 8; experience 1–20 years post-FRCR). Two consultant radiologists with a subspecialist interest in thoracic imaging (consultant thoracic radiologists; CTR1/CTR2) independently interpreted the CXRs, blinded to the clinical report. All pertinent imaging (previous and follow up CXRs, cross-sectional imaging) were available, and patient demographics and clinical history provided. Best practice in reporting is to review previous imaging when available. Additional imaging was made available to the thoracic radiologists so that a robust reference standard diagnosis could be obtained for the image bank. Features to be considered normal (incidental findings) and significant (abnormal) were agreed in advance, based on the work of Robinson et al.[19] The expert thoracic radiologists indicated if the CXR was normal or abnormal, and for all abnormal cases, identified, localised and provided a diagnosis for all abnormalities present.

Report comparison

Two independent arbiters compared both the interpretations of the expert thoracic radiologists and each thoracic radiologist interpretation with the clinical report. Both arbiters had experience in comparing radiology reports for agreement in academic practice as part of clinical reporting assessment. Reports were determined to be in concordance only when both independent arbiters agreed that all abnormalities were identified and localised. Arbiters were blinded to the source of the report and did not have access to the images, patient demographics or clinical history.

Statistical analysis

Inter-observer agreement, between thoracic radiologists and between each thoracic radiologist and the clinical report, was determined using Kappa (K) statistic. Agreement was categorised according to Landis and Koch.[22] Moderate ($0.41 < K < 0.60$) agreement corresponds to 15–35% of data that is reliable and substantial ($0.61 < K < 0.80$) translates to 35–63% reliability.[23] Chi square and McNemar's test were used to examine the proportion of cases where the thoracic radiologist interpretations were in concordance with the clinical report provided by consultant radiologists and reporting radiographers. For this measure agreement was exact, missing no pathologies and not adding any other findings, rather than an agreement at the level of a clinical diagnosis. Statistical difference between observers was determined by examination of the 95% confidence intervals for Kappa; overlapping indicates no statistical significant difference for all analyses and sub analyses.[24]

Results

A summary of cases included and reviewed by expert thoracic radiologists is presented in Fig. 1.

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