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The development and evaluation of an audit tool for measuring reporting accuracy of radiographers compared with radiologists for intra-luminal pathology detected at computed tomography colonography (CTC)

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ABSTRACT

Objective: To design and test an audit tool to measure the reporting accuracy of radiographers using radiologist reports as the gold standard.
Design: A database was designed to capture radiographer and radiologist report data. The radiographer preliminary evaluation of intraluminal pathology was given a score (PDS score) by the reporting radiologist based on the pathology present, the discrepancy between the preliminary evaluation and the final report and the significance of that discrepancy on the clinical management of the patient. To test the reliability of this scoring system, 30 randomly selected cases (n = 1815) were retrospectively compared and assessed for accuracy using the PDS score by 3 independent practitioners. Inter rater reliability was assessed using percentage agreement and kappa scores.
Results: There was 100% agreement between participants for all significant pathologies. Inter rater agreement was 80–93% for normal studies and insignificant pathologies.
Conclusion: Results indicate that the tool provides a practical, easy to use and reliable method to record, monitor and evaluate a preliminary evaluation of the colon by radiographers.

Background

Bowel cancer is one of the three most common cancers in both men and women[1] with 41,600 new cases diagnosed in the UK in 2011.[2] Incidence is strongly related to age with 95% of cancers presenting in people aged 50 and over, and the highest rates found in those aged 85 and over.[3] The incidence of mortality from bowel cancer is strongly linked to tumour size and progression[4] so it is important to detect bowel cancer early in order to achieve the best outcome for the patient. Research suggests over 90% of bowel cancer patients will survive the disease for more than five years if diagnosed at the earliest stage.[2,5] In recognition of this the Bowel Cancer Screening Programme (BCSP) started in 2006 and is predicted to save over 2000 lives each year by 2025 through identification of adenomas, a non-malignant precursor to the colonic tumour which account for 95% of all colorectal tumours and polyps.[4]

The current methods of imaging the bowel for patients with symptoms suggestive of a colorectal cancer are optical colonoscopy (OC), double contrast barium enema (DCBE) and computed tomography colonography (CTC), also referred to as virtual colonoscopy (VC). In 2013 the SIGGAR Trial published two papers looking at CTC versus DCBE and OC versus DCBE. This large, multi-centred, randomised trial looked at 3838 patients from 21 UK hospitals and concluded that CTC detected significantly more colorectal cancers or large polyps than DCBE, was more appropriate for the frail and elderly and was as sensitive but less invasive than OC.[6,7]

CTC is a relatively new method of examining the large bowel. It was first described by Amin et al., in 1996[8] and advocated for use in the frail and elderly by Domjan in 1998.[9] In 2007 the European Society of Gastrointestinal and Abdominal Radiology (ESGAR) published a consensus statement on conducting and interpreting the examination.[10] More recently an expansion of literature through the publication of a number of important multi-centre trials has resulted in the wide use of CTC for investigation of

Abbreviations: CTC, computed tomography colonography; VC, virtual colonoscopy; DCBE, double contrast barium enema; GI, gastrointestinal; P score, pathology score; PDS score, pathology discrepancy significance score; OC, optical colonoscopy; BCSP, bowel cancer screening programme.

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symptoms suggestive of CRC and recommendation for its use in screening for CRC.[11]

NICE guidance now recommends the use of CTC over DCBE for imaging the colon[12] and BCSP guidance states that CTC, not DCBE should be used for screening patients.[13] DCBE is not recommended by any of the institutions discussed in this paper and as a result, has been disregarded as a choice for radiological investigation.

With suitable bowel preparation of the patient to include faecal tagging, insufflation of the bowel lumen with CO_2 and 3D reconstruction of images the colon can be demonstrated to a standard comparable to OC.[7] When full cathartic bowel preparation is inappropriate[7] minimal preparation CTC is undertaken using an oral contrast tagging agent, usually Gastrografin,[14] but no purgation. This is used for patients with limiting co-morbidities or poor mobility where full bowel preparation would be contra-indicted[15] and DCBE or OC deemed inappropriate.[16] Patients at the study hospital receive Picolax (sodium picosulfate) or Senna (hydroxanthanthracene glycosides) laxative and Gastrografin (sodium amidotrizoate and meglumine amidotrizoate) tagging. Patients with significant comorbidities or contraindications are given Gastrografin tagging only.

The requirement to provide a safe, acceptable test, combined with a move towards extending the upper age limit for bowel screening, an ageing population and an expectation from service users that the "best test" will be offered means the demand for CTC is set to increase at a rapid rate. In order to manage this pressure on resources whilst providing a viable, efficient service radiographer engagement in image reporting will be essential.[17] A recent systematic review of radiographer reporting of this examination acknowledged that with sufficient training and experience radiographers could offer a valuable contribution to the service by providing a primary clinical evaluation of intraluminal pathology.[18–20] With gastrointestinal (GI) radiographers transferring their skills from DCBE to CTC there is a need for them to develop comparable competencies for this modality. It is therefore necessary to audit the performance of radiographers in the quality and accuracy of their clinical evaluation of intraluminal pathology.

Aims of the study

To develop an audit tool to assess radiographer reporting accuracy when compared to the gold standard radiologist report for CTC examinations in a clinical setting.

To validate the audit tool by repeating the report scoring process with a single dataset and multiple users.

Study design

Descriptors were set to group reports by pathology with conservative parameters for each group. These were established using accepted published data on recommendations for the reporting of abnormalities at CTC.[13,21] The CT Colonography Reporting and Data System (C-RADS) uses a scale of C0–C4 to categorise CTC abnormalities as described in Table 1.[22]

Table 1
C-RADS descriptors.[22]

Scale	Descriptor	Action
C0	Inadequate study	
C1	Polyps ≤ 6 mm	Continue routine surveillance
C2	Intermediate polyp 7 mm-9mm	Surveillance or colonoscopy recommended
C3	Polyps ≥10 mm	Follow up colonoscopy recommended
C4	Colonic mass or malignancy	Surgical consultation recommended

It should be noted that normal studies are not coded within C-RADS for reporting abnormalities. Also, C-RADS was used to inform the design of the pathology discrepancy and significance (PDS) scoring used for this study but was not used to categorise pathology.

This audit tool assigned a pathology or "P score" using very similar parameters to C-RADS but was more cautious by establishing a cut off of ≤4 mm for polyps in the P2 group (see Table 2). This was done because at the time of the study the local policy was for radiologists to report on all polyps, however small. As a result all diminutive polyps seen at CTC were described in the final report and it was important that the radiographer preliminary evaluation reflected this.

Using these P scores the radiographer preliminary evaluation was assigned a final score which incorporated the P score, the level of correlation between the two reports and the clinical significance of any discrepancy demonstrated. This is the "pathology discrepancy and significance score" (PDS score) and is recorded by the radiologist at the time of reporting (see Table 3).

It is this score which is used to determine radiographer accuracy. Where more than one pathology is present the P score will reflect the most clinically significant (see Table 2). The PDS score however will be applied to any missed pathology with the score relating to the significance of the pathology missed. For example, a reported tumour but a missed 10 mm polyp would result in a PDS score of 4 but a reported tumour alongside a missed 4 mm polyp would result in a PDS score of 2 (see Table 3).

Method

Radiographers at the study hospital contribute to CTC reporting by offering a preliminary clinical evaluation of intraluminal colonic pathology. Prior to commencement of this role radiographers completed a recognised training course to gain skills in CTC technique and initial image interpretation.[21] Throughout the study period the supervising radiologist offered direct support as required and gave feedback to the trainee by completing a comments box provided as part of the audit tool database. This database was set up using Access 2010 (Microsoft Corporation) to capture the information presented in Table 4.

The database is designed to facilitate data collection, the review of findings and the provision of feedback to encourage peer review through discussion. Peer review encourages assessment of quality, enables the provision of feedback, and supports reflection on practice with the intent to improve care quality.[23]

The radiographer entered the patient demographics and their findings on the database as described above. The radiologist reported each examination blinded to the radiographer's findings and then checked the radiographer preliminary clinical evaluation with their own; made comment on any pathology missed and scored the relevance of the discrepancy (PDS score). They also added their identity to the database to enable the radiographer to identify their supervisor if required. The final report was issued with consideration given to the radiographer findings thus providing a double read of the bowel and improving the sensitivity of the test.[24]

A retrospective audit was undertaken of the audit tool described. The purpose of this was to determine whether the audit tool produced consistent and replicable results, irrespective of who undertook the scoring. The study was approved by the Trust Clinical Audit Team.

From this database of 1815 cases 30 were selected by taking all cases on Monday of each week between 02.09.13 – 04.11.13. No differentiation was made between symptomatic and screening cases. Although the sample size was small it was representative of

Table 2
P Score descriptors.

Score	Pathology
P0	Not scored, inadequate study
P1	No intra-luminal pathology reported
P2	Diminutive polyp ≤ 4 mm, diverticulae
P3	Small polyp 5 mm – 9 mm/diverticular disease to include wall thickening and stricturing
P4	Polyp ≥10 mm, carcinoma, complicated diverticular disease (collection, fistula, abscess)

Table 3
PDS score descriptors.

Score	Description
PDS0	Not scored – inadequate study/missing data
PDS1	Report agreement (P1–P4 reports)
PDS2	Discrepancy with P2 reports (insignificant discrepancy)
PDS3	Discrepancy with P3 report
PDS4	Discrepancy with P4 report

the larger database; 24 patients had received Senna, 5 had been given Picolax and one had Moviprep purgation. An antispasmodic was given to 24 of the 30 selected cases.

For the purpose of the audit tool validation an additional two radiographers were also asked to undertake the scoring process by comparing the radiographer preliminary report with the final radiology report. Both were experienced GI radiographers, one a trainee and the other with an established role in evaluating intra-luminal pathology at CTC. They worked independently and without prior knowledge of the radiologist score. Their results and the initial radiologist score were used to produce three datasets for evaluation.

The aim was to determine whether the PDS score could be reliably replicated by other users and therefore suitable as an audit tool for a much bigger research project looking at the entire database.

Because of the high agreement between raters and the small variation in scores across categories, agreement was tested using both percentage agreement and Kappa scores in order to interpret reliability.[25,26]

The results of this statistical analysis of interrater reliability are detailed in Table 7.

Table 4
Database information.

Patient ID	Patient identifier, number unique to each study.
Radiographer ID	Initials of the radiographer providing the preliminary clinical evaluation.
Radiologist ID	Initials of the reporting radiologist.
Study date	Date of examination.
Radiographer report	Radiographer findings to include presence and severity of diverticular disease and the presence, size and location of any polyps or malignancy. Description of location to include anatomical area and CT slice number for both prone and supine scans.
PDS score	The PDS score represents a measure given to describe report discrepancies which considered both the difference between the two reports and the clinical significance of that discrepancy.
Radiologist comments	Descriptive comments to support the PDS score. These may also include constructive feedback to the radiographer as part of the ongoing training and development of reporting skills.
Further comments	For follow up information on further examinations such as endoscopy or pathology reports

Table 5
Pathology distribution.

P Score	Distribution	Description
P1	5	Normal – 5
P2	22	Diverticular disease – 17 Diminutive polyps – 5
P3	1	7 mm polyp
P4	2	Colorectal malignancy

Results

The sample reports selected for audit contained adequate pathology to test the audit tool with pathology reported on 25 of the 30 studies, as shown in Table 5.

The results demonstrated agreement between tool users ranged from 80 to 100% for normal studies and insignificant discrepancies, as shown in Table 6.

A PDS score of 0 was not recorded by any participants indicating that all studies included were diagnostic and the radiographer preliminary evaluation and final radiology report were documented on the database (see Table 6). PDS scores of 3 and 4 were not recorded by any participants indicating 100% agreement between participants for any clinically significant (P3 and P4) pathologies (see Table 6).

Discussion of results

This study involved a small dataset from the total database of over 1800 cases; a larger dataset may have given more robust measures of validity and reliability. However, the current number was considered to have sufficient degrees of freedom to provide a reasonably robust result.

As there were no PDS scores of 3 or 4 (i.e. discrepancy with 5–9 mm polyps or colorectal malignancy) and all the radiologists' scores were PDS1 (report agreement) there was insufficient variability in the results to enable a kappa score to be obtained. This will frequently occur in datasets such as these where there is good agreement.[27]

If scores for PDS1 (report agreement) and PDS2 (insignificant discrepancies) are combined, inter-rater agreement becomes 100% for all participants using the audit tool to assess reader/reporter agreement.

Because current policy is for all intra-colonic pathology to be mentioned in the radiologist report it was felt appropriate for the radiographer to comment on all polyps, however small, and to detail size, position and degree of certainty in diagnosis. The decision on whether to include diminutive polyps in the final report lay with the radiologist but the need to include these findings increased the likelihood of reader or reporter error or discrepancy as sensitivity and specificity for polyp detection at CTC reduces with reduced polyp size.[7]

Making the effort to detect and describe diminutive polyps did however give the trainee the opportunity to develop advanced skills in pattern recognition and use of the reporting software in the clinical setting where, whilst all patients were symptomatic or had

Table 6
Frequency results - PDS scores for all participants.

PDS Score	Trainee radiographer	Experienced radiographer	Radiologist
1	24 (80%)	28 (93.3%)	30 (100%)
2	6 (20%)	2 (6.7%)	0
3	0	0	0
4	0	0	0

Table 7
Summary of statistical analysis.

Findings compared	Number of valid cases	% Agreement	Kappa score
Radiologist v experienced radiographer	30	93	*
Radiologist v trainee radiographer	30	80	*
Experienced radiographer v trainee radiographer	30	87	.444

*Kappa scores were not calculable or poor because of low or no variance between responses.[27]

a positive FoB result through the BCSP, pathology was likely to be less frequent than in a more "customised" training environment where positive cases are pre-selected for interpretation.

The study uses a polyp size of 4 mm as the cut off between diminutive and small polyps. This decision recognises the discrepancies around accurate measurement of polyps with CT under sizing when compared to endoscopy, and endoscopy over sizing when compared with pathology specimens.[4]

It is acknowledged that reporting on 4 mm polyps is not in agreement with the findings of some studies[28,18] where 6 mm is the minimum suggested polyp size for reporting but setting the standards described and ensuring rigorous assessment of training through audit encourages recognition, reporting and measuring of small lesions by the radiographers and is supported by opinion from other studies advising surveillance and/or polypectomy for small and diminutive polyps.[29,30]

These studies acknowledge the lack of data as polyps, once detected, are usually removed[29] and agree that establishing a cut off size for polypectomy is difficult. The BCSP minimum dataset for CTC reporting would classify any number of polyps less than 5 mm diameter as C1 (normal, benign lesion or polyps <5 mm) but a joint document from the British Institute of Gastrointestinal and Abdominal Radiology and the Royal College of Radiologists advocate the reporting of <6 mm polyps, especially multiple polyps and when confidence levels are high.[31]

Review of scoring by the different participants, even with the small numbers used, suggests that the more experienced the reader the less likely they are to score an insignificant discrepancy and the more confident they are in calling subtle differences in pathology descriptions a match. If it had been possible to have all studies matched independently by 3 radiologists the tool may have demonstrated a higher degree of reliability. It should be noted that, in the clinical setting, a radiologist is responsible for producing all PDS scores.

In clinical use as an audit tool it would be necessary to set standards by which to measure radiographer performance based on the PDS scores achieved. This has not been described in this paper as its purpose was solely to describe and validate the tool.

Finally, it is also important to emphasise that the audit tool does not recognise the accuracy of either report or identify when the radiologist report is changed in response to the opinion of the radiographer. Neither would it identify a significant missed pathology if the lesion was missed by both radiographer and radiologist. The team using this tool in clinical practice is however, confident that double reporting of CTC images reduces the likelihood of such an event occurring.[24]

Conclusion

The results indicate that the audit tool provides a practical, easy to use and reliable method to record, monitor and evaluate a preliminary evaluation of the colon by radiographers. It provides an effective method of recording data which can be accessed to support radiologist reporting whilst providing radiographer training, support and audit. Over time it can be used to monitor effectiveness of training models and provide data on the individual performance of radiographers providing a preliminary clinical evaluation of intraluminal pathology as part of a radiology report.

Further recommendations

If more sites could adopt the audit tool, there would be an opportunity to look into a potential accuracy threshold deemed safe practice by reporting radiographers.

If data were collected for many radiographers it would be possible to inform and give guidance on the activity required to achieve competence and excellence levels in radiographer preliminary clinical evaluation.

The comments section of the database has recently been extended to enable collection of retrospective data to include endoscopy and pathology reports for review to determine the accuracy of both the radiographer clinical evaluation and the radiology report as compared with endoscopy reports or pathology results to provide data for BCSP QA audit.[32]

Conflict of interest

None.

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