The role of the radiographer in a Computed Tomography Colonography service: to look at service provision and the reporting of intra-luminal pathology

Submitted by Susan Jane Rimes to the University of Exeter as a thesis for the degree of Masters by Research in Medical Imaging in October 2015

I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

Signature: ……..

Abstract

Phase 1 - Accuracy of radiographer primary clinical evaluation of intraluminal pathology at computed tomography colonography.

Objective; Computed Tomography Colonography plays a vital role in the diagnostic pathway for colorectal cancer and colonic polyp management. As demands for the service grows and imaging departments are encouraged to move away from offering the barium enema and towards a CT service radiographer skills need to develop to support this. There is potential for radiographers to be trained to provide a clinical evaluation of the bowel lumen and this study looks at radiographer accuracy for this task as demonstrated in the clinical setting over a four year period.

An audit was completed to determine the accuracy of a radiographer primary clinical evaluation of intraluminal pathology identified at computed tomography colonography.

Design; A retrospective audit following development and validation of a suitable audit tool was undertaken on a database of radiographer preliminary clinical evaluations to measure the accuracy of the radiographer opinion against radiology reports, endoscopy and pathology findings.

Method; A database was designed to capture radiographer and radiologist report data. The radiographer's preliminary clinical evaluation of intraluminal pathology was given a score (the PDS score) by the reporting radiologist based on the pathology present, the discrepancy between the preliminary clinical evaluation and the final report and the significance of that discrepancy on the clinical management of the patient. A one-way analysis of variance was undertaken to assess for consistency in use of the audit tool by the radiologists. Agreement for the radiographer primary clinical evaluation was assessed using percentage agreement and kappa scores. Significant discrepancies between findings were compared against endoscopy and pathology reports.

Results; There was direct or near agreement between the radiographer primary evaluation and the final radiology report for 95.6 %(98.4% adjusted) of cases.

There was a significant discrepancy between findings in 2.7 %(2.8%adjusted) of cases and a major discrepancy recorded for 0.3 %(0.2% adjusted) of cases. 1.4% of cases did not have a radiographer preliminary clinical evaluation prior to reporting by a radiologist.
Conclusion; With suitable training radiographer preliminary clinical evaluation of intraluminal pathology at Computed Tomography Colonography is accurate enough to provide a valuable contribution to decision making during the procedure and to support a double read reporting service. Thought should be given to independent radiographer reporting of intraluminal pathology for Computed Tomography Colonography.

Phase 2 - Survey of current clinical practice of radiographers performing Computed Tomography Colonography.

Objective; To benchmark current accepted practice for UK radiographers in all areas of providing a Computed Tomography Colonography service.
Design; An online survey was conducted and promoted by various sources including the College and Society of Radiographers.
Method; UK radiographers were invited to take part in a survey investigating provision of a Computed Tomography Colonography service including managing referrals, prescription and administration of drugs, patient care, decision making during the procedure and image evaluation. In addition it collected data on the competencies, grades and qualifications of staff and basic demographic information on the hospital.
Results; Radiographers were involved in all aspects of the Computed Tomography Colonography service but roles varied greatly between sites and individuals although they seemed appropriate for the employed grade and qualifications of staff. Most respondents demonstrated effective use of radiographer skills in a few key areas but few provided a radiographer led service, no hospital provided a Computed Tomography Colonography service without radiologist support and no respondent offered independent radiographer reporting. Opinions on training varied; those with the most autonomy of practice

felt appropriately trained and qualified whilst those in a more supporting role on lower grade desired more training. Gastrointestinal radiographers seemed to receive more training opportunities and were employed at higher grades when compared with their cross-sectional imaging colleagues undertaking similar tasks.

Conclusion; There is potential for advanced radiographer roles to be developed through use of protocols, sharing of best practice and effective use of referral pathways and patient group directives to provide enhanced services.

There is a need for the definition of roles and responsibilities within grades for radiographers in order to achieve parity in practice across specialties and between hospital sites. These developments requires support through education by the provision of formal accredited post graduate courses to underpin advanced practice at this level, support research and encourage peer review as practice evolves.

List of contents

Chapter 3 – Development and validation of the audit tool

Chapter 4 – Audit of radiographer preliminary clinical evaluation of intraluminal pathology

Chapter 5 – A survey of the role of the radiographer in Computed Tomography Colonography

List of associated work

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) - publication. (1)

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.

Radiographer preliminary clinical evaluation of intraluminal pathology for computed tomography colonography (CTC) - presentation, regional Bowel Cancer Screening Programme meeting (2)

No abstract provided for this meeting

Radiographer preliminary clinical evaluation of intraluminal pathology for computed tomography colonography (CTC) – poster UKRC(3)

Abstract
Objective; An audit was completed to determine the accuracy of a radiographer primary clinical evaluation of intraluminal pathology of computed tomography colonography. *Design;* A retrospective audit using a validated audit tool was applied to a database of radiographer clinical evaluations to measure the accuracy against radiology reports, endoscopy and pathology findings.
Method; A database was designed to capture radiographer and radiologist reporting data. The radiographer's preliminary clinical evaluation of intraluminal pathology was given a score (PDS score) by the reporting radiologist based on the pathology present, the discrepancy between the preliminary clinical evaluation and the final report and the significance of that discrepancy on the clinical management of the patient. A one-way ANOVA was undertaken to assess for consistency in use of the audit tool by the radiologists. Accuracy of the radiographer primary clinical evaluation was assessed using percentage agreement and kappa scores. Significant discrepancies were compared against endoscopy and pathology reports.
Results; There was agreement with or an insignificant discrepancy between the radiographer primary evaluation and the final radiology report for 95.6% of cases. There was a significant discrepancy between findings in 2.7% of cases and a major discrepancy recorded for 0.3% of cases.
Conclusion; With suitable training radiographer primary clinical evaluation of intraluminal pathology of computed tomography colonography is accurate

enough to provide a valuable contribution to decision making during the procedure and to support a double read reporting service.

Survey of current practice of CTC radiographers; United Kingdom Radiology Congress.(4) (presentation), Rimes S, Fox D, Knapp K, Meertens R. June 2015. ACC Liverpool.

Abstract

Objective; To benchmark current accepted practice for UK radiographers in all areas of providing a computed tomography colonography (CTC) service.
Design; An online survey was conducted and promoted by various sources including the College and Society of Radiographers.
Method; UK radiographers were invited to take part in a survey investigating provision of a CTC service including managing referrals, prescription and administration of drugs, patient care, decision making during the procedure and image evaluation. In addition it collected data on the competencies, grades and qualifications of staff and basic demographic information on the hospital.
Results; Radiographers are involved in all aspects of the CTC service but roles vary greatly between sites and individuals although they seem appropriate for the employed grade and qualifications. Most respondents demonstrated effective use of radiographer skills in a few key areas but few provided a radiographer led service, no hospital provided a CTC service without radiologist support and no respondent offered independent radiographer reporting. Opinions on training varied; those with the most autonomy of practice felt appropriately trained and qualified whilst those in a more supporting role on lower grade desired more training.
Conclusion; There is potential for advanced radiographer roles to be developed through use of protocols, sharing of best practice and effective use of referral pathways and patient group directives leading to enhanced services.

List of tables

List of figures

Abbreviations

AfC- agenda for change

ANNOVA – analysis of variance

BE – barium enema

BCSP – bowel cancer screening programme

BSGAR – British society of gastrointestinal and abdominal radiology

CAD – computer aided detection

CRC – colorectal cancer

C-RADS – CT colonography reporting and data system

CTC – computed tomography colonography

FAP – familial adenomatous polyposis

GI – gastrointestinal

GP – general practitioner

HCPC – health and care professions council

HNPCC – hereditary non polyposis colorectal cancer

HQUIP – health quality improvement partnership

IRAS – Integrated Research Application System

IVCM – intravenous contrast medium

NICE - national institute for health and clinical excellence

NPSA – national patient safety alert

OC – optical colonoscopy

PCE – preliminary clinical evaluation

PenCLAHRC - Peninsula Collaboration for Leadership in Applied Health and Research Care

PHE – public health England

PDS – pathology discrepancy score

PGD – patient group direction

RCR – royal college of radiologists

SCoR – society and college of radiographers

SIGGAR – special interest group in gastrointestinal and abdominal radiology

WTE – whole time equivalent

Chapter 1 Introduction

1.1 Introducing the study

This study was undertaken to look in detail at the role played by UK radiographers in delivering a computed tomography colonography (CTC) service. With CTC now established as the gold standard radiological investigation of the large bowel (5) it is essential that radiographers as a professional group have an understanding of their role based on national guidance, published research evidence and current accepted practice. This work hopes to benchmark current radiographer practice and produce some information on the potential for radiographers to offer a 1st read or preliminary clinical evaluation (PCE) for intraluminal pathology and to deliver a radiographer led CTC service.

The need for CTC will continue to expand as barium enema (BE) is considered inadequate for use by the bowel cancer screening programme (BCSP)(6), less sensitive by referring clinicians (5, 7) and inappropriate for frail and elderly patients (8). As imaging departments transfer skills and resources from BE to CTC it is important for radiographers to remain involved as an essential part of the service and that their skills and the support they offer is recognised and rewarded within their job roles.

This research was designed to look at all aspects of the service, from referral through to reporting and radiographers in the UK currently involved in CTC were invited to participate. The complete study was formed into two discrete phases

1. Development and validation of the audit tool and audit of radiographer preliminary clinical evaluation (PCE)
2. Survey of current UK scope of practice for CTC radiographers

1.2 Background of the disease

Colorectal cancer (CRC) is the fourth most common cancer in the UK with 41,600 people diagnosed with the disease in 2011. This represents an increase

in incidence of 6% in the last 10 years(9). It remains the third most common cancer in both men and women and is the second most common cause of cancer death in the UK(9).

However, deaths attributed to bowel cancer have dropped by 14% over the last decade with 90% of patients surviving more than 5 years if diagnosed early, with younger patients demonstrating a better response to treatment than the elderly(9). CRC is an age related disease with 95% of cases presenting in the over 50's and the highest rates of diagnosis demonstrated in those aged between 70 and 75 years. Historically UK cancer survival statistics were weak when considered against other developed countries, but 1 and 5 year survival is still lower in England than in other comparably wealthy countries. Recent initiatives, put in place over the last 10 years have gone some way to redress this with data from the Office for National Statistics now showing a trend of increasing survival (10, 11).

Colonic imaging is undertaken in symptomatic patients to detect the presence of three main pathologies: polyps, cancers and diverticular disease and its complications. Presenting symptoms for all three pathologies may be very similar and severity of symptoms is not always in line with the severity of the disease or stage of the cancer (12, 13). Presenting symptoms which are considered to be indicative of a high risk of cancer include rectal bleeding, weight loss, abdominal pain, anaemia, change in bowel habit towards diarrhoea and a palpable mass (14).

However, many of these symptoms are also present in patients with irritable bowel syndrome or diverticular disease, may present in response to stress or anxiety in the patient or simply be part of the natural ageing process of the bowel (15, 16).

Diverticular disease is a common disorder in the UK, affecting 50% of those aged over 50. Presence and severity increases with age; it is seen at autopsy in 85% of individuals at age 85 and will be symptomatic in 15-20% of that

patient group (13). It was traditionally attributed to a low fibre, highly processed diet but these views are now being challenged with etiological factors such as obesity, smoking, genetics and ethnicity all thought to contribute to the pathogenesis of the disease (12).

The presence of diverticula, termed diverticulosis, is often asymptomatic, but progression of the disease to include diverticulitis, sinus, abscess and fistulae formation can result in admission to hospital for acute management, prescription of IV antibiotics and occasionally surgical intervention (12).
CTC provides more information than BE for patients with diverticular disease as it can accurately inform on the degree of inflammation through assessment of bowel wall thickening and can visualise perforation, collections and other complications in surrounding soft tissues (13).

In order to manage CRC risk, bowel screening for colonic cancer is undertaken in developed countries in order to detect polyps as the precursor to cancer. In addition the National Institute for Health and Care Excellence (NICE) gives guidance for the management of patients suspected of having colorectal cancer and describes a process of rapid referral and diagnosis (14).

In 2000 the NHS Plan came into action(17) and defined rapid referral pathways for patients suspected of having cancer, focusing on breast, bowel and lung cancer. This was supported by target times to be met for referral to diagnosis and referral to treatment with financial penalties for Trusts failing to meet standards. Financial support was given over the 5 years, 2000 – 2004 especially to diagnostics and cancer services to prevent delays in diagnosis and to manage the range of programmes effectively. In order to deliver the NHS plan within the Modernisation Agenda, National Service Frameworks and tools such as the Cancer Strategy were established to set standards for care and provide service models for defined patient groups (18). The National Cancer Plan was also published in 2000 and gave guidance on evidence based best practice on which to model services. The intention of the National Service

Frameworks were to ensure availability, quality and consistency of care across the NHS whilst demonstrating cost effectiveness and patient focused care (18).

These transformations in healthcare delivery were governed by national bodies responsible for ensuring that the promised changes in care were delivered. Some are still performing this role to day and include the National Institute for Clinical Excellence, now the National Institute for Health and Care Excellence, the National Patient Safety Agency and the Patient Advice and Liaison Service.

In 2013 Public Health England (PHE) was formed to bring over 70 health organisations together to provide a single public health service. The role of PHE is to protect and improve the health and wellbeing of patients through sharing information and expertise and by reducing inequalities in NHS healthcare. They also have responsibility for improving the understanding of healthcare through research and for developing the specialist workforce needed to support the NHS (19). The Care Quality Commission is the current regulatory body.

Whilst benefits have been demonstrated by such a prescriptive system it has had critics over the years. Many claim there is little room for clinical opinion or patient choice, should either result in disruption to the patient pathway or a breach of referral to treat times (20, 21). There has also been criticism that the focus on finance and targets has disadvantaged true patient care with the failures demonstrated by the Mid Staffordshire Healthcare Trust being cited as an example(22).

In addition to these improved outcomes for the diagnosis and treatment of CRC, 2006 saw the start of a 3 year roll out programme for screening in the UK through the NHS BCSP. It offers biennial faecal occult blood testing for all aged between 60 and 69 with follow up investigation for all those testing positive (23).

This has been supported more recently with the introduction of the Bowel Scope service which commenced with pilot sites in 2013. Ongoing roll out of this service is now managed by Public Health England (24). The service offers a one off flexible sigmoidoscopy to all aged 55-64 years with the removal of small

polyps (<10mm) during screening and colonoscopy for high risk adenomas. A multi-centre randomised controlled trial by Atkin et all concluded that flexible sigmoidoscopy screening with removal of small polyps at examination is safe and, when offered only once between the ages of 55 and 64, confers a substantial and long lasting benefit (25).

The study identified a 43% reduction in mortality from bowel cancer and a 50% reduction in incidence of cancer for lesions in the rectum and sigmoid. This represented a 33% reduction for cancer overall within the screened group (25).

Recently published results of the UK Bowel Scope pilot study concluded that

> *"delivery of a flexible sigmoidoscopy screening programme to prevent CRC is feasible and should be implemented" p225 (26).*

Most bowel cancers develop from benign adenomatous polyps which originate from glandular tissue within the large bowel or rectum. The adenoma to adenocarcinoma sequence can take 10 years to progress with up to 15 years before the presence of clear symptoms;(23) this time factor makes CRC an age related disease with presentation most likely in those aged over 55 (27)

The graph below (fig 1), taken from Cancer Research UK bowel cancer incidence statistics demonstrates the link between incidence and age.

This image has been removed by the author of this thesis to comply with copyright law

Fig 1.1 Average Number of New Cases Per Year and Age-Specific Incidence Rates per 100,000 Population, UK, 2009-2011 (27)

The presence of identifiable symptoms, a cost effective and safe method of screening combined with slow disease progression makes screening for this disease realistic. The clear improvements in outcomes following intervention in what is a common cancer in the developed world makes it worthwhile and improvements in the UK cancer survival statistics would support this (9).

Calling the population forward for screening would also seem appropriate when considered against a background of ambiguity in presentation of the disease making it hard for patients to recognise, and reluctance for patients to present themselves for investigation.

This may go some way to explain why the single most significant delay to treatment remains the reluctance of the patient to react to symptoms and present to their general practitioner (GP). A study in 2008 by the School of Health and Related Research, University of Sheffield and cited in the BCSP Guidance for Public Health and Commissioners states that

> *"despite slow disease progression, 20% of patients will first present in A&E after experiencing mild symptoms for weeks or months and around 50% will present with disease spread".p.16 (28)*

Looking more closely at the epidemiology of CRC, incidence of developing the disease increases with a previous history of adenoma or localised carcinoma. A family history of the disease or a personal history of inflammatory bowel disease are further risk factors. There is some discussion on whether this can be attributed to a true inherited link or whether it is simply due to families and relatives taking the same lifestyle choices with respect to diet and healthy living and as a result experiencing a similar level of risk (29).

In 5-10% of presentations there is a genetic risk from inherited conditions such as familial adenomatous polyposis (FAP) and hereditary nonpolyposis colorectal cancer (HNPCC)(30). Genetic conditions such as FAP and HNPCC often present in the young.

There are also lifestyle factors to be considered. CRC is more prevalent in the developed world where a highly processed diet is most common. It is linked to a diet high in fats and low in fibre, with obesity, smoking and alcohol consumption all increasing risk to an individual (31). This is recognised by the Department of Health whose document “Improving outcomes: A strategy for cancer” along with the associated annual reports, discuss reducing the incidence of preventable cancers through lifestyle changes (32, 33).

Significant work is being done to raise public awareness and reduce risk factors for colorectal cancer, predominantly based around maintaining a healthy lifestyle. Recommendations include reducing intake of saturated fats by eating less red meats and processed foods and eating more fresh fruit and vegetables. Regular exercise and maintenance of a healthy weight is also important. In 2011 the World Cancer Research Fund updated its work on the scientific evidence linking diet to the prevention of cancer which, in figures released in 2007, attributed 30% - 50% of the worldwide incidence of colorectal cancer to dietary and nutritional factors (34).
In addition to the detection of CRC and polyps imaging of the large bowel must also recognise the presence of inflammatory diseases such as colitis and Crohns disease and be alert to the presence of diverticular disease and its complications.

1.3 Choices in imaging for colorectal cancer

There are four commonly used imaging options available when evaluating the bowel wall and mucosa. Endoscopic options include optical colonoscopy (OC)(35) and flexible sigmoidoscopy(26) with both offering diagnostic and therapeutic potential through direct visualisation of the bowel mucosa and the opportunity for polypectomy and biopsy. Diagnostic radiology offers BE and CTC(5), both providing accurate imaging of the colon but no option for therapeutic intervention. There are advantages and disadvantages to all of these procedures.

Flexible sigmoidoscopy is a quick, well tolerated examination which requires minimal patient preparation and can be undertaken without sedation as an out-patient or day case procedure. They are often undertaken by nurse endoscopists who have extended their scope of practice to include both diagnostic and therapeutic procedures. For patients with symptoms suggestive of pathology on the left side of the bowel (7) it provides a readily available and cost effective diagnostic test.(25) As 59% of colorectal pathologies occur in or distal to the descending colon, for low risk patients with symptoms of rectal bleeding it is the obvious first choice of investigation for symptomatic patients with other more invasive tests to follow as necessary (36).

This image has been removed by the author of this thesis to comply with copyright law

Fig 1.2 Bowel Cancer (appendix to rectum), Percentage Distribution of Cases within the Large Bowel, Great Britain, 2007-2009(36)

To this end the BCSP introduced the bowel scope service offering a single flexible sigmoidoscopy for all aged between 55 and 64 years. The pilot sites for this programme started in 2013 with the first wave of the programme currently underway (26).

Colonoscopy is a more comprehensive endoscopic test, allowing for complete visualisation of the large bowel and providing both diagnosis and intervention. It carries a higher procedural risk with risk of perforation ranging between 0.06%-0.19% and a mortality rate ranging from 0%-0.07% (37). Consideration also needs to be given to patient safety when using purgative laxatives (38, 39) but in spite of this it remains the gold standard test for evaluation of the colon (5, 35) for CRC and should be recommended whenever it is safe to do so.

Both endoscopic tests allow for direct visualisation of the bowel wall, for biopsy to provide pathology specimens and for therapeutic intervention through polypectomy. By contrast the radiology examinations, barium enema and CTC are a diagnostic tool only. BE requires full purgative bowel preparation along with good patient mobility and compliance to obtain adequate images.(5) It carries an element of risk from perforation in the range of 0.004% - 0.2%, (37, 40) risk from the use of ionising radiation and from the need for purgative bowel preparation. It is now thought to be an outdated test and NICE Guidance recommends the use of CTC over BE wherever resources permit.(41) When compared against CTC and colonoscopy it is less sensitive and less specific. Results of the SIGGAR trail concluded that

> *"CTC should be the preferred radiological test for patients with symptoms suggestive of colorectal cancer" p.1185 (5)*

By comparison CTC has a sensitivity and specificity comparable with optical colonoscopy but carries a lower 0.005 -0.059% risk of perforation (42-44), does not require sedation, does not require anticoagulants to be stopped prior to the procedure and, when minimal preparation is used does not require adjustment of many patient medications incompatible with full bowel preparation (38). The use of intravenous iodinated contrast media (IVCM) as part of the procedure is thought to increase procedural risk, especially for patients with additional risk factors such as renal impairment or potential for dehydration, both of which are exacerbated by the preparation for the procedure(45). Use of IVCM as standard is not encouraged by national guidance (46) and is not undertaken routinely by the study site. It is given to selected patients (see vetting & prepping chart, p.38) in line with trust protocol (appendix 1.1).

However, a critical analysis of literature by Ali Rao and Newhouse in 2006 found little evidence to support this (47). Clinical decisions to avoid routine use of IVCM may be attributed more to a need to streamline the service and to

avoid the resource and cost implications of managing incidental findings at CTC (48).

Whilst CTC would be considered the radiological test of choice there are resource and financial implications to Trusts in offering CTC over the BE which should not be overlooked.

Guidance from the International Collaboration for CT colonography recommends access to multi detector CT, the use of dose modulation where available(46) and access to software providing axial 2D display, multiplaner reformats and a 3D endoluminal reconstruction(46) for reporting.

All members of the CTC team require training appropriate to their role with regular audit processes in place to monitor activities and outcomes (46). For many radiology departments offering colonic imaging scanner capacity and availability of skilled radiologists to issue reports currently restricts expansion of their service; this is reflected in the wording of recently updated NICE guidance 131 which states

> *"consider computed tomographic (CT) colonography as an alternative to colonoscopy or flexible sigmoidoscopy then barium enema, if the local radiology service can demonstrate competency in this technique".p.9* (7)

A review of the SIGGAR trials acknowledged this with the statement

> *"BE is well established, relatively cheap and remains widely performed, a large proportion by radiographers"* p.3 (49)

Whilst all colonic imaging requires effective bowel purgation to achieve best results advances in image interpretation software and use of computer aided detection for CTC enables acceptable results to be obtained with minimal bowel preparation. This offers a safe yet sensitive option for imaging patients unable to tolerate full bowel preparation (50, 51) or an invasive examination such as colonoscopy or barium enema. With an ageing population and a screening programme which follows patients until the age of 69, it is inevitable that patients will present with disabilities, co-morbidities and frailties which exclude them from endoscopic procedures and or preparation regimes. The CTC offers

a safe and effective alternative for these patients. Patient choice is also a factor when deciding on imaging modalities, many patients, adverse to undergoing endoscopy and possible sedation are more accepting of CTC, even when the limitations of the procedure are described to them (52).

BE is a well-established imaging modality for evaluating the colon. It requires full bowel purgation to obtain quality images and is dependent on good patient mobility and compliance in order to complete the procedure. Sensitivity and specificity is lower in the BE than in other imaging modalities but results are very operator dependent (5). An experienced radiologist or radiographer undertaking the procedure on appropriate patient groups who are able to tolerate the examination can obtain acceptable results using this accessible and affordable test. It is also accepted practice for a BE service to be radiographer led with radiographer reporting of the images (53). Work done by Culpan and Law reported radiographer sensitivity for detecting CRC of 90.6% and 98% respectively (53, 54). This needs to be considered against the increased workload for reporting radiologists as they are handed back the burden of colorectal reporting in the form of CTC interpretation.

Whilst CTC may be the gold standard in radiological imaging of the colon some centres still have resources focussed on the BE. This may remain until training of staff in the new procedure is undertaken and additional CT capacity is made available for the increased workload.(55) For some this transition may be complete or underway with skills and resources transferred but others describe the negative impact of incorporating the new service on an already overstretched workforce.

> *"Development of new services (e.g. CT colonography etc.) which has occurred without additional funding and has fallen to the mantle of existing interested radiologists, who then withdraw their services from other routine services / reporting to accommodate the new service within their job plan." P.53 (55)*

Information collated through this research on the role played by radiographers will support this transition and is discussed in Chapter 5.

1.4 The development of CTC as method of imaging

CTC was first described by Vining and Gelfand in 1994(56) where the technique was discussed at a radiology meeting. It was later described by Amin et al in 1996(57) and advocated for use for the frail and elderly by Domjan in 1998 (51). Ongoing scanner developments now allow for rapid low dose acquisition of images (58, 59) and imaging software and off-line workstations allow assessment through 2-D and 3-D images (60). These developments have made the procedure more readily available and the radiological test of choice for symptomatic patients (61). CTC requires, as a minimum, some cleansing of the bowel or restriction in diet and the use of a stool tagging agent as preparation. The procedure requires administration of an antispasmodic and the appropriate use of intravenous contrast media (IVCM) (46). There is now published guidance on undertaking and reporting CTC which includes recommendations on preparation, imaging, dose reduction and image interpretation. It gives information on the use of computer aided detection (CAD) along with guidance on training the team, improving the patient experience and effective clinical governance (46, 62-64).

1.5 The role of CTC in the symptomatic and screening population

It is clear from the review of literature discussed in 1.2 that colonoscopy should be the first choice for imaging the colon in symptomatic patients(35) with CTC or BE offered as an alternative (5). Whilst CTC is excellent at detecting cancers (sensitivity 97%, specificity 97%) this accuracy reduces when included pathologies are extended to all polyps producing a range of sensitivity from 45% - 95% and a specificity of 26% - 97% (65). This impacts on the patient pathway by increasing the need for additional procedures. The SIGGAR trial identified that 30% of CTC patient’s required additional colonic investigation, either for diagnostic or therapeutic reasons, as compared with 8.2% of patients offered colonoscopy (35).

CTC has an important role to play in the pathway of any patient where conventional OC is contraindicated or where a complete study was not achieved (64). Ongoing debates over the appropriateness of BE have now concluded that it is an outdated test and should no longer be offered (5, 61). The SIGGAR trial identified a higher CRC and large polyp detection rate at CTC than at BE (73% v 5.6%) with CTC missing 3/45 cancers and BE missing 12/85 (5) . It made recommendations that any radiology departments not currently providing CTC over BE to be working towards that goal. In response to this view and in light of extensive randomised controlled trials looking at comparison of these three procedures (5, 35) the BCSP now require CTC to be offered as the alternative second screening investigation to OC (64).

Use of CTC as the primary screening tool is also under consideration. It has much to offer, especially as the technology continues to improve to reduce scan times and doses and CAD is used to improve test sensitivity (66). The test is certainly a more acceptable and safer option for the frail and elderly (67, 68) and avoids the need for multiple screening tests to achieve diagnosis. However, it is acknowledged that CTC accuracy is very dependent on the quality of the examination and the competence of the individual issuing the report. The NHSBCSP, European Society of Gastrointestinal and Abdominal Radiology (ESGAR) and British Society of Gastrointestinal and Abdominal Radiology (BSGAR) / RCR all acknowledge this in their guidance documents. The BCSP have issued guidance for all imaging performed for the programme (46) and ESGAR have recently updated their CTC guidelines (62) to support improvement and standardisation for the procedure. Guidance on the use of CTC for suspected CRC has also been produced by the Royal College of Radiologists (RCR) and BSGAR which supports the planning and delivery of a CTC service whilst acknowledging the cost, training and workforce implications (69).

1.6 The role of the radiographer in CTC

CTC as an examination crosses some of the natural boundaries established in imaging departments; it is a CT procedure, but is often undertaken by gastrointestinal (GI) radiographers utilising their expertise developed through performing and reporting barium enemas. As CTC is a complex CT examination it is agreed that a formal radiologist report is required (64) but there are radiographers reviewing the initial scans, especially for intraluminal pathology during the procedure to determine how to proceed and make decisions on the need for additional views and the administration of intravenous contrast media (IVCM). There are also radiographers offering an opinion on intraluminal pathology in a more structured format so again, a blurring of accepted boundaries is apparent.

Radiographers are predominantly responsible for carrying out the procedure and caring for the patient. This includes placing the rectal tube, administering the carbon dioxide and giving antispasmodic drugs and (IVCM) as required. It is likely that they will make decisions on how to progress with the procedure, possibly following department protocols with support from radiologists for the more complex decisions.

The prescription only medications given need to be prescribed and dispensed. This is a task undertaken by a medical practitioner or potentially by a non-medical prescriber through the use of patient group directions (70). The non-medical prescriber is often a radiographer who, following training, can give specific drugs to a defined group of patients for an identified purpose. Whilst all of these practices are routinely carried out and are accepted practice for radiographers(71) there is little published evidence on the extent of radiographer involvement and as a result little recognition of the role extension demonstrated.

The BCSP produced guidance on providing a CTC service to support the screening programme; this considers the role of the radiographer in managing

the patient, performing the procedure and making decisions on additional imaging during the scan. It does not currently support radiographer reporting in any form (46, 72).

Responsibility for the BE has been successfully devolved from radiologist to radiographer with radiographers confidently undertaking the examination and reporting on these examinations (54). Established post-graduate courses with progression through to an MSc qualification have been developed for GI radiographers. This has resulted in very real cost savings and improved efficiency for departments as radiographers replace radiologists to provide a more flexible service at a reduced cost (73). The Society and College of Radiographers (ScoR) document on Clinical Evaluation and Clinical Reporting states that

> *"Diagnostic Radiographers are, with appropriate skills development, able to make first line interpretation of images in support of patient management and, following College of Radiographers approved postgraduate training, to provide definitive reports for a wide range of examinations" p1(67).*

The same document discusses the requirement for innovation in workforce planning and service delivery to enhance quality, efficiency and effectiveness.

This study will look at whether it is appropriate to take the model successfully applied to GI imaging and use it for the provision of a CTC service with radiographers taking a key role in both performing and reporting on the examination.

Radiographer reporting of CTC is currently not accepted by the NHS BCSP who state that all CTC reports provided for their patients should be issued by a radiologist who has sufficient expertise and has undertaken appropriate training (63, 64, 69). The BSGAR and ESGAR also support the requirement for CTC reporting to be undertaken by an experienced consultant radiologist (63, 69) but do acknowledge the role of the radiographer in providing a preliminary read.

Work done by Burling (74) supports this view citing low polyp detection rates of 72% by radiographers, long image interpretation times compared to radiologists and lack of skills to interpret extracolonic findings as reasons to discourage independent reporting by radiographers. The paper did however acknowledge the ability of the radiographer to identify 100% of the cancers and recognised their role in providing an initial report in clinical practice.

Other research on reporting responsibilities has been undertaken, reaching the conclusion that reporting of the CT scan should be done by a radiologist (75).

A recently published systematic review of the diagnostic accuracy of radiographer reporting of CTC examinations (76) did not support radiographers in the role of providing a single formal written report on the lumen of the bowel. This review looked at eight studies which provided data on the accuracy of radiographer reporting following training, with training recommendations being independent reporting of 50-75 cases (46, 77). However, three of the studies involved radiographers with experience of reporting between 61 and 200 cases and these were subject to subgroup analysis. They demonstrated a statistically significant 21% improvement in sensitivity for the detection of lesions ≥ 5mm, suggesting that radiographer reporting accuracy improves with experience.

In addition, sub group analysis of the eight studies demonstrated that there was no significant difference in accuracy between training radiologists and radiographers' sensitivity to detecting lesions,(76) again suggesting that the important factor was experience. Such experience can be gained in the clinical setting through mentoring of the trainee, double reporting and audit of reporting competencies. A paper published by Miller, Price and Vosper looked at post graduate training for radiographers and acknowledged that

> *"much of the training provided for extended role activities is ad hoc and neither validated nor accredited"* p.60(78)

However, it documented that training for complex tasks was more likely to involve external training. As an indicator 90% of radiographers trained in performing and reporting BE's undertook an external course validated and or

accredited with additional study over a 2yr period (78). If comparable external training supported by workplace training and mentoring over a similar time period was offered to radiographers reporting CTC the reporting accuracy may compare favourably with radiographer reporting skills in other areas. Law published a study in 2006 which looked at radiographer reporting of barium enema studies and reported a sensitivity of 98% and specificity of 93% for CRC (54). An earlier study by Culpan published in 2002 reported radiographer sensitivity of 90.6% compared with radiologist sensitivity of 98.7% for CRC (53). These suggest that radiographers can reach and maintain clinical standards comparable to their radiologist colleagues for certain defined areas of practice (79, 80).

A joint document published in September 2012 by the Royal College of Radiologists (RCR) and the ScoR supports double reporting through team working and evidences its success in many areas, including GI imaging (73). The document makes reference to this in the discussion of effective radiological report team working. The authors' state

> *"Radiographers with appropriate training may report within a defined scope of practice, with radiologists providing review of difficult cases or those outside the clinical scope of the reporting radiographers" p15(73).*

The same document discusses the importance of post graduate training for the radiographers and describes programmes with

> *"radiologist and reporting radiographer involvement in the programme faculty, course design and assessment processes" p16(73)*

and a

> *"rigorous process for auditing reporting practice during the training period" p16(73).*

This is combined with an expectation that audit will continue during practice post qualification (73).

1.7 The role of audit and Clinical Governance

As discussed radiographer reporting within CTC is an emerging skill and as such requires stringent assessment through audit and ongoing governance. Clinical governance focuses on ensuring achieved standards are maintained and improved within the organisation and the NHS Executive (1999) acknowledged the need for involvement and support at all levels to achieve this (81). These views have been reiterated more recently by Lord Darzi in the NHS Next Stage review final report where he talks of the need to provide safe, effective care. (82)

> *"People want to know they will receive effective treatment. They want care that is personal to them, and to be shown compassion, dignity and respect by those caring for them. People want to be reassured that they will be safe in the care of the NHS".* P.33 (82)

In aspiring to this Darzi describes a requirement for clinical governance with an ability to measure, recognise and publish data on quality of care and encourages research and innovation to improve care (82). The publication of a document titled "High Quality Care for all"(82) and changes in legislation in the form of The Health and Social Care Act 2012(83) followed Darzi's report, both with a focus to improve care quality within the NHS. This need for change was reinforced by the failings identified at Mid Staffordshire NHS Foundation Trust which resulted in the publication of a more recent government document "Quality in the new Health System – Maintaining and improving quality from April 2013". This was published in its final form in 2013 in response to a request from the Secretary of State for Health to conduct a review into the systems and processes in place for safeguarding quality in the NHS(84). In responding to the changes in the way healthcare is run and managed in England it contained the following statements –

> *"Robust systems and processes to monitor, manage performance and regulate the quality of care provided to patients are essential. However,*

> *the success of these is almost entirely dependent on the values and behaviours of staff and organisations working throughout the system." P.7 (84)*
>
> *"Healthcare professionals and clinical teams, their ethos, values and behaviours, will remain the first line of defence in safeguarding quality."p.10 (84)*

A desire to follow a model of healthcare which monitors and manages performance through the actions of the clinical team has led to the research described in this thesis. It aims to take a new working practice, audit and evaluate its effectiveness and then, through presenting and publishing findings, disseminate the information to a wider audience. NICE recognises the need for sharing best practice and offers access to evidence based clinical guidance to facilitate this (85). Within the profession of radiography sharing of best practice is acknowledged and achieved through the work of the ScoR in supporting special interest groups within the profession, by the provision of a peer reviewed journal and by meetings and conferences such as the UK Radiology Congress (UKRC).

This study will look at the current position and potential scope for the radiographer in both undertaking the procedure and in providing a PCE of intraluminal pathology. The purpose of this work is to ensure that imaging of the colon remains affordable, efficient and flexible enough to accommodate the needs of an expanding service by making best use of available resources.

The work reported in chapters 3 and 4 of this thesis was undertaken to, through an audit of an existing database of radiographer 1st reads, determine whether radiographers can develop the skills to produce reports on CTC intraluminal pathology which are in agreement with the findings of an experienced radiologist and can, as a result, contribute to the final report through independent or double reporting. In preparation for this an audit tool was developed and validated to ensure it was fit for purpose(1).
In addition, an online survey, as reported in chapter 5 was undertaken to establish the current role of radiographers undertaking CTC in the UK.

A review of current literature revealed no publications specifically describing the role of radiographers in CTC. Work done by Burling(46) on behalf of the BCSP looking at standards for CTC in the screening programme clearly describes the requirement for a radiologist to produce the final report for all CTC undertaken for the programme.

> *"CTC interpretation should be undertaken only by consultant radiologists who have been designated to report CTC by the lead radiologist for the screening centre" p.12 (64)*

but goes on to acknowledge the involvement of radiographers as part of the skilled team

> *"A team approach is critical to the success of CTC. The local organisation of a team will depend on the skills and competencies of its members. The skills and competencies needed should be clearly defined in the screening centre's protocols" p.14(64)*

A national survey of current practice of hospitals providing CTC imaging for the NHS BCSP undertaken by Plumb in 2013(72) considered the training of radiographers in CTC image acquisition and described training for 91% of respondents with 54% of those through a formal training course. It did not look at any other roles the radiographers might have undertaken as part of a local team.

The aim of phase 1 of this study is to design, validate and implement the use of an audit tool used to audit radiographer PCE's which support radiographer involvement in CTC reporting.

The aim of phase 2 of this study is to survey radiographers in the UK undertaking CTC to understand the current role of UK radiographers in undertaking all aspects of the procedure to include prescribing drugs and reporting on images.

Chapter 2 – Methodology and methods

This chapter will introduce the study and give some background to the work through discussion of CTC as an accepted procedure and the development of a role for radiographers in providing a CTC service.

It will cover the study design, justify the methodology chosen and describe the methods used to research each discrete phase.

2.1 Approvals

An ethics submission for the study was submitted through the Integrated Research Application System (IRAS). Approval was granted by the College of Engineering, Mathematics and Physical Sciences Research Ethics Committee, University of Exeter and Taunton & Somerset NHS Foundation Trust Research and Development Executive Group. On review of the IRAS submission by these bodies ethics approval was not required by the University of Exeter or by Taunton & Somerset NHS Trust for the two audits undertaken. Audit approval was obtained from Taunton & Somerset NHS Trust Audit Department and the Radiology Audit team (appendix 2.1). Approval was also obtained from the College of Engineering, Mathematics and Physical Sciences, University of Exeter (appendix 2.2). The appropriate Trust audit documentation was completed (appendix 2.3). Participant consent was incorporated into the design of the survey with informed consent from the participant being a prerequisite for access to the survey questions.

Participant information (appendix 2.4) and promotional material used (appendix 2.5) are included within the appendices.

2.2 Development and validation of the database and audit tool

In November 2010 two radiographers at Taunton & Somerset NHS Foundation Trust began to offer a PCE of intraluminal pathology on CTC examinations. This followed an external course and in-house training by a supervising radiologist. The external course took the form of a one week training programme at the host

hospital where participants learnt to undertake the procedure and evaluate images. The course offered a combination of lectures, hands on experience in undertaking the procedure and the opportunity to evaluate the images of over 50 endoscopically proven cases (86). Participants were also taught to use a VitreaWorkstation™ with 2-D, 3-D and “fly through” options for viewing scans.

This training was consolidated in the workplace where the radiographers began supervised reporting with support and training provided by experienced GI radiologists. Data were collected on their first 50 PCE’s and these were audited for accuracy against the radiologist report before the radiographers began offering a PCE as part of a double reporting service. This also provided a pilot to the validation audit.

In February 2011 a report database was set up using Access 2010 (Microsoft Corporation) to allow radiographer reports to be written and stored in an accessible format independent to the Radiology Information System used for formal reporting and the Picture Archiving and Communication System used for report and image distribution. To enable radiologists to monitor training and competence and to give timely feedback to the radiographers an audit tool was developed. The database was separate to the radiology information system used for formal reporting but was accessible by all staff as required.

Integral to this was a scoring system developed to categorise PCE’s by pathology, the level of correlation between the PCE and the radiology report and the clinical significance of any discrepancy demonstrated between the opinions of the radiographer and radiologist. This was termed the “pathology discrepancy and significance score” (PDS)(1) and was recorded by the radiologist at the time of reporting. In the clinical setting the PDS score was the method by which the radiologist gave feedback to the radiographer. For the purpose of this study it enabled the observational PCE data to be converted into categorical data with ordinal variables for input and interrogation through SPSS (87). The process and rationale behind the PDS score is discussed in detail in chapter 3.

The radiographers entered patient demographics and the date of the study along with their findings. This was completed before the radiologist report was made available to ensure the radiographer was able to give an independent, unbiased evaluation. The radiologist reported the study blinded to the radiographer PCE but checked the two opinions before verifying and publishing the report. Any changes to the report were made at this stage. At the time of reporting the radiologist entered their ID on the database and gave the PCE a Pathology Discrepancy Significance score (PDS) as described in chapter 3. The radiologist also added any additional comments needed to support the education and training of the radiographers.

2.2.1. Audit patients and procedure

CTC data from the period February 2011 – April 2014 were used for the validation and PCE audits. The data collected provided a means to monitor radiographer competence and provided a process for giving feedback but before it could be used for academic work, subject to peer review and assessment, validation of the data tool was required.

This retrospective validation audit was undertaken to determine whether the audit tool produced consistent and replicable results, irrespective of who undertook the scoring, whether the PDS score could be reliably replicated by other users and whether the audit tool was suitable for a bigger research project looking at the entire database.

For the validation audit 30 systematically selected cases (all cases undertaken each Monday from 02.09.13 - 04.11.13) were taken from the entire database(1). This ensured the dataset included reports and PCE's respectively from all radiologists and radiographers involved in the study. CTC examinations from all referral routes were included. No differentiation was made between symptomatic and screening cases. Although the sample size was small it was representative of 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 validation an additional two radiographers were also asked to undertake the PDS scoring process by comparing the radiographer preliminary report with the final radiology report. Both were experienced GI radiographers, one a CTC trainee and the other with an established role in evaluating intra-luminal pathology at CTC. They worked blinded to one others and the radiologist PDS score. The CTC images were not reviewed again at this stage; the radiographers simply scored the PCE against the radiology reports. These results and the initial radiologist PDS score were used to produce three datasets for evaluation.

Having developed a suitable audit tool and established its validity in the clinical setting the audit tool was then applied to the clinical database of radiographer PCE's to assess the level of agreement between the radiographer PCE and the radiology report. The aim was to determine whether a radiographer could produce a PCE of intraluminal pathology to a standard comparable to that of the radiologist.

Data collected between February 2011 and April 2014 were used to look at the accuracy of the radiographer report when compared with the radiologist report; considered to be the standard for the purposes of this study. 1815 cases were considered for inclusion, studies with no radiographer PCE at the time of reporting were issued a PDS0 (incomplete data). Any studies with a PCE issued but not assigned a score by a radiologist at the time of reporting were retrospectively scored by a radiographer to ensure inclusion in the study. The rationale for this is described further in chapter 4. The database used to collect the data is as described in detail in chapter 3.

All patients undertook CT colonography performed on a GE Lightspeed VCT 64 slice scanner. Scans were performed to protocol with a collimation width and slice interval of 0.625mm. Patients were imaged in the supine position using

120kV and a modulated mA with a range of 100 – 500mA and a 0.5 second rotation. The prone and all additional scans were performed using a low dose technique of 120kV, 100mA and a 0.5 second scan rotation.

IVCM was given if indicated at the time of request or following recognition of positive pathology on review of the initial scan.

All patients received bowel preparation and faecal tagging unless contraindicated (38, 39). A number of bowel preparation regimes were offered to patients dependent on their ability to tolerate cathartic bowel preparation and their existing co-morbidities (38). This is described in detail in table 2.0 – Vetting and Prepping chart

Table 2.1 CTC– vetting and prepping chart

PROTOCOL	COL2(NC)	COL2 + IVCM	COL3(NC)	COL3 + IVCM	COL4(NC)	COL4 + IVCM
PREP	Picolax & Gastrografin prep	Picolax and Gastrografin prep	Senna & Gastrografin prep	Senna & Gastrografin prep	Gastrografin only	Gastrografin only
IV CONTRAST	None	100mls of Ultravist 300 IV	None	100mls of Ultravist 300 IV	None	100mls of Ultravist 300 IV
INDICATIONS	CIBH Fe deficiency anaemia Rectal bleeding, Diverticular disease BCSP referrals	As COL2(NC) **PLUS :** weight loss, or other features suggesting malignancy	As COL2(NC) but not fit for full bowel prep – see current guidelines on Intranet	As COL2+IVCM but not fit for full bowel prep – see current guidelines on Intranet	All laxatives contraindicated	All laxatives contraindicated
COMMENTS	Check mobility / age/ creatinine before booking – consider COL3(NC)	Check mobility / age/ creatinine before booking – consider COL3	Check mobility / age/ creatinine before booking Consider admission for supervised prep and hydration Consider alternative imaging – AP4	Check mobility / age/ creatinine before booking Consider admission for supervised prep and hydration Consider alternative imaging – AP4	Check mobility / age/ creatinine before booking Consider admission for supervised prep and hydration Consider alternative imaging – AP4	Check mobility / age/ creatinine before booking Consider admission for supervised prep and hydration Consider alternative imaging – AP4

N.B. In very elderly, frail or immobile patients consider contrast standard CT. If in doubt discuss with radiologist

2.2.2 Audit reading strategy

All studies were reviewed at the time of the scan to determine the need for additional scans or administration of IVCM (74). This initial review was undertaken by the radiographers, one a CT specialist and one a GI specialist and all had received formal or in-house training on the evaluation of CTC images. Any complex decisions were referred to the supervising radiologist. Images were reviewed on a bone window setting with a window width of 2500 and a window level of 250.

On completion of the examination the scans were reviewed by one of two radiographers and a PCE was issued onto the report database. The radiographers were experienced reporting radiographers (GI), had completed a 1 week CTC training course (86), had produced a minimum of 50 supervised PCE's and had been approved by the lead CT radiologist as competent to contribute to the double report service. A VitreaWorkstation™ v6.0 using Vitrea® CT colon analysis software was used by the radiographers to evaluate the studies with radiographers encouraged to view and measure pathology on the 2D supine scan and to use the low dose scan and 3D images to confirm findings.

Radiographers issued a report to include position, slice number, size and description of any pathology identified. Measurements were taken on the optimal dose supine scan, using the 2D view, a window width 1500 and a window level of -200 to ensure accuracy in measurement (88). The radiographer PCE was issued before and therefore blinded to the view of the radiologist and equally, the radiologist produced their provisional report blinded to the radiographer PCE. The definitive radiology report took account of both, represented the opinion of the team and was open to discussion. The PDS score represented the reporting radiologist's interpretation of the difference between opinions and was issued before any discussion or amendment of final reports. This process was not able to identify any discrepancies where the radiologist had overlooked a lesion correctly identified by the radiographer.

Any significant pathology requiring urgent review of the scans was referred to the "next available" radiologist for an urgent report which was completed within 24 hours.

This rapid referral for review was undertaken by the radiographer issuing the PCE. All in-patient scans were reported by a radiologist within 24 hours. All other scans were reported over a 2- 4 day period and were distributed evenly between four experienced consultant radiologists. All CTC reporting radiologists had at least 5 years' experience in CTC and 3 of the 4 had completed an accredited CTC training course. Radiologists were free to use either the VitreaWorkstation™ or utilise the 2D and 3D imaging offered by Siemens *syngo®.*via when reporting on scans.

Radiologists initially reviewed extra colonic findings and gross intra colonic pathology on their Carestream PACS workstations as this provided the most effective workflow strategy. Review on Vitrea® or *syngo®.*via followed and at this stage comparison with and initial scoring of the level of agreement with the radiographer PCE was undertaken. For the purpose of the validation audit an independent retrospective score of agreement was also allocated to each PCE by an additional 2 radiographers. The radiographers comprised of one experienced CTC reporting radiographer and one novice reader currently undergoing supervised training. They worked independently of one another and without knowledge of the initial score given.

Studies not reviewed by radiographers in a timely fashion were given a PDS score of 0 (incomplete data). However, because of the confidence held by radiologists in the value added by the radiographer PCE, the final report would normally be held back until the PCE was available to review. Once this was completed a PDS score could be assigned and the final report released. This resulted in very few studies recorded as PDS0 on the final database.

2.2.3 Audit statistical analysis

The validation audit required the measurement of both nominal and ordinal data; descriptive statistics were used to look at inter-rater reliability and frequency tables were generated for all data collected (89). Frequency tables were used to describe both the range of pathologies demonstrated within the sample and the distribution of scores given by each of the 3 participants (reporting radiologist and 2 retrospective scores by radiographers).

The mode was considered the most appropriate measure of central tendency (90) and was described as a number or a percentage.

Percentage agreement was measured to determine the level of inter-rater agreement and inter-rater reliability was assessed using Cohen's kappa to determine the effect of chance on the results obtained (87, 90). Because this study looked at the interpretation of a diagnostic test there was potential for a degree of subjective interpretation by observers and consideration should be given to the likelihood of agreement or disagreement due to chance.

> *"Items such as physical exam findings, radiographic interpretations, or other diagnostic tests often rely on some degree of subjective interpretation by observers. Studies that measure the agreement between two or more observers should include a statistic that takes into account the fact that observers will sometimes agree or disagree simply by chance" p.360 (91)*

Some consideration should also be given to the limitations of kappa as the value is dependent on and affected by the proportion of subjects in each category, the number of categories and the variance (90).
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 (92, 93).

For the PCE audit one way analysis of variance (ANOVA) was performed to look for statistical differences between the PDS scores assigned by the five PCE assessors (four radiologists, one radiographer). One way ANOVA was used to look at the differences between the scores assigned by each of the PCE assessors and at the differences in the assigned scores between the radiographers to determine whether any effect noted was real or due to chance (90). Convention would consider a p-value or significance value of $p<0.05$ to be statistically significant and due to real effect rather than chance (94).

One-way ANOVA was also used to look for any statistically significant difference between the PDS scores given to each of the two radiographers providing the PCE's.

Frequency tables were used to describe both the range of pathologies identified and the PDS scores assigned to them.

Frequency tables were also used to further investigate significant and major pathologies by looking at the level of agreement between the PCE, the final report, endoscopy results and pathology findings. Again, the measure of central tendency used was the mode, described as a number or a percentage (90).

All significant and major pathologies were further assessed through theming and by comparison and analysis of radiology, endoscopy and pathology reports.

2.2.4 Reliability issues with audit

Unreliable data could be introduced into the audits as a result of inter-observer inaccuracy as all observers have a different clinical perception of what they see (95). This should be minimised in this study by accurate assessment of pathology and appropriate application of the PDS score. Inaccuracies could also be introduced through equipment limitations or differences in equipment configuration which could result in a variance in measurements (95, 96). This is reduced by ensuring all staff use the correct software to view images and use an appropriate and standardised reading strategy (69). However, none of these limitations are expected to cause a systematic bias or change to the results since the same equipment was available to all observers.

There is further potential for poor data collection due to study design as described in Fig2.1; the development of a robust audit tool(1) was undertaken to minimise this.

This image has been removed by the author of this thesis to comply with copyright law

Fig 2.1 Major sources of bias in Clinical Research.(97)

During the audit there was potential for inter-observer bias and misclassification bias through the use of a radiographer for retrospective scoring of PCE's to complete the audit data(97) however it was felt that this retrospective scoring by a radiographer would minimise the effect of transfer bias resulting from cases lost to the study through incomplete data for follow up(97) and be of overall benefit to the study.

2.3 Survey of current UK radiographer practice in CTC

The research question for this phase of the study asked "what is the current role of the radiographer in CTC?"

The purpose of the work was to delineate current practice and make information available to inform future scope of practice and give guidance on requirements for radiographer training, both clinical and academic.

Evaluating and reporting on images is just a small part of the CTC examination and this section of the study takes a more holistic view of the procedure from referral through to report. It investigates the current role of the radiographer involved in CTC in the UK by asking questions on a number of discrete topics.

An online survey was made available to UK radiographers currently involved in providing a CTC service. It was designed and accessed through SurveyMonkey® and piloted on colleagues before release. The numbers of UK CTC radiographers are currently unknown therefore a comprehensive advertisement strategy was targeted to yield responses from as many of this population as could be reached.

2.3.1 Data tool development

In order to develop the survey questions process mapping was initially undertaken to define the stages of the procedure from referral to report (98). During this process thought was given to the tasks involved and who might undertake them. This resulted in production of the six survey sections

Questions were devised to cover all potential practices within each subsection and were checked and reviewed by colleagues in a pilot study before finalising the

survey. In retrospect more time should have been spent developing a more robust questionnaire through qualitative research prior to starting the survey. Interviewing GI radiographers when designing the research tool may have given insight on areas of practice that needed investigating and may have enabled the researcher to design a survey with less multiple choice questions. This would have likely resulted in less ambiguity in the results.

Staff from nearby hospital sites who were, at that time transitioning across from providing BAE to offering CTC were also asked about their practice in order to inform on the content of the survey questions.

2.3.2 Data collection

A survey was used to collect quantitative data from an online questionnaire; the data were then filtered and cross referenced to investigate the relationships between selected variables. The questionnaire comprised of single choice answers, multiple choice options and free text comments boxes. The qualitative data collected from the comments was used to describe and interpret data and to gain a more subjective view of the results (89). This combination of statistical and interpretive analysis works well for health service related research with qualitative data being used to facilitate interpretation of findings from quantitative research (89) (99).

A questionnaire was produced consisting of 32 questions (appendix 2.6) relating to the provision of a CTC service. The questions were grouped to cover the following themes –

1. Hospital demographics and referral patterns
2. Managing referrals
3. Managing prescription; administration of bowel preparation and faecal tagging
4. Medicines management and the use of patient group directions (PGD's)
5. Patient care and clinical decision making during the procedure
6. Reporting and primary clinical evaluation of images
7. Education – training and qualifications
8. Participant demographics – employed grade, specialty and skills

The approved questionnaire was transferred to SurveyMonkey® (SurveyMonkey UK Ltd, UK), a leading online survey platform. The SurveyMonkey® gold package was used as it provided unlimited question and answers, permitted cross tabulating and filtering of results and was enabled to download results in a number of formats for ease of analysis. SurveyMonkey® was used because it offered secure, encrypted connections for collecting data, encryption of sensitive data and required a unique username and password for access. It also minimised the amount of personal data collected and had a comprehensive privacy policy covering the use, sharing and retention of data(100). It proved easy to access through the website to manage and process the data. Participants accessed the survey through the unique link –

www.surveymonkey.com/s/radiographers-ctc2014.

The survey was not enabled to collect any personal data on respondents. Respondents were given the opportunity to leave a contact email in order to receive feedback on the findings of the project but this was not linked to the results so all responses remained anonymous. This is in line with the principles of the Economic and Social Research Council Framework for Ethics 2012; one of which states that

> *"The confidentiality of information supplied by research participants and the anonymity of respondents must be respected" p.3(101).*

Using "by invitation" e-surveys is an effective way of reaching a specific target group and provides an accessible platform for giving an anonymised response(102) but care needs to be taken with the design of the surveys in order to balance access for participants against controlling their suitability (103). It needs to be recognised that using a web based tool to widen access of participation gives less control over the validity of the results and little knowledge of the response rate as there is no record of how many people viewed but did not complete the survey (102). This survey was promoted amongst radiographers and was only accessible to radiographers currently involved in providing a CTC service. However as respondents were anonymous and their workplace was not identified it was not possible to determine whether the

collected data represented the practice of many sites or whether there were multiple responses from staff working within the same hospital or NHS Trust.

The survey was presented to a number of colleagues as a pilot to test the process and gain feedback from respondents. Slight amendments were made as necessary before the full survey was released.

The survey was promoted nationally by the SCoR and locally by the University of Exeter via links with radiography departments developed through the undergraduate Medical Imaging Programme. In addition flyers were produced (appendix 2.3) and distributed by post to radiology departments and handed out at meetings including the 4th National Radiology Mangers Conference 2014 where the survey was explained and publicised. These actions were designed to ensure it reached the target audience.

The SCoR also publicised the research project on their website which offered a direct link to the survey and supported it through Facebook and Twitter. Regular responses to comments and postings through social media ensured the promotion stayed current for a number of weeks.

The survey was available online for radiographers to complete from 20/05/14 to 24/09/14 and 75 responses were received over that period.

All the individuals completing the survey were involved in undertaking CTC examinations at their hospital.

The first question asked whether the respondent was involved in providing a CTC service; only yes answers to this question were able to access the rest of the online survey.

2.3.3 Statistical analysis

The data were downloaded into Excel / SPSS and descriptive statistics were used for analysis of quantitative data. Descriptive statistics explain the process of organising the raw data, summarising it and presenting findings in a meaningful way but does not draw any conclusions from those data (89, 95).

Questions were grouped into themes to facilitate identification of patterns in behaviours and activities and responses were cross tabulated to investigate links between activities and to look for similarities in working practices. A number of the questions gave respondents the opportunity to add free text comments. These were considered alongside the quantitative data and used to add depth and give explanations to the data (89). Where the same comment has been repeated by a number of respondents it is only included once as an example in the text but the number of duplications of the comment is stated alongside. Where there are many comments with a similar theme these have been grouped together for consideration. Every effort has been made to give representation to all opinions and the balance between negative and positive responses has been maintained.

Frequency tables were used with the mean as the measure of central tendency, expressed as a number or a percentage (90).

A number of questions gave the opportunity to add free text comments to enable respondents to expand on their responses to give depth and explanation to the data (89). These responses were best interpreted using qualitative data analysis using thematic analysis to group themes as they arose during analysis of the survey responses (89).

2.3.4 Potential for bias

The main potential for bias within the survey lay with the selection bias introduced at the planning stage (97). Completion of the survey relied on self-selection of participants so was at risk of volunteer bias because

> *"volunteers, by definition, are not chosen at random but self-selection" p.25* (95)

and motivation bias where the same flaw in study design results in the selection of those most engaged and motivated by the subject. This is an important bias which needs consideration when the results are reviewed.

The survey includes some multiple choice and free text responses; these invite bias through inter-operator variance where different observers have different clinical perceptions (95) and performance bias where respondents work differently with different expectations across different sites (97). In addition there will be some inevitable bias introduced at analysis as

> "*open ended questions are difficult to analyse without introducing some bias in interpretation*"p.64 (95)

In addition, the use of a survey rather than an interview to gather individual responses results in a degree of forced bias by limiting responses to those available rather than collecting information through conversation. Forcing a response on an online survey can increase the rate of participants failing to answer questions and failing to complete the survey (104). Multiple responses to questions were permitted in an attempt to minimise this and there was no requirement for participants to complete every question.

This concludes the description of the methodology and methods used. The following chapters give a detailed description of each of the three phases within the study.

Chapter 3 – Development and validation of the audit tool

3.1 The need for validation

Clinical audit in healthcare enables service providers to measure quality of care and services against agreed standards and make improvements where necessary (105). In order to audit the reporting accuracy of radiographers as compared to radiologists it was necessary to first develop a suitable audit tool, to establish the tool as fit for purpose and to check consistency of use of the tool through a process of validation.

The Health Quality Improvement Partnership describes the importance of having confidence in clinical audit data in order to make changes in practice (106). This level of confidence relies on the ability to collect quality data and it is recognised that failings in data entry, poorly designed audit tools and inappropriate interpretation of data at the time of entry can all influence the quality of data and the confidence of those both inputting and interpreting that data (106).

Effective audit follows a cycle of activity as demonstrated in Fig 3 with stage 2 covering the collection of data and the measuring of that data against agreed standards.

This image has been removed by the author of this thesis to comply with copyright law.

Fig.3.1 – Audit cycle p,23 (107)

3.2 Developing an audit tool

There were a number of ways this audit tool was developed and piloted prior to the start of this research project to ensure that it was effective and fit for purpose. Initially a training database was set up, using the same format but independent of the main database, to establish that the correct information was recorded, that data storage was safe, accessible and available to work with on a daily basis and to allow the trainee radiographer to start to issue PCE's without any expectation that their opinion

would contribute to the definitive report. A scoring system (PDS score) was used to standardise data entry through coding (89). Categorising written report data through coding also set the data into an appropriate format for transfer to IBM SPSS (87). The same scoring system was used for both databases. The PDS score, as described in 3.3 also reduced the potential for bias(106) by reducing the potential for debate over insignificant and equivocal findings.

A pilot evaluation was undertaken by a radiologist using the PCE's provided by the first radiographer to commence training. The results of this preliminary audit were used, along with guidance from relevant literature (79, 108) to inform the initial standards for future audit. The standards are described in the T&S NHS Trust Audit Proposal documentation (appendix 2.1) and are discussed in chapter 5.

In addition to setting initial standards for future audit this early work also identified that the tool was easy to access and to use. It established that all users were engaged, data was entered accurately and there were few omissions.

The audit tool was then validated to ensure consistency in the results generated and to check inter rater reliability before it was used to determine the reporting accuracy of radiographers using the entire database of 1815 studies recorded over a four year period. This chapter covers the development, audit and validation of this tool.

3.3 Setting up the database

A database was set up to record data for radiographers undertaking preliminary clinical evaluations of CTC examinations. It was used to store demographic and report data, to give feedback to the radiographers and to facilitate audit to measure competence. It was set up using Access 2010 (Microsoft Corporation) and captured the information described in table 3.1.

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 3.1 – database information

It was accessible by all users through a shared access folder on the Trust computers.

Its role in the clinical setting was to capture and record the radiographer PCE and to provide a mechanism for the reporting radiologist to give feedback on the radiographer's opinion.

The database was designed to facilitate data collection, review findings and provide 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 (105).

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 any 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 accuracy of the test (109).

The process of holding both the radiographer PCE and the definitive reports for review and audit supports team working by allowing both opinions to be considered, encouraging discussion of equivocal findings and providing a robust tool for clinical governance (80, 110).

Because the radiographer PCE was measured against the radiologist report which was not proven through endoscopy or pathology findings(35) it was considered appropriate to devise a scoring system which considered not just the accuracy of the PCE as compared with the final report but also included the clinical significance of any pathology mis-reported by the radiographer. The score defined matched and missed pathologies within the PCE. It considered the pathology, whether it was accurately recorded by the radiographer and if not, the clinical significance to the patient of any inaccuracy. This produced a score which was less subjective and less influenced by disagreement over small (<5mm), equivocal or insignificant lesions which can be hard to define with accuracy using CTC (96, 111). It also ensured that any feedback given was objective, that it was consistent across all users and that it could be clearly interpreted by the radiographer.

3.4 Audit descriptors

Initially 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 (46, 86). The CT Colonography Reporting and Data System (C-RADS) uses a scale of C0-C4 to categorise CTC abnormalities(112) as described in table 3.2.

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

Table 3.2 – C-RADS descriptors(112)

C-RADS uses a scale of C0-C4 to categorise Ct colonography findings(112) and does not code normal studies. 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”, as described in table 3.3, 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. This was done because 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 PCE reflected this

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

Table 3.3 – P Score descriptors

Using these P scores the radiographer PCE 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 was recorded by the radiologist at the time of reporting. This score is defined in table 3.4.

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

Table 3.4 – PDS score descriptors

This score was used to determine radiographer accuracy. Where more than one pathology was present the P score reflected the most clinically significant. The PDS score however was applied to any inaccurately recorded pathology with the score relating to the significance of the inaccuracy. For example, a reported tumour but a missed 10mm polyp would result in a PDS score of 4 but a reported tumour alongside a missed 4mm polyp would result in a PDS score of 2. As part of their ongoing training the radiographer was responsible for regularly checking the PDS scores and radiologist comments for their PCE’s and for reviewing the images for any PDS scores of 2-4. The radiologist had a responsibility to inform the radiographer of any significant missed pathology (P3 and P4) and to review the images with the radiographer.

3.5 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 3.5. There

are only 3 significant (P3&4) pathologies within these data but this in line with the entire database.

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

Table 3.5 – Pathology Distribution

The results demonstrated agreement between tool users ranged from 80 – 100% for normal studies and insignificant discrepancies, as shown in Table 3.6.

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 3.6 – Frequency results – PDS scores for all participants

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. 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. Statistical analysis was undertaken using percentage agreement and the kappa statistic to determine inter-rater reliability(113), as described in table 3.7.

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*.(91, 113)

Table 3.7 – Summary of statistical analysis

3.6 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 5-9mm 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 (91).

It is also noted that the study sample only included a total of 3 (10%) P3 and P4 cases, thus reducing the potential for a PDS 3 or 4 score resulting from a false positive PCE to just 3 opportunities. This can be compared with the complete database where P3 and P4 pathologies represented 35% of the pathologies recorded. The discrepancy in numbers of P3 and 4 pathologies between the two sample groups limits the conclusions that can be drawn from this small dataset and is likely to be due to sampling error resulting from the small sample size of the validation dataset. Sampling error is inversely related to sample size and is most noticeable for small sample sizes(89). This was not felt to be an issue as the

purpose of the audit was specifically for tool validation through assessment of inter-rater agreement.

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 at the study hospital 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 (35).

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 a positive faecal occult blood test 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 4mm as the cut off between diminutive and small polyps. This decision recognises the discrepancies in polyp measurement during procedures when compared with measurements of the pathology specimen. CT will often measure a polyp smaller than it’s true size and endoscopy will oversize when compared with pathology specimens (88).

It is acknowledged that reporting on 4mm polyps is not in agreement with the findings of some studies(76, 114) where 6mm 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. This is supported by opinion from other studies advising surveillance and / or polypectomy for small and diminutive polyps (115, 116)

These studies acknowledge the lack of data as polyps, once detected, are usually removed(115, 116) and agree that establishing a cut off size for polypectomy is difficult. The C-RADS minimum dataset for CTC reporting would classify any number of polyps ≤ 6mm diameter as C1 (normal, benign lesion or polyps ≤6mm)(117) but a joint document from the British Institute of Gastrointestinal and Abdominal Radiology and the RCR, in agreement with the NHS BCSP advocate the reporting of ≤6mm polyps, especially multiple polyps and when confidence levels are high(69).

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 would be responsible for producing all PDS scores.

For clinical use as an audit tool it was necessary to set standards by which to measure radiographer performance based on the PDS scores achieved. This has not been described in this chapter as the purpose here was solely to describe and validate the tool but it will be covered in a later chapter looking at an audit of the complete database to determine the accuracy of the radiographer PCE.

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. The initial purpose of the tool was solely to determine how well radiographers could interpret intracolonic pathology when compared with radiologists and not to identify inaccuracies in the radiology report. However, since developing the audit tool described discussions have taken place with The Peninsula Collaboration for Leadership in Applied Health and Research Care (PenCLAHRC) to move this work forward. PenCLAHRC are part of the National Institute for Health Research and undertake research projects involving modelling of patient pathways, capacity and resource planning and workforce analysis in order to encourage best use of resources and identify efficiency savings (ref http://clahrc-

peninsula.nihr.ac.uk/penchord) accessed 21.03.16. There is potential for the findings of this research to be taken forward for modelling and statistical analysis. If this is undertaken there will be a clear need for additional information to be collected on how often the radiologist report is amended following review of the radiographer PCE to inform on whether some tasks are being undertaken to no benefit and to determine how roles within the team should be assigned.

Finally, the data tool would not 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 (50, 109, 118, 119).

3.7 Conclusion

The results indicate that the audit tool provides a practical, easy to use and reliable method to record, monitor and evaluate a PCE 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 could be used to develop and monitor effectiveness of training models and provide data on the individual performance of radiographers providing a PCE of intraluminal pathology as part of a radiology report.

The validated tool was used for the audit of the accuracy of a radiographer PCE of intraluminal pathology compared with the radiology report for CTC described in Chapter 4.

Chapter 4 – Audit of radiographer preliminary clinical evaluation of intraluminal pathology

4.1 Clinical audit in healthcare

This chapter outlines the audit of a PCE of intraluminal pathology on CTC studies by suitably qualified and experienced radiographers. It justifies the use of audit as an appropriate research tool in a clinical setting and discusses the results with consideration to their impact on future service delivery models.

4.2 Introduction to audit

Audit is defined as “the systematic and critical analysis of the quality of clinical care” (18). It enables health care professionals to measure their performance, recognise good practice and make improvements as appropriate.(18) NHS England define audit as a way for care providers and patients to recognise where a service is performing well and when there is a need for improvement (120).

Healthcare practice is managed and improved through the audit cycle by which healthcare workers can observe their practice, set standards by which to measure the quality and effectiveness of their care and then measure practice against these standards. There then follows a period of change in response to the audit findings. The process can be repeated with on-going observation and audit of the new practice, again to determine effectiveness (18).

Audit forms part of the process by which the quality of care can be assessed at a local level and contributes to the overall evaluation of the quality of care within the NHS at local, strategic and national level (18). In addition, local clinical audit is a recognised method of ensuring clinical practice meets defined quality standards; this is essential information for those learning a new skill such as reporting or developing work which expands their current scope of practice. This is recognised by the Health and Care Professions Council (HCPC) which states that radiographers must be able to assure the quality of their practice through engagement in evidence based practice and participation in clinical and other audit (121). This is of particular

importance when developing a new service, advancing into a new area of practice or introducing a new model for service delivery.

The RCR also recognise the need for effective clinical audit and offer support through “audit live”, a resource providing audit templates for use when identifying best practice in key stages of the audit cycle (122). There are audit tools available for over 100 radiology topics.

A number of these audit templates, “Peer review – Using Double Reporting as a Tool for Revalidation”,(123) “CT Colonography Practice”,(124) “Single reader hit and miss rates in the Breast Screening Service”(125) and “An audit of Radiology Report Quality”(126) have been used as guidance for the clinical audit described in this chapter.

4.2.1 Peer review

The database and the system established for data collection for this audit was also structured to encourage peer review through discussion. HQUIP defines peer review as

> *“an assessment of the quality of care provided by a clinical team with a view of providing feedback and thereby supporting reflection on practice. The intent is that this will lead to improvements in the quality of care”.p.11(105)*

One of the important roles of the radiologist in supporting the education of the radiographers providing the PCE was to provide feedback in the form of comments to explain any discrepancies between the report of the radiographer and radiologist. This acted as a prompt for the radiographer to review and discuss the images with the radiologist. These comments were considered in this audit of radiographer PCE’s, alongside endoscopy and pathology findings, when reviewing the significant discrepancies (those with PDS scores of 3 or 4). The qualitative data from the comments gave additional depth of information to the audit but, more importantly, provided the information to enable staff to learn from their mistakes. It also provided quality assurance in line with the key principles laid down by the RCR for reporting QA –

"Accepting that discrepancies will occur

Mitigating against discrepancies through QA programmes

Having processes in place to minimise any patient harm

Having systems in place for shared learning from these discrepancies without culture of blame".p.6 (127)

Using the method described in Chapter 3 a local database was set up to collect data on radiographer PCE of the lumen of the bowel. The database was used in the clinical setting to assess and monitor competency and develop training models. It was also used to facilitate compliance with audit as required by external validators for the BCSP. The audit database was developed by the lead radiologist and radiographer managing the CTC service.

4.3 Setting audit standards for clinical use

Using the model described in chapter 3 audit standards were set with reference to recent literature on reporting accuracy. They were applied to the four discrepancy groups as set out in table 4.1 with identified pathology categorised as in table 3.3. A policy and practice guide on Radiographer Reporting by Audrey M. Paterson et al published in 2004 states that

> *"published studies demonstrate that standard of at least 95% sensitivity and 95% specificity can be maintained"p.210 (79).*

This was used to inform but did not dictate the standard set for PDS4, those discrepancies representing a major pathology and it relates well to a documented 96.1% accuracy for the test, established through systematic review and meta-analysis(115). It is anticipated that, using an audit cycle model (107) these standards will be re-visited and re-evaluated using the information gained by this work. Standards for PDS1-3, agreement between findings or insignificant and small discrepancies, were established following discussion between the tool users and with reference to the following papers –

A study conducted by St Marks Hospital in 2007 looked at the CT colonography interpretative performance of radiologists in a non-academic environment and

demonstrated an individual accuracy of experienced radiologists of 93% (95% CI 68-100%) with a mean accuracy of 88% (108).

A more recent study by Magriet de Haan et al in 2012 compared the diagnostic yields of a radiologist and trained technologists in the detection of advanced neoplasia within a CTC screening programme. The study looked at 6 different reading strategies, all of which detected all the cancers. They concluded that 2 technologists providing a primary read of CTC images were able to achieve comparable sensitivity and greater specificity than a single radiologist. They also noted that a multiple read strategy comprising of 1 radiologist and either 1 or 2 technologists was also more sensitive that a single radiologist read.(128) Reports from one radiologist showed a diagnostic yield of 6.1% compared with an increased diagnostic yield of 6.9% (1 radiologist, 2 technologists) or 6.7% (1 radiologist, 1 technologist) for the multiple read strategies. The relative true positive (TP) value also increased from 1.00 for a single radiologist to 1.13.and 1.10 for a radiologist and 1 or 2 technologists respectively (128). This study reinforced the view of the department that double reading of CTC was an appropriate use of radiographer time. These audit standards were used for all clinical audits undertaken to determine the competence of radiographers on completion of their training and for later audits to ensure report standards were maintained.

It should be noted that these standards were set in 2011 when the database was first set up and before this project had been considered.

On reflection, the author acknowledges that the evidence on which these standards were set is weak. There was little evidence available to use at the time and none which related directly to assessing the competence of radiographer reporting in a clinical setting. There was also little evidence in the form of clear standards on the reporting accuracy expected from radiologists so it was difficult to benchmark standards for radiographers to aspire to.

The studies used cannot be directly compared as their designs and methodologies are inconsistent and as such, should not have been used to set audit standards. A properly designed consensus exercise should have been undertaken as part of the literature review and in the absence of any clear national guidelines (107). There is now more published literature available and the author has a greater understanding of the topic. In the light of the work done for this thesis the standards will be revised and an updated literature review conducted before further audit in the clinical setting is undertaken. The results of radiographer PCE accuracy from phase 1 of this study will also be used to inform future audit standards

Score	***Score descriptor***	***Standard for accepted discrepancy level***	***Exceptions***	***Definitions and instructions for data collection***
PDS0	Not scored, inadequate study	N/A	None	Each report evaluated for discrepancy and scored for most significant pathology only
PDS1	Agreement with report – P1-P4	12%(108)	None	Each report evaluated for discrepancy and scored for most significant pathology only
PDS2	Discrepancy – Diminutive polyp ≤ 4mm, diverticula	25%(50)	None	Each report evaluated for discrepancy and scored for most significant pathology only
PDS3	Discrepancy – Small polyp 5mm – 9mm / diverticular disease to include wall thickening and stricturing	10%(50)	None	Each report evaluated for discrepancy and scored for most significant pathology only
PDS4	Discrepancy – Polyp ≥ 10mm, carcinoma, complicated diverticular disease (collection, fistula, abscess)	5%(79)	None	Each report evaluated for discrepancy and scored for most significant pathology only

Table 4.1 – description of audit standards

In justifying acceptable levels of discrepancy it is appreciated that that the recognition of and description of small colonic lesions is subjective (50) and will vary between any two reporters and that, even with the advantage of faecal tagging and 3D imaging, it can be difficult to differentiate between small polyps and adherent faeces and to accurately measure polyp size (88, 96). In view of this it was felt that a discrepancy of up to 25% was acceptable for the accurate recognition and description of findings of limited clinical significance (P2 pathology) but acceptable discrepancy levels were reduced to 5% when detecting, measuring and describing cancers and large polyps (P4 pathology).

4.4 Audit results

The CTC database, as described earlier, contained radiographer PCE's which were used to inform the final radiology report issued by the radiologist. Data from the period 18th February 2011 – 09th April 2014 were used, a total of 1815 cases.

The PCE's were issued by two radiographers over a period of 3 years. Of these 25(1.4%) were excluded because the radiographer PCE was not completed. When the database was first established it relied upon just one GI radiographer providing the intraluminal evaluation and as a result data were not entered during periods of annual leave or absence. It was not felt appropriate, given the purpose of the database, to evaluate studies retrospectively.

PDS scores were issued by 4 consultant radiologists; all experienced in reporting CTC examinations. Any radiographer evaluation not scored at the time of the report was retrospectively scored by an experienced CTC radiographer using the validated audit tool described in chapter 3 (1). This was undertaken because it was felt that omission to score at the time of reporting might occur more often for a normal or insignificant finding with no relevant feedback to give to the radiographer. Omitting this data would have introduced bias to the results. Scoring by a radiographer raises the potential for bias by the radiographer who scores studies with a view to achieving

correlation. To minimise this effect the scoring process is prescriptive and well defined to reduce the effect personal opinion on the assigned scores.

This was looked at in detail through cross tabulation of the PDS scores assigned by the 4 radiologist and the radiographer. Results as shown in table 4.2 indicate that the radiographer scores show parity with the radiologist scores so do not impose bias on the study but were not limited to defining the normal or matched studies as anticipated but spread across all categories. The radiographer scored category represented 20% of the total data; a significant proportion of the total and a level of compliance which would need to be improved to get reliable unbiased data for future use of the audit tool.

Radiographer / radiologist	***No record***	***PDS1***	***PDS2***	***Pds3***	***Pds4***	***Total***
Radiographer	1	331	33	15	1	381
Radiologist 1	0	404	11	0	0	415
Radiologist 2	1	225	20	7	2	255
Radiologist 3	11	321	19	3	0	354
Radiologist 4	5	335	34	24	2	400
Total	18	1616	117	49	5	1815

Table 4.2 to demonstrate audit score cross tabulation for PDS scores issued by each radiologist / radiographer

Retrospective scoring of these studies by a radiographer has the potential to influence findings by introducing bias(97) but one-way ANOVA testing of all the PDS scores resulted in a p-score of 0.164 representing no statistically significant difference between the radiologists' scores at the time of reporting or with the radiographer retrospective scores used to provide inclusive data sets. This is reassuring and suggests that there is parity in the scoring and in the use of the tool.

However, there needs to be an awareness of the small numbers documented for PDS 3and 4 and the influence this might have on results (89).

One-way ANOVA testing was also undertaken to establish that there was no statistically significant difference in the PDS scores given to the two radiographers. A p-value of .887 identified that there was parity in the accuracy of their 1st reads and no bias in the scores assigned to any individual.

The patients presenting for investigation represented a symptomatic population and included direct referrals and patients from the BCSP with positive findings from faecal occult blood testing. Table 4.4 describes the range and frequency of pathologies documented in the radiology reports within these groups.

P score	***Pathology description***	***Frequency***	***Percent***
P0	No record	12	0.7
P1	No pathology	387	21.3
P2	Polyp < or = 4mm, diverticula	776	42.8
P3	Polyp 5-9mm, diverticulosis, wall thickening, narrowed lumen.	411	22.6
P4	Polyp > 10mm, malignancy, complicated diverticular disease	229	12.6
Totals	1815	100.0	100.0

Table 4.3 to demonstrate the range and frequency of pathology identified

This table demonstrates a good range of pathology across all the cases and identifies a number of key points –

- Records were not available for 12(0.7%) of the 1815 cases.
- Normal or insignificant findings were described in the radiology report for 1163 (64.1%).

- The remaining 640 (35.2%) cases had significant pathology described, cancer, large polyps and often extensive or complicated diverticular disease, sometimes with the additional presence of small incidental polyps, not related to the presenting clinical symptoms of the patients.

It should be noted that where radiology reports described one or more pathology, the most significant was used to determine both the P score and the resulting PDS score.

Table 4.4 below describes the frequency of the PDS scores assigned to the PCE's by the reporting radiologist. As previously described the PDS score links the pathology, the clinical significance and the ability of the radiographer to recognise and describe it accurately in the 1st read.

Thus, a significant pathology, identified and described by the radiographer would receive a PDS score of 1; the same lesion not identified or accurately described by the radiographer would result in a PDS score of 4

Score	***Frequency***	***Percent***	***Cumulative percent***
No record	25	1.4	1.4
PDS 1 – match	1619	89.2	90.6
PDS 2 – insignificant discrepancy	117	6.4	97.0
PDS3 – significant discrepancy	49	2.7	99.7
PDS4 – major discrepancy	5	0.3	100.0
Total	1815	100.0	

Table 4.4 demonstrating PDS score frequency

Of the 1790 cases with first reads available for review 1619 (89.2%) demonstrated a match between the opinion of the radiographer and radiologist (PDS score 1).

In 117 cases (6.4%) there was a disagreement of opinions but the discrepancies were felt to be insignificant to the clinical management of the patient (PDS score 2).

In 49 (2.7%) cases there was felt to be a significant discrepancy between reports (PDS 3) and in 5 cases (0.3%) the radiologist felt that a major pathology had been overlooked by the radiographer issuing the PCE (PDS4). This result needs to be considered against the earlier table describing the pathology demonstrated which recorded P3 or P4 in 640 (35.2%) of cases.

The 54 (3%) cases where the difference of opinions was felt to be of relevance to the management of the patient were looked at more closely. Endoscopy and pathology reports were checked for all the PDS 3 & 4 scores. Table 4.5 demonstrates the relationship between the two sets of findings.

	Compared interventions	***Frequency***	***Percent***	***Cumulative percent***
Valid	No intervention	26	48.1	48.1
	Endoscopy / pathology matches radiology	23	42.6	90.7
	Endoscopy / pathology disputes radiology	5	9.3	100.0
	Total	54	100.0	

Table 4.5 describing the correlation between endoscopy, pathology and radiology reports for PDS3 and PDS4 scores

Results were available for all 54 cases.

For 26/54 cases no further intervention was undertaken with the clinicians deciding to manage the patient conservatively so it was not possible to determine whether the radiology report or radiographer 1st read were correct.

For 23/54 cases endoscopy and / or pathology findings were in agreement with the radiology report

In 5/54 cases there was disagreement between the radiology report and findings at endoscopy. Looking at each of these cases individually the following is identified –

Case 1 – The radiology report described two small (PDS score 3) polyps not identified by the radiographer. Of these polyps just one was confirmed at endoscopy with the pathology report describing a high grade dysplasia.

Case 2 – The radiology report described a 7mm caecal polyp which was not identified by the radiographer. The follow up endoscopy was normal.

Case 3 – The radiology report described a 6mm sigmoid polyp not identified by the radiographer. This polyp was not identified at endoscopy but a tiny caecal polyp, overlooked at CTC was removed.

Case 4 – The radiology report described a sigmoid polyp which was overlooked by the radiographer. Endoscopy confirmed the presence of this polyp and the pathology report described a high grade dysplasia. In this instance the radiology report significantly undersized the lesion.

Case 5 – The radiology report described two small polyps, not identified by the radiographer and a thickened bowel wall suggestive of colitis. The endoscopy and pathology reports described colitis but did not confirm the presence of polyps.

All of these cases had PDS scores of 3 indicating that findings were thought to be clinically significant but did not relate to major pathologies. It is important to remember that this study considers small polyps of 5mm and above to have clinical significance.

It was also felt appropriate to look more closely at the 5 cases (0.3%) given a PDS score of 4, indicating that the radiographer failed to identify a major pathology

reported by the radiologist. For all of these cases the radiology report was confirmed by endoscopy and / or pathology.

Again comparisons were made between the radiology report and findings at endoscopy and pathology. Two patients went on to have surgery where the pathology report confirmed the radiology diagnosis of cancer. Looking more specifically at the imaging for these two lesions missed by the radiographer, both involved the caecum. One was a missed caecal polyp in a poorly prepared, under distended bowel and the other a lesion at the terminal ileum, including the ileocaecal valve.

The remaining three had no further intervention but from further investigation it can be concluded that the decision to not intervene was in the best interests of the patients.

One case represented a false positive PCE, the radiologist did not support the findings of the radiographer and a sigmoid lesion was reported as faecal residue.

Another case related to an 84 year old patient who was reported to have a 7mm pedunculated polyp. No intervention was recorded; the patient was frail and elderly and passed away a short time later. It should be noted that, on review of the radiology report, a PDS score of 4 was incorrectly assigned by the radiologist in this instance. A 7mm polyp should have represented a PDS of 3.

Adjusting the data to reflect this resulted in an increase to 2.8% for significant discrepancies but a reduction to 0.2% for major discrepancies. This represents just 4 out of 1815 patients representing 98.4% agreement with the radiologist report*.

The final case referred to a 93 year old with multiple polyps of which some but not all were identified by the radiographer. Again, it was considered inappropriate to intervene.

In order to complete the Trust Audit alongside the academic project percentage agreement between radiologist and radiographer for each pathology grouped P1 –

P4 and described as a PDS score were also considered against the standards set for audit. These are described in table 4.6.

	Percentage agreement	***PDS percentage discrepancy***	***Standard percentage***
PDS1	89.2	N/A	88
PDS2	N/A	6.4	15
PDS3	N/A	2.7(2.8)	10
PDS4	N/A	0.3(0.2)	5

*Table 4.6 to demonstrate the correlation between radiographer and radiologist for all pathology described. (*adjusted data in brackets)*

All results fell within the standards set for this audit. No further training of the radiographers currently providing PCE was required and the decision was made to continue the service and to recruit more radiographers to commence training in order to build up the team prior to replacing barium enema examinations with CTC for all patients referred for bowel imaging.

None of the PDS scores 3 and 4 reviewed in this study related to discrepancies in the recording of diverticular disease. It is not possible to make any robust conclusion from this observation. Whilst it is possible that the radiographers were able to recognise and catagorise diverticular disease very well it is also probable that radiologists focussed on the presence of polyps and cancer when issuing PDS scores and did not fully consider the relevance of diverticular disease. It should also be noted that scoring diverticulitis by degrees of bowel wall thickening and lumen narrowing is subjective, even with guidance from the parameters set by the PDS scoring tool.

4.5 Discussion

The results of this study are very positive and suggest that radiographers are able to issue an accurate PCE of the colon in agreement with that of their radiologist colleagues. However, in reaching that conclusion there are a number of assumptions made and some influencing factors that should be considered.

The database was large and represented work over a four year period. Data input was accurate and for the most part complete but a potential for bias was introduced when the absent PDS scores were completed retrospectively in order to provide a complete dataset. The rationale for this was that the absent data may have represented the normal or “matched” findings and to remove it from the audit would have swayed the results. One-way ANOVA testing of the data tool as part of the initial validation concluded that no bias was introduced by including this data, nor was there any significant difference between the results of the four participating radiologists.

The study made the assumption that all radiographers worked independently and always submitted their data before and therefore blinded to the final report. It also made the assumption that the radiologist applied the PDS score accurately and issued the initial report blinded to the radiographer PCE. Significant bias could be introduced by abuse of this assumed integrity by participants. If the audit tool was developed for use by a wider group of participants quality control measures would need to be introduced to prevent the potential for corruption of data.

Also, the radiographer PCE’s were completed by just two participants. Whilst one-way ANOVA testing identified no statistically significance between the accuracy of the reports for these individuals more robust and reproducible results could be obtained with a larger cohort of participants. This could be achieved with further research undertaken utilising widened participation through the inclusion of other hospitals, all providing PDS data using the same data tool.

Four consultant radiologists provided the PDS data and additional supporting comments for this study. These radiologists were very supportive of the programme and committed to working in partnership with the radiographers to provide a quality service. It is not possible to predict how radiographer accuracy might be affected within a less robust team. Again, further research to include a number of hospital sites with a range of clinical practices may provide this information. It would also be informative to collect data on how radiographer accuracy might be related to duration of training and the number of studies reviewed during the training period to determine when competency / level of expertise is reached. It would also be useful to collect data on assigned PDS scores when the radiologist is the novice and the radiographer the expert or most experienced. Also, the audit tool, whilst designed to provide audit data and support radiographer training need not be exclusive to that staff group; it could be used to good effect to support trainee radiologists reporting CTC and expanding its use across staff groups would add depth to data collected. Further research in this area would provide the information needed to set standards for report accuracy for CTC, especially if the data on report agreement and discrepancy could be considered against colonoscopy and pathology findings for a sufficient number of studies.

One of the problems with determining radiology report accuracy in a clinical setting is the difficulty in defining what is correct (111). Negative predictive values are hard to collate if patients do not have further investigation and are not followed up; positive predictive values rely on the ability to access the appropriate data to collate results. With patients imaged for CRC searches for data need to include endoscopy and pathology results and a search of the cancer register. Literature would also suggest that CTC is less specific when describing small polyps (35, 96), resulting in subtle differences in reports across the three disciplines. The differing opinions collated for the PDS3 patients 1-5 described in 4.4 demonstrated correlations with this as opinions differed between radiographer, radiologist and endoscopist for all of these cases.

This study looked at colonoscopy, flexible sigmoidoscopy and pathology results for all PCE's given a PDS3 or 4 by the reporting radiologist. Of these 54 cases only 28 had undergone a further intervention, for the remaining 26 it was not possible to confirm the accuracy of the radiology report or the PDS score as the patients were not followed up. If standards for reporting accuracy are to be established more data is required and again this could be achieved by disseminating the audit tool to more sites. However, whilst this would give access to a greater pool of data, that data would still be subject to the same bias arising from the lack of further intervention.

Where large studies such as the SIGGAR trial have been in a better position to accurately determine the sensitivity and specificity of CTC as reported by radiologists their findings compare well with the radiographer PCE accuracy of this study. The arm of the SIGGAR trial comparing CTC with BE reported that CTC missed 3/45 colorectal cancers in a study group of 1277 patients(5). This study reported a miss rate of 4(3 adjusted)/229 major pathologies in a study group of 1813 patients. These findings were further supported by Lauridson in 2013 who reported an overall per polyp sensitivity for radiologist reported studies of 69%(95% CI 48.1-89.6) for polyps ≥10mm.(118). This study describes an effective process for assessing report quality for CTC through the mechanism of double reporting, an effective tool for the objective assessment of performance (123, 126, 127). It acknowledges the problems associated with collecting data specifically for the purpose of audit and provides the PDS scoring system which allows for ongoing audit and feedback to staff along with improving clinical outcomes in reporting.

4.6 Conclusion

This study concludes that radiographers can, with appropriate support and training over a period of time, provide a preliminary clinical evaluation of intraluminal pathology to a standard comparable to that of an experienced consultant radiologist. Existing literature acknowledges the need for training for any individual reporting CTC with a suggested training numbers of 50 – 75 studies as a baseline for reporting competence (46). However, a systematic review of radiographer reporting of CTC

undertaken by Meertens et al undertook subgroup analysis of radiographers who had reported 50 or less training cases against those who had competed 61 – 200 training cases and reported a statistically significant 21% increase in sensitivity for those with the additional training(76) which might suggest additional experience over the minimum 50 cases would be preferable; the personal experiences of the radiographers involved in the work for this PCE audit would support this view. Further research is required to establish the amount of training required to reach the levels of “competent” and “expert”; the audit tool used for this project would provide the mechanism to do this.

Chapter 5 – A survey of the role of the radiographer in Computed Tomography Colonography

5.1 Introduction

As described in Chapter 2 there is a current lack of literature describing the role of the radiographer in managing a CTC service. Guidance has been provided on how best to undertake the procedure (46, 62) but little attention has been given to who should undertake key tasks. This survey, in conjunction with the audit of radiographer PCE of intraluminal pathology aims to provide information on current radiographer roles in order to inform on best practice and potential role development.

CTC is a relatively new procedure, first described by Amin et al in 1996(57); it has been developed and refined over recent years to become a widely accepted examination (41, 46). However, many still consider the procedure to be radiologist led with the report issued by an appropriately trained radiologist in recognition of the complexity of image interpretation and the software used to aid interpretation and diagnosis (76).

Traditionally radiographer roles have developed in response to a need to provide imaging efficiently with limited resources,(79) often in situations where pressure on capacity is at a limit. The rapid acceleration in demand for CTC has required many providers to explore new methods for delivering the service through using resources more effectively. Centres are under pressure to provide CTC as it is now considered to be the radiological examination of choice when investigating bowel pathology (5) and as a result radiographers are being utilised to provide this service. This has required radiographers to learn new skills and resulted in the development of roles specific to the needs of individual sites. They work within boundaries defined by their departments but with little national guidance or published literature to refer to and constraints on access to suitable postgraduate courses to support their activities (129). Courses are available but funding and release from clinical activities can be hard for radiographers to obtain. The ScoR Strategy for Research 2010 – 2015 (129)

describes a lack of funding or insufficient funding as a current barrier to research and it is likely similar constraints apply across other areas of postgraduate study.

This survey asked a number of questions to radiographers currently providing a CTC service in order to determine their level of involvement and responsibility and to establish a baseline for accepted radiographer practice.

5.2 Results

5.2.1 Hospital demographics and referral patterns

The first section of the survey looked at basic demographics as described in table 5.1 and asked about hospital size and activity. Hospital size was grouped into 3 categories with most respondents describing a hospital of 400-800 beds.

Hospital size(bed numbers)	***Number of respondents(n=68)***	***Number of CTC's performed per annum***		
	-	<100	100-500	>500
<400 beds (26.47%)	18	5	11	2
400-800 beds (57.35%)	39	4	21	14
>800 beds (16.18%)	11	0	3	8

Table 5.1 – hospital size at which the respondents were based along with the spread of CTC's undertaken within each category of hospital

It is shown by this table that most sites perform between 100 and 500 CTC's per year but with a significant number undertaking over 500. As expected, the larger the hospital, the greater the number of procedures carried out but the figures did demonstrate that a CTC service was not limited to larger sites but that smaller hospitals were also involved. Breaking this data down to look at each hospital by size, CTC was undertaken with enthusiasm in all trusts, irrespective of size with 72% of the smaller hospitals performing over 100 scans per year.

Respondants were asked to list the bowel imaging offered by their trust. Table 5.2 demonstrates the spread of imaging offered with sites providing some or all of the procedures listed.

Imaging offered (68 respondents)	***Number of respondents sites offering the procedure****
Barium enema	12 (17.65%)
CT Colonography	39 (57.35%)
Colonoscopy	39 (57.35%)
Flexible sigmoidoscopy	34 (50%)
All of the above	38 (55.88%)

*Respondents were encouraged to select all options that applied to them.

Table 5.2 – the range of imaging offered by respondents sites

These figures clearly demonstrated the equality given to CTC and colonoscopy; selected in equal numbers by respondents. In keeping with NICE(41) and other national guidance(46, 62) the use of the BE has reduced for respondent sites and hospital size did not seem to be a significant factor affecting whether the BE was still offered or not.

Supporting comments indicated that sites still providing BE were doing so in fewer numbers or for very select indications such as possible fistula or for single contrast water soluble studies. Other sites were restricted from offering just CTC because of resource limitations on scanning time but many had plans to resolve this. It should be noted that only radiographers involved in CTC were invited to complete this survey; sites across the UK offering just a BE service were not identified by this project.

Comments
"We only currently have capacity to perform 5 CTC examinations per week as we only have one very pressurised scanner and one barium radiographer that performs these scans between his barium and reporting lists" *"Only approximately 4 barium enemas carried out a month now"* *"CT colonoscopy offered to those who have failed colonoscopy, are unsuitable for enema prep and those with known disease who require staging at the same time"* *"Barium enemas only done now in query fistulas in certain circumstances"*

5.2.2 Managing referrals

Having established the basic demographics of respondent's hospitals the survey then went on to ask questions around referral management to establish the role played by the radiographer and to determine the level of autonomy in their practice.

Respondents were first asked to describe referral patterns and the results are laid out in table 5.3 below.

Accepted referrers	***Number of responses (total 65)***
General practice	*25 (38.46%)*
Out-patient clinics	61 (93.85%
In-patient referral	58 (89.23%)
Bowel cancer screening programme	48 (73.85%)
Fast track referrals (cancer pathway)	53 (81.54%)

Table 5.3 – demonstrating referral patterns for CTC

Fewer sites accepted CTC requests from General Practitioners (GP's) however comments suggested that some accepted BE requests from GP's which would be

converted to CTC if thought to be in the best interests of the patient. Others recommended referral for a gastrointestinal opinion first and would then accept the CTC request through that route.

The BCSP uses CTC to evaluate the colon where colonoscopy has failed or the patient is not suitable for OC(64) and 48 of the 65 respondents sites accepted referrals through this route. The BCSP guidelines state that anyone reporting CTC for BSCP patients must be reporting a minimum of 100 studies per year (46). However, by filtering responses to look just at those respondents taking BCSP referrals it was noted that 10% of sites performed less than the required 100 studies per year. This is demonstrated in table 5.4. The survey did not investigate who undertook reporting of these studies; they may have been interpreted by other sites with sufficient numbers to meet BCSP reporting criteria.

Total patients scanned per year	***Number of respondents***
Less than 100	5 (10.42%)
100 – 500	20 (41.67%)
Over 500	23 (47.92%)

Table 5.4 to demonstrate the number of CTC's performed per year by sites scanning BCSP patients.

Respondents were asked a question on accepting referrals with options ranging from the radiographer taking sole responsibility for the referral to the radiographer not having any involvement and for all referrals to be managed by a radiologist. The 65 respondents were asked to tick all answers that applied to their working practice. Table 5.5 below demonstrates a range of responses; the largest group accepting referrals were the radiologists.

	Always	***often***	***sometimes***	***never***	***total responses***
Radiographer using clinical judgement	7 (13.73%)	9 (17.65%)	16 (31.37%)	19 (37.25%)	51
Radiographer following protocol	9 (17.31%)	19 (36.54%)	8 (15.38%)	16 (30.77%)	52
Radiologist	35 (57.38%)	11 (18.03%)	15 (24.59%)	0 (0.00%)	61
Team decision (radiologists and radiographers)	2 (10.42%)	8 (16.67%)	19 (39.58%)	16 (33.33%)	48

Table 5.5 to demonstrate staff involvement in approving referrals

Team working scored quite poorly in these responses but the presence of responses in the often and sometimes boxes implied that a degree of collaboration must have taken place if only to differentiate patients and assign a route for referral and management of the request. It was also clear that no respondent felt a radiologist was never involved in referral decisions. This links in well with the views from respondents overall on radiologist involvement in the service.

The comments listed below may clarify some of the responses given –

Theme	*Comments*
Radiographer vetting using a protocol with radiologist support	*"The majority of CTC vetting is carried out by Advanced Practice GI radiographers following a locally agreed protocol. Where more complicated decisions need to be made advice will be sought from a consultant radiologist."* *"Radiographers vet the CTC requests using our protocol and clinical judgment. Anything outside this is returned to the referrer, changed to a CT long prep or if unsure, discussed with a radiologist."* *"Mostly radiographer led but always radiologist if any concerns / queries."* *"If not clear cut radiographer refers decision to radiologist."*
Radiologist vetting	*"At the moment radiologists vet request cards but may change to radiographers in the near future."* *"All referrals are vetted by a CTC radiologist although we do have a lead radiographer in CTC who can vet the requests but they are always checked by a radiologist. Radiographers that are trained in carrying out CTC cannot vet the requests."* *"We are a private hospital and most of our CTC referrals are for a named radiologist. Any queries that we have we discuss with him over the phone as he is not physically on site when we scan."*
Miscellaneous	*"Delegated to booking clerks under a protocol from radiologist."* *If a patient has a failed colonoscopy but has had good prep – the radiographer performing the list of CTC's can accept one patient per day, time permitting."* *"Team? Ha!"* *"Radiographers decide between full and minimal bowel prep."*

The next question asked about challenging referrals which were considered inappropriate with results recorded in table 5.6 below; it did not specify at which point the referral might be challenged so applied to requests both approved and awaiting approval. Again participants were asked to score all choices which applied to them so many will have given multiple answers.

	Always	***Often***	***Sometimes***	***Never***	***Total responses****
Radiographers using clinical judgment	8 (16.33%)	9 (18.37%)	21 (42.86%)	11 (22.45%)	49
Radiographers following a protocol	7 (15.56%)	9 (20.00%)	16 (35.56%)	13 (28.89%)	45
Radiologist	25 (43.10%)	14 (24.14%)	18 (31.03%)	1 (1.72%)	49
Team decision (radiographers and radiologists	8 (16.33%)	10 (20.41%)	23 (46.94%)	8 (16.33%)	49

**There were 65 responses to this question with the total responses to each section listed in the final column of the chart. It would seem from the results that not all respondents have answered each section of this question.*

Table 5.6 to demonstrate staff involvement in challenging inappropriate referrals

These results showed more variation than the previous question with more involvement demonstrated from all groups. It would seem that, whilst a radiographer was less likely to be involved in approving a request they were more likely to challenge a request they feel to be inappropriate.

The comments below go some way to explaining the rationale for this discrepancy –

Comments	*"Discussions may take place between GI radiographers and radiologist. Generally this will be taken forward by the radiographer who will discuss the specific request with the referring clinician."* *"CTC is used as a last resort for patients too difficult for barium enema or failed colonoscopy."* *Radiographers used to vet all CT referrals (bar CT colons) however this stopped prior to an IRMER inspection and now they do no vetting of any nature."* *"We only see request on the day that the patient arrives for a scan. A bit late, but challenged if needed."* *We have a comprehensive requesting pathway which identifies unsuitable patients for CTC. We offer faecal tagging CTC and faecal tagging CT abdo/pelvis."* *"Radiographers used to be more involved before e-requesting was introduced. Now all requests are electronically passed to GI radiologists for vetting."* *"We do not normally get inappropriate requests."* *"Patients may contact the department and liaise with a CT radiographer. If we feel the patient won't cope with the preparation / procedure then this will be discussed with the radiologist. Also, if the radiographer feels the clinical information isn't justified we will also liaise with the radiologist or referrer."* *"Again, mostly radiographers in the first instance but always with backup of radiologist if needed."*

When results were filtered to look in detail at the respondents who had no involvement with approving requests it was noted that many did have involvement with challenging referrals they felt to be inappropriate.

The question on approving requests was filtered to focus on respondents who reported no radiographer involvement in approving by protocol combined with no radiographer involvement in approval by using clinical judgement. Of these 19 respondents 12 would get involved in a protocol directed challenge of an inappropriate request and 11 respondents would challenge the request using their own clinical judgement. It is essential that, as independent autonomous practitioners,

radiographers are able to challenge a request and they should feel comfortable questioning the decisions of others; this is good professional practice which reduces errors, encourages effective team working and supports education and role development (73).

Responses were also filtered to look at the radiographers who approved requests to look at their involvement with other activities undertaken as part of the referral process. The results, described in Tables 5.6 and 5.7 demonstrated a clear involvement in the procedure but less definition of responsibility for the other tasks such as deciding on the use of bowel preparation and challenging referrals. There appeared to be less agreement between respondents for these areas of the patient pathway.

Table 5.7

	Using clinical judgement (always)	***Using clinical judgement (often)***	***Using clinical judgement (sometimes)***	***Using clinical judgement (never)***	***Number of respondents***	***Using protocol (always)***	***Using Protocol (often)***	***Using protocol (sometimes)***	***Using protocol (never)***	***Number of respondents***
Challenging referrals	6	8	6	4	**24**	6	8	4	5	**23**
Deciding on bowel preparation and tagging	4	0	5	8	**17**	2	10	2	3	**17**

Table 5.8

	Always	***Often***	***Sometimes***	***Never***	***Total respondents***
Taking clinical responsibility for the patient during scanning	16	4	0	0	**20**
Involved in the production of patient group directions	11	6	0	1	**18**

Tables 5.7 and 5.8 to demonstrate respondents who approve referrals cross referenced with other key tasks governing the referral process and the procedure

5.2.3 Managing prescription and administration of bowel preparation and faecal tagging

This section asked questions about the type of bowel preparation used, the use of tagging and the roles and responsibilities of the radiographer in managing these factors. A successful CTC examination relies on effective bowel purgation to produce a clean bowel and faecal tagging to compensate for any shortcomings in bowel preparation and improve reporting accuracy by enabling the reporter to differentiate between tissue and faecal residue (46, 115). Successful imaging however should not be to the detriment of the patient and there are important issues to consider when balancing the effectiveness of a purgative laxative against the well-being of the patient (38).

The first question in this section was again related to demographics and was set to establish the bowel preparation and tagging regimes most used by the UK hospitals represented.

Picolax was the most frequently used laxative with 36 of the 58 respondent sites prescribing it for their patients. The comments for this section give added insight and it was clear that some hospitals tailored their prep regime to suit the patient with many offering a reduced prep regime to their high risk patients. The comments listed below give interesting feedback and would support the view that many sites are now relying on Gastrografin only, generally combined with a low residue diet, to provide effective and safe purgation along with adequate faecal tagging (46, 130). This is reflected in the 12 respondents who described a preparation which offered no purgation and the 20 that described “other methods” of preparation. The comments would imply that other methods include the recognition of Gastrografin as an effective purgative.

Range of comments received –

Tagging only	*"Gastrografin"(3 responses)* *"Gastrografin for 2 days before appointment."* *"Omnipaque for faecal tagging."* *"No purgation is used, just faecal tagging."* *"We have recently stopped Picolax prep for a faecally tagged prep with no laxatives."* *"Bisocodyl tablets and Citrafleet."*
LRD only	*"Patient follows a low residue diet."(4 responses)*
Tagging + LRD	*"Gastrografin and low fibre diet."(3 responses)*
Purgative bowel prep +/- LRD / tagging	*"Cleanprep or Picolax depending on patient contraindications and reasoning for scan."* *"Citrafleet."* *"Citrafleet and kleanprep – all with Gastrografin stool tagging."* *"Citrofleet."* *"Gastrografin and Moviprep."*
Other	*"Referring clinician fills out questionnaire regarding patient co-morbidities and preparation is selected accordingly."* *"Gastrografin combined with bisocodyl tablets."*

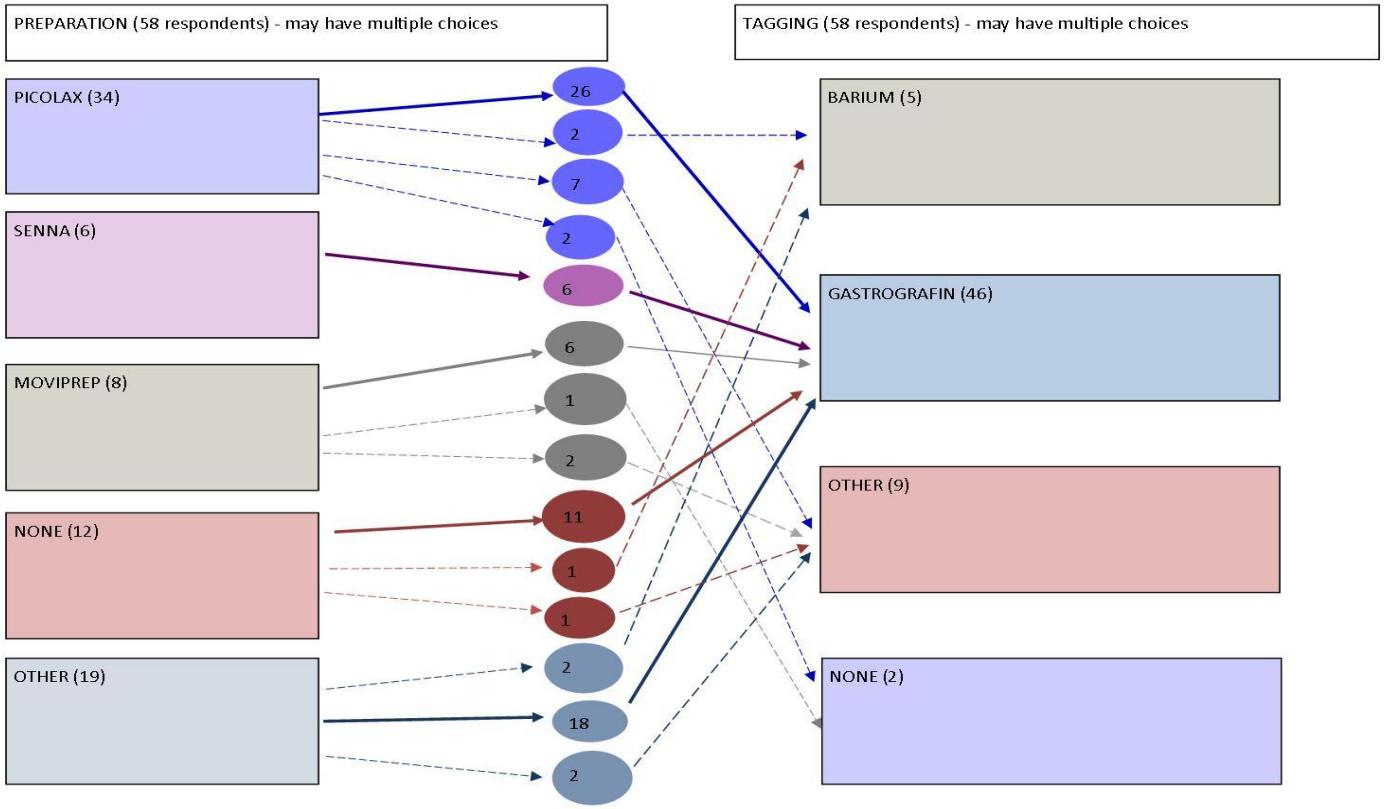
Gastrografin was the most widely used faecal tagging agent with 46(82%) of respondents prescribing it at their sites. Respondent comments suggested that sites using tagging regimes other than Gastrografin or barium were most likely to use Omnipaque with the reasons given for use being competitive cost and ease of posting the plastic container. This is not raised as an issue by any other respondents and the survey does not ask how the medication is dispensed but the NPSA and NICE does offer guidance on this. The NPSA rapid response report on oral bowel cleansing solutions recommends a clinical assessment of the patient, an explanation on the safe use of the product and a safe system for the supply of medication (38).

. NICE recommend “patient decision aid” to involve the patient in the decision (131) it could be argued that neither of these activities can be safely and comprehensively undertaken by the prescriber if medications are sent out in the post.

Filtering results to look at the tagging agent given by sites that do not use any bowel preparation increased the use of Gastrografin to 91% of respondents with comments confirming that a number of sites were achieving acceptable results using a low residue diet and Gastrografin tagging only. Gastrografin -Sodium Amidotrizoate (Sodium Diatrizoate) and Meglumine Amidotrizoate (Meglumine Diatrizoate) exerts a mild laxative effect which is attributable to its hyperosmolarity(132) and this, combined with a low residue diet can be sufficient to achieve acceptable bowel purgation.

A chart mapping the relationship between the bowel preparations and tagging agents is included (fig 5.1).

Fig 5.1 – chart depicting the relationship between laxative and tagging agent



It is clear from this that, for whichever regime of purgation is chosen, Gastrografin was the most used tagging agent. This likely reflects the osmolytic effect of Gastrografin which offers additional bowel cleansing.

The decision on which bowel preparation to give is complex and affected by factors such as the age and morbidity of the patient, medical conditions including cardiac or renal failure and existing drug regimens which may be disrupted by the use of a cathartic bowel preparation (38). The results reflect this in the range of regimes used, often varying within as well as between sites. Who makes the decision on bowel preparation and tagging was another question asked in this survey of current practice.

Table 5.8 below demonstrates variation between sites although the decision was most likely to be made by the radiologist, one would presume at the time of authorising the request. There were 58 respondents who answered this question. Only 17% of respondents listed the referrer as the individual responsible for the decision on prep and tagging, a small percentage given the NPSA view that the referrer should take responsibility for this action (38).

	Always	***Often***	***Sometimes***	***never***	***Total respondents (58)***
Referrer	6 (17.14%)	2 (5.71%)	8 (22.86)	19 (54.29%)	35
Radiologist	21 (47.73%)	8 (18.18%)	13 (29.55%)	2 (4.55%)	44
Radiographer using clinical judgement	2 (5.88%)	11 (32.35%)	6 (17.65)	15 (44.12%)	34
Radiographer following protocol	5 (12.50%)	17 (42.50%)	5 (12.50%)	13 (32.50%)	40
No choice as all patients receive the same	15 (39.47%)	2 (5.26%)	3 (7.89%)	18 (47.37%)	38

Table 5.9 to demonstrate which member of the team makes decisions on the bowel preparation given.

It was noted that 17 respondents always or often gave all patients the same preparation. These were selected for further analysis to determine whether there was a single regime which respondents felt comfortable prescribing to all patients. The respondents documented that 4 gave Picolax to prepare the bowel, 2 used senna, 5 used an alternative laxative and 4 used no purgation but described the use of Gastrografin as a tagging agent and effective laxative, often in conjunction with a low residue diet. This would suggest no consistency in the bowel preparation given by different respondents in this situation.

Comparatively few respondents described radiographer involvement in decisions around bowel preparation but when looking at the group of respondents who stated that radiographers always or often made these it was seen that this group also took a key role in other areas of the service. This is demonstrated in Tables 5.9 & 5.10 where this sub-group was cross analysed against five other key tasks.

Table 5.10

	Using clinical judgement (always)	***Using clinical judgement (often)***	***Using clinical judgements (sometimes)***	***Using clinical judgement (never)***	***Total respondents***	***Using protocol (always)***	***Using Protocol (often)***	***Using protocol (sometimes)***	***Using protocol (never)***	***Total respondents***
Agree referrals	4	6	1	2	**13**	5	7	1	0	**13**
Challenge referrals	4	3	2	3	**12**	4	2	2	3	**11**
Make decisions on scanning & use of IVCM	3	4				3	3			

Table 5.11

	Always	***Often***	***Sometimes***	***Never***	***Total respondents***
Taking clinical responsibility for the patient during scanning	4	3	0	0	**7**
Involved in the production of patient group directions	5	1	0	0	**5**

Tables 5.9 and 5.10 to describe respondents who always or often decide on bowel preparation cross referenced against other key tasks

These tasks were looked at again when the relationship between responsibilities and grading was investigated.

5.2.4 Medicines management and the use of patient group directions (PGD's)

Ensuring patients are not placed at risk by the preparation for the procedure is essential and compliance with NPSA Guidance(38) is recommended. Who takes responsibility for this when prescribing, dispensing and administering laxatives and tagging agents needs to be considered. The Rapid Response Report on reducing risk from oral bowel cleansing solutions suggests that this responsibility lies with the referring clinician who should undertake a clinical assessment of the patient to ensure there are no contraindications to a bowel cleansing agent. They should authorise the use of the bowel cleansing agent at the same time as they authorise the procedure or test and should also explain the safe use of the medicine to the patient or carer (38).

Results from this survey indicate that this is in fact a shared responsibility with table 5.11 indicating that all staff groups may be involved in this decision making process.

	Always	***Often***	***Sometimes***	***Never***	***Number of responses (53)***
Referrer at time of request	15 (38.46%)	7 (17.95%)	9 (23.08%)	8 (20.51%)	39
Radiologist	20 (48.78%)	9 (21.95%)	9 (21.95%)	3 (7.32%)	41
Radiographer using clinical judgement	5 (15.63%)	10 (31.25%)	6 (18.75%)	11 (34.48%)	32
Radiographer following protocol	7 (21.88%)	11 (34.38%)	3 (9.38%)	11 (34.38%)	32
Other	3 (21.43%)	1 (7.14%)	0 (0.00%)	10 (71.43%)	14

Table 5.12 to demonstrate who ensures compliance with NPSA Guidelines – reducing risk of harm from oral bowel cleansing solutions.

Responsibility for this task was spread across the team but was more likely to be undertaken by the referrer or the radiologist accepting the referral.

A number of respondent's comments indicated that they did not know who took this responsibility, for others the problem had been avoided by moving away from giving a purgative. Some sites used protocols for this process and managed the prescription, dispensing and administration of drugs through PGD's.

The use of PGDs provides a legal framework that allows some registered health professionals to supply and/or administer a specified medicine(s) to a pre-defined group of patients, without them having to see a prescriber(70). As such they can allow radiographers to safely manage the bowel preparation, antispasmodic and IVCM given to patients during CTC offering an

> *" advantage for patient care, without compromising patient safety"* p.9 (70).

NICE guidance describes the need for a multidisciplinary working group to produce and review PGD's; (70) with this in mind a number of questions were asked about PGD's used for CTC.

The first questions were set to determine whether PGD's were widely used during the procedure and if so, which drugs were prescribed and administered by radiographers using this legislation. When asked about the use of PGD's 37 (63.79%) of the 58 respondents said that radiographers used PGD's to administer medication in their hospital and the table 5.12 demonstrates which drugs these PGD's were used for.

Medications managed using PGD	***Number (total 35 responses)***
Laxatives	*9 (25.71%)*
Tagging agents	*14 (40.00%)*
Antispasmodics	*24 (68.57%)*
Intravenous iodinated contrast	*24 (68.57%)*
All of the above*	*11 (31.43%)*

**NB. The 11 responses using PGD's for all the listed medications can be added to each individual Prescription only Medication(POM) total to give a true measure of the use of PGD's.*

Table 5.13 to demonstrate the use of PGD's to prescribe and administer medication for CTC (35 responses)

There were 35 responses to this question with participants asked to select all that applied. IVCM and antispasmodics were the most common medications given under a PGD. This fits with the autonomous role of many CT radiographers who run protocol led, mostly unsupervised lists which are managed more effectively if the drugs given during the procedure are administered by the radiographer. Laxatives are less likely to be prescribed under a PGD than other medicines but the supporting comments suggest that this may be due to the move away from the routine use of a purgative as part of the bowel cleansing regime. The lack of PGD's for managing laxatives and tagging agents may also occur because this task is undertaken, along with approving the request, by a radiologist or the referrer at the time of requesting or approving the examination.

In addition the use of a PGD to prescribe a prescription only medication requires informed consent from the patient who needs to consent to be treated by a person other than a doctor, along with an assessment of the patients' suitability to be treated by the individual working to the PGD (70). This can be hard to incorporate into patient pathways where radiographers may not meet their patients prior to the procedure.

NICE guidance (70) and legislation through The Human Medicines Regulations of 2012(133) gives support for the appropriate use of PGD's and offer guidance on the production and management of robust documentation. Recommendations include forming a multi-disciplinary group with clearly defined roles and responsibilities. The

next question asked who was involved in writing PGD's for medicines administered for CTC and table 5.14 demonstrates the range of responses.

	Always	***Often***	***Sometimes***	***Never***	***Number of responses (total 36)***
Radiologist	14 (58.33%)	6 (25.00%)	0 (0.00%)	4 (16.67%)	24
Radiographer	11 (67.74%)	7 (22.58%)	1 (3.23%)	2 (6.45%)	21
Other	3 (27.27%)	1 (9.09%)	1 (9.09%)	6 (54.55%)	11

Multiple responses were permitted when answering this question.

Table 5.14 to demonstrate which staff take responsibility for writing PGD's.

The professional groups represented by the "others" group included pharmacists, radiology nurses and clinical directors. This was in line with the recommendations for the production and use of PGD's (70). Roles for this task appeared more clearly defined with staff groups either involved or not with less activity on an occasional basis.

The group of radiographers always involved in writing PGD's were filtered out and their roles in other areas were looked at. Having radiographers responsible for writing PGD's did not seem to link in with additional radiographer responsibility elsewhere. These sites were no more likely to have radiographers approving or challenging requests or making decisions on the use of bowel preparation. They were however, more involved in ensuring compliance with NPSA guidance and this would link well with an advanced practitioner role including the production of formal documents.

Interestingly though, when asked about the grading of radiographers involved in PGD production there seemed to be a discrepancy between radiographers specialised in CT or GI imaging.

A GI radiographer writing a PGD was likely to be employed at a higher grade than their CT colleague and there were a relatively higher number of GI radiographers in

total graded and Band 8a and above performing the task. This is demonstrated in table 5.15

	Band 5	***Band 6***	***Band 7***	***Band 8a***	***Band 8b***	***Total responses***
GI radiographer	_	_	4 (30.77%)	8 (61.54%)	2 15.38%)	13*
CT radiographer	_	2 (12.50%)	19 (79.17%)	4 (16.67%)	_	24*

**Multiple responses to this question were permitted. Results would suggest that for some respondents multiple staff employed at different grades were involved in the production of PGD's*

Table 5.15 to demonstrate the grade of radiographers involved in producing PGD's

It was possible that other aspects of the clinical role influenced this grading decision for the high banded staff but it was concerning that some lower graded CT staff are perhaps being expected to undertake complex tasks at an inappropriate grade. This is an area where more focused qualitative research would be needed to determine what other factors are involved and to evaluate not just staff grades but their level of experience in the role.

5.2.5 Patient care and clinical decision making during the procedure

Patient care is an important aspect of any procedure. With CTC thought needs to be given to the often frail condition of the patient who may be hungry, tired and dehydrated on arrival at the department. With the procedure involving bowel insufflation, injection of an antispasmodic and possible use of IV contrast (46, 62, 64) there is good reason to provide considered aftercare for every patient. All patients should have close access to a toilet, somewhere appropriate to recover and should be offered refreshments before they leave the department (46). Any patient given an antispasmodic or IVCM should be monitored for a period of time as both carry risk from reaction and unwanted side-effects.(46, 72, 134) All staff should be trained to recognise peri and post-procedure complications and facilities should be available to manage any immediate complications (46).

Who undertook this care both during and after the procedure were questions asked by this survey. Results in table 1.16 showed a team approach for responsibility during the scan with both radiographers and radiologists involved.

	Always	***Often***	***Sometimes***	***Never***	***Total respondents (36)***
Radiologist	11 (44.00%)	0 (0.00)	10 (40.00%)	4 (16.00%)	25
Radiographer	30 (88.24%)	4 (11.76%)	0 (0.00%)	0 (0.00%)	34

**Respondents were asked to tick all that applied*

Table 5.16 to demonstrate clinical responsibility for the patient during the scan

There were 36 respondents to this question and 34 out of 36 documented that radiographers were always or often responsible for the patient during the scan compared with a lower level of 11 out of 36 radiologists always or often responsible. However, there were 10 comments left in response to this question and every one stated that a radiologist was always available in the department to offer support as necessary. The information from the comments would suggest that respondents may have been including care of the patient during the scan rather than clinical responsibility for the patient when making answer choices for this question.

The 4 (16%) respondents who stated that radiologists took no clinical responsibility for patients during the procedure were filtered out to determine the degree of involvement their radiographers took in other aspects of the service.

All respondents worked in centres scanning 100 – 500 patients / year with 50% offering CTC as the only form of imaging and the remaining 50% also offering BE.

75% of these respondents described referrals accepted by radiographers using a protocol and had radiographers as likely as their radiologist colleagues to challenge an inappropriate request. However, none made the decision on the choice of bowel preparation and only 50% had involvement with ensuring compliance with NPSA guidelines.

All respondents in this group used PGD's to administer medication and all were involved in the production of those PGD's (70).

As expected, they also took the decision on the use of IVCM; 100% had a protocol for this activity but 50% also documented use of clinical judgement and referral to a radiologist to aid the decision.

Patient aftercare seemed to be shared between the teams with the radiographer most likely to give immediate post procedure care but with involvement from all other staff groups as appropriate. This is depicted in table 5.17

	Always	***Often***	***Sometimes***	***Never***	***Total responses***
Radiologist	0 (0.00%)	0 (0.00%)	11 (52.38%)	10 (47.62%)	21
Radiographer	24 (70.59%)	7 (20.59%)	3 (8.82%)	0 (0.00%)	34
Nurse	2 (9.52%)	0 (0.00%)	9 (42.86%)	10 (47.62%)	21
Health Care Assistant	13 (48.15%)	6 (22.22%)	3 (11.11%)	5 (18.52%)	27

**Multiple responses to this question were permitted*

Table 5.17 to describe who provides patient aftercare

Comments described the involvement of nurses following complications.

Comments	*"Nurses only apply aftercare if there has been a reaction or issue during the test otherwise the radiographer and HCA will discuss aftercare with the patient and the HCA will sit with the patient after the test alerting the radiographer if there are any issues."* *"The patient will always be escorted back to the changing room, usually by an HCA but often a radiographer. On some occasions a nurse may look after the patient in the recovery area post procedure."*

Of the 10 respondents who stated that radiologists were never involved in patient aftercare the responses indicated that care was provided by the radiographer (always 80%, often 10%) and health care assistants (always 30%, often 20%). Of the same group 33% claimed the radiologists also had no involvement with the

procedure. However, as stated earlier, no respondent claimed that lists ran without a radiologist available for support. The radiographers providing this care are graded at bands 5 – 7 and comprise both CT and GI specialists.

As with other aspects of the procedure, decisions on when to give IV contrast or take additional views was not reliant on any one member of the team. This is shown in table 5.18.

	Always	***Often***	***Sometimes***	***Never***	***Total responses***
Radiographer using clinical judgement	9 (30.00%)	15 (50.00%)	4 (13.33%)	2 (6.67%)	30
Radiographer following protocol	12 (48.00%)	11 (44.00%)	1 (4.00%)	1 (4.00%)	25
radiologist	8 (30.77%)	6 (23.08%)	10 (38.46%)	2 (7.69%)	26
Team decision (radiographer / radiologist)	5 (20.00%)	8 (32.00%)	8 (32.00%)	4 (16.00%)	25

**Multiple responses to this question were permitted.*

Table 5.18 to demonstrate who makes decisions on scanning such as when to give IV contrast or take additional scans.

The results and the accompanying comments for this question indicated a great deal of involvement from radiographers in making this decision. They regularly used both protocols and clinical judgement to decide on giving contrast and perform additional scans when pathology was demonstrated. As can be seen from the comments below some were also expected to determine when IVCM would be inappropriate.

Comments	*"The scans are vetted according to the information we receive on the request, the decision to give contrast is often taken at this time. If contrast is deemed appropriate during the scan this may be decide by the radiographer or following discussion with the radiologist."* *"Protocol states IV for all suitable patients. May not use IV if renal function is poor. Additional views done depending upon what is seen at time of examination."* *"Radiographers decide on whether to do a 3rd run for spasm / collapse and will go on to scan chest if malignant looking pathology without the go ahead from the radiologist."* *"IV contrast decisions are normally made before appointment day by the radiologist when requests are sent to them for vetting. However such decisions can also be made during scanning if the findings of the initial non-contrast scans warrant additional scans or the administration of IV contrast."* *"If the radiographer performing the CT scan spots a bowel tumour they will add on a CTC chest scan to complete staging. If anything else is spotted then they will discuss this with a radiologist before the exam is completed."* *"We give IV contrast to all our CTC patients and the radiographer is responsible for making sure there are no contraindications. If there are this would then be discussed with the radiologist. During the procedure if any additional scans are required this can be judged by either the radiographer or the radiologist."* *"Requests are protocolled but clinical judgements on the day. Very experienced CT radiographers may add on additional scans i.e. chest. Otherwise advice is sought from the radiologist."*

These findings are to be expected as CT radiographers routinely mange IVCM for their patients and this has been established practice for many years (71).

5.2.6 Reporting and primary clinical evaluation of images

The next group of questions asked about reporting of the resulting scans to determine how much involvement and responsibility radiographers had for this task and how, if at all, it related to their level of responsibility in other areas. There were three questions asked which related to the reporting of CTC studies. The first two asked who reported on intraluminal and extra luminal findings on the scan.

	Intraluminal report	***Extraluminal report***
Radiographer 1st read	*8 (14.29%)*	*1 (1.85%)*
Radiographer final report	1 (1.79%)	0 (0.00%)
Radiologist / radiologist report	10 (17.86)	9 (16.67%)
Radiologist independent report	40 (71.43)	46 (85.19%)
Radiologist / radiographer report	10 (17.86)	0 (0.00%)

**There were 56 respondents for this question but each may have given more than 1 response.*

Table 5.19 to describe CTC reporting processes

It is clear from table 5.19 that radiographers were not generally involved in reporting CTC examinations. Of the 56 respondents for this question only 1 was currently issuing an independent report on intraluminal findings and just 8 offer a first read or PCE of the lumen as a contribution to the final report. There were a number of sites offering double reporting but the majority (71%) have a single report issued by a radiologist.

There are a number of reasons for this as the listed comments describe and it should also be noted from the comments that although the contribution from radiographers may not have been formally recognised a number described informal reporting procedures –

Themes	*Comments*
Positive comments	*"Radiographers highlight to the radiologist any unusual appearances but the report comes from the radiologist."* *"Radiographers make comment on anything seen on a proforma that we have developed."* *"Only a GI radiologist will report the scans and currently they are only read once but this is under discussion.*
Negative comments	*"Radiologist reports with CAD."* *"Radiographers are not allowed to report anything in this department and there is no support from the radiologists for them ever to do so."* *"At present we (radiographers) write what we see on the back of the form. As much as we would love to report staffing pressures are making this impossible at the moment."*

The respondents who did describe radiographer primary clinical evaluation or final report of intraluminal pathology were filtered out and considered separately to determine the role of their radiographers in other areas of the service.

Nine respondents were included.

The one respondent who described independent radiographer reporting of intraluminal pathology also described GI and CT radiographer involvement in all other key areas of service provision, effective use of PGD's and protocols with responsible staff employed at agenda for change (AfC) bands 7 and 8.

The other 8 respondents described a process of radiographer PCE of the colon provided alongside a radiologist report. Their activities in other areas were similar to those of the radiographer reporting independently and again with staff employed at AfC bands 7 and 8.

The final report related question approached the subject from a slightly different angle and asked about all reporting activities undertaken by radiographers and the associated training they has received as part of their job. Looking just participants

who reported as part of their job resulted in 10 responses which were interpreted individually.

Within this group 5 respondents reported on BE but not CTC images, of these 2 said they would value additional training in CTC, maybe to support their progression into this area. There were just 2 respondents reporting on both examinations and they felt their training was adequate for their role. There were also just 2 respondents reporting solely on CTC examinations, one felt well trained, the other felt a need for more to support the in-house training they had received.

Finally, 1 respondent reported on non GI studies and felt appropriately trained to perform this task.

5.2.7 Education – qualifications and training

Further questions were also asked to determine the amount of training radiographers received to carry out their role, looking at academic study, external and internal courses and training.

Qualification	***All qualifications obtained(54 responses)***	***Highest CTC qualification (53 responses)***
Degree / DCR	49 (90.74%)*	42 (79.25%)
Post graduate module	13 (24.07%)	8 (15.09%0
Post graduate qualification – PgC / PgD	15 (27.78%)	2 (3.77%)
Masters level qualification	6 (11.11%)	0 (0%)
Doctorate	1 (1.85%)	1 (1.89%)

**The assumption is made here that the radiographers claiming not to have a radiography degree or diploma have misinterpreted the question and have just listed their highest qualification rather than all their qualifications as no radiographer would be permitted to practice in the UK without a 109ecognized qualification and registration with the HCPC.*

Table 5.20 demonstrating the range of qualifications held by respondents.

Answer choices (55 responses)	***Responses***
Attended a CTC course	18 (32.73%)
Completed in-house training	40 (72.73%)
Attended a study day	14 (25.45%)
No training given	9 (16.36%)

Table 5.21 demonstrating additional training undertaken by respondents

The results, as demonstrated in both tables 5.19 and 5.20 showed that whilst many staff had post graduate training or qualifications, few had continued their studies to achieve an MSc or a Doctorate. When looking at specific CTC qualifications numbers dropped further with just 8 of 53 having undertaken a post graduate module, 2 with a PgC or PgD and just 1 had completed a doctorate.
This most likely reflects the availability of and access to appropriate training courses rather than a willingness to learn and develop because other CTC training is undertaken to address the clinical need for training.
Respondents were then asked whether their individual training met their needs or whether they felt they would benefit from further training.There were 55 responses to this question; 36 felt adequately trained and 19 felt further training would be beneficial.

Of these 55 responses 40 participants had undertaken some in-house training, 18 had been on a course and 40 had attended a study day. Only 9 respondents had no CTC related qualification and felt they had received no training to undertake CTC. The questions on qualifications, training and competence to undertake the role were split to look at those with no formal CTC training compared against those with CTC qualifications ranging from a Postgraduate Certificate to Doctorate.

Respondents with formal qualifications-
Within the group with qualifications 1 respondent had completed a CTC related doctorate; they had also completed a CTC training course, a CTC study day and in-house training. The individual was a CT radiographer employed at AfC band 7. As expected, this individual felt appropriately trained. Despite the high level of relevant

expertise available to this Trust all CTC reporting was conducted independently by a radiologist.

Overall there were 11 respondents in this group, 1 with a doctorate as described, 2 with a PgC/PgD and 8 with a post graduate module. No one had completed an MSc related to CTC but it should be noted that 5 held MSc's in other specialties and 1 had an unrelated Doctorate. Within the group 9 had also completed a CTC course, 10 had been given in-house training and 4 had been on a study day.

They were employed at bands 6(4 radiographers), 7(6 radiographers) and 8b (1 radiographer). Of this group 7 were CT radiographers, 2 were GI radiographers and 2 undertook both modalities.

Respondents with no formal qualifications-

This group comprised of 42 respondents. Although they had no formal CTC qualifications many had undertaken other forms of CTC training. To summarise, 8 had been on a CTC course, 29 had undertaken in-house training and 10 had attended a study day. Only 9 had received no training but 18 felt they would benefit from further training. However table 16 demonstrates that this group does have qualifications and expertise appropriate to their specialties if not in CTC.

Respondents were employed at AfC band 5 (1 radiographer), band 6 (24 radiographers), band 7 (13 radiographers) and 1 radiographer employed at each of the bands 8a and 8b. When looking at their specialty 32 worked as CT radiographers, 4 were GI radiographers, 1 covered both areas of practice and 5 did neither.

When filtering to compare training within specialty groups; CT described 32 of the 39 respondents as having no CTC qualifications and 8 of 40 respondents with no CTC training.

Within the GI group 4 of 6 respondents had no CTC qualification but all had received CTC training.

It might be reasonable to assume from this that the GI radiographers undertaking CTC are more likely to receive specific training than their CT specialist colleagues.

This may reflect the focused work of a GI radiographer as compared with the diversity of imaging performed by CT radiographers.

5.2.8 Participant demographics – employed grade, specialty and skills

Included in the survey were questions around grading of staff in order to investigate the relationship between AfC band of radiographers and the responsibilities they held, the tasks they undertook and their speciality.

Responsibility for scanning and for patient care both during and after the procedure was predominantly a role for the radiographer employed at AfC bands 6 and 7 but results demonstrated a shift towards bands 7 and 8 for the more complex tasks such as producing PGD's and providing a clinical evaluation of intracolonic pathology. Decisions made during scanning such as taking additional scans or giving IVCM were distributed across all grades. This is depicted in the task tree, Fig 5.2

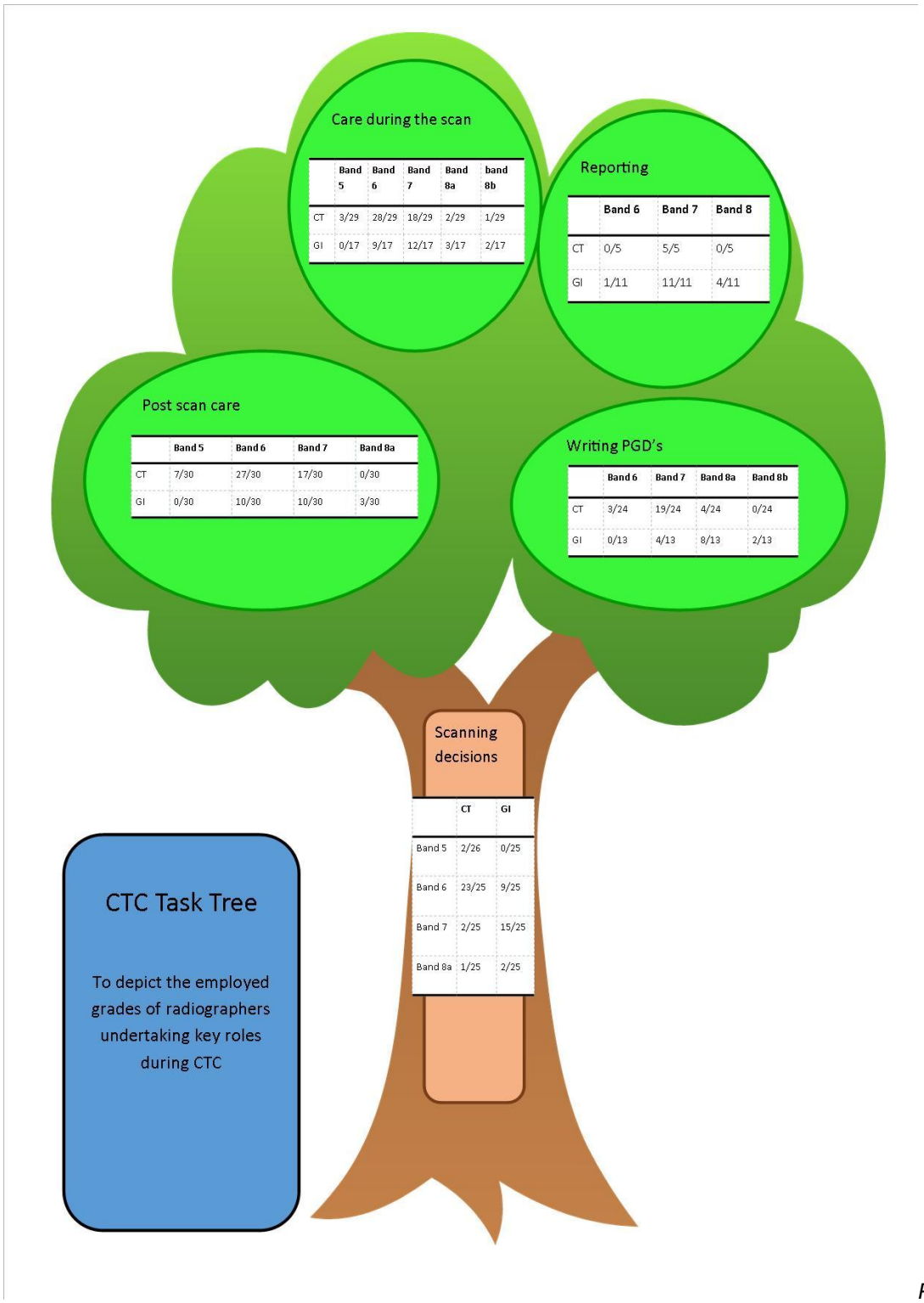


Fig 5.2

Fig 5.2 Task tree to demonstrate the relationships between grade and tasks performed.

Respondents were encouraged to select all options that applied to them so multiple responses to each question were received.

The final questions were set to determine basic demographics for the respondents and asked about the grade and specialty of the radiographers who completed the survey.

Employed A4C band of respondent	***Responses (total 53)***
Band 5	1 (1.89%)
Band 6	29 (54.72&)
Band 7	20 (37.74%)
Band 8a	1 (1.89%)
Band 8b	2 (3.77%)

Table 5.22 to demonstrate the A4C band of respondents

Specialty	***Responses (total 55)***
CT	40 (72.73%)
GI	6 (10.91%)
Both	3 (5.45%)
Neither	6 (10.91%)

Table 5.23 to demonstrate the clinical specialties of respondents

As can be seen from tables 5.22 and 5.23 the radiographers undertaking CTC who responded to this survey were mostly employed at bands 6 and 7, as specialist and advanced practitioners, with more than 70% from a CT background. This spread across bands 6, 7 and 8 was in keeping with the most recent radiography workforce census(135) which described 25.1 whole time equivalent radiographers per establishment employed at band 6 and 16.7 whole time equivalent employed at band 7. There were fewer band 5 radiographers in the CTC group of staff but that was to be expected in a specialist role. Overall there were less responses from GI radiographers as compared to CT but this can be accounted for by the different numbers of CT and GI radiographers employed (135).

The diagram below (fig 5.3) illustrates the average number of whole time equivalent staff by band for respondents who use AfC pay bands or equivalent as described in the Diagnostic Radiography UK Workforce Report 2014 (135).

Fig 5.3 Average number of WTE staff by band (135)

This image has been removed by the author of this thesis to comply with copyright law

The same document states that on average each respondent site had approximately 9.4 radiographers undertaking advanced practice and 0.2 carrying out consultant level practice (135). Again, this supports the finding of the CTC data on the grades of staff undertaking the work

5.2.9 Summary of findings

This work established that CTC was more likely to be performed than BE in the respondents' sites and that this factor was not linked to the size of the hospital or the number of procedures carried out. For these sites there has been an effective transfer of skills from BE to CTC for GI radiographers and there is evidence of education and training for radiographers to support this change in procedure. The 2012 Scope of Practice Survey for Diagnostic radiographers described GI radiographer involvement in CTC for 46% of respondents (136). The current barrier to a complete transition to CTC for some respondents' hospitals would seem to be a lack of resources, most commonly access to scanning time.

It was clear that the radiographer was predominantly responsible for undertaking the procedure, acquiring images and caring for the patient. Help with these tasks may be provided by health care assistants or nurses. The radiologist did not tend to be involved in the scanning but no respondent described CTC undertaken without a radiologist available for guidance.

Radiographer roles in managing referrals, prescribing and administering medication and evaluating images were harder to define with no consistent patterns emerging. Where radiographers have taken on these tasks respondents detailed that they were protocol led or the task undertaken by staff with the appropriate clinical expertise and

training. By comparison other respondents described reliance on radiologists for all aspects of the service other than scanning and patient care and there were examples of a range of practices in between with radiographers undertaking a few select tasks in certain situations. The way sites staff and run their service seemed to evolve out of a need to provide; possibly based on the resources they could access balanced against those they were restricted by, rather than on any guidance or recommendation.

The use of a PGD for the prescription and administration of antispasmodics and IVCM was identified as common practice, the use of PGD's for prescription of laxative and faecal tagging less so, possibly because it was linked to processes of referral which were often dealt with by radiologists. Where PGD's were used they appear to be used appropriately and were written and managed by a team as recommended by NICE guidance(70) and defined by law (133)

Radiographers undertaking advanced practice roles in CTC were appropriately graded at bands 7 and 8 with scanning and patient care predominantly undertaken by specialist radiographers at band 6. However, a GI radiographer undertaking CTC was more likely to be performing similar tasks at a higher employed grade that their CT colleagues.

Radiographer reporting or the provision of a PCE of intraluminal pathology was only described by 10 respondents as compared with 40 respondents who describe radiologist only reporting. The 2012 Scope of Practice Survey undertaken by the Society and College of Radiographers reported 8 of their 143 respondent sites offering radiographer reporting of CTC (136).

There were radiographers with formal qualifications in reporting, who had expertise in evaluating images in order to make decisions on additional imaging, the use of IVCM and the need to complete staging scans not currently contributing to the

reporting process; this role could be considered in the future. Radiographers actively sought training to undertake CTC but access to academically accredited courses was limited by a number of factors(129) and radiographers tended to use a mix of continuing professional development activities, study days and short courses to support development of clinical skills. Where an MSc or Doctorate had been obtained it was unlikely to be specific to CTC. This likely reflects the lack of courses provided by higher education institutes and the lack of funding provided by employers to support study at this level (129).

5.3 Discussion and further research

From the skills and working practices described by the CTC radiographers who have responded to this survey it would appear that CTC has the potential to be a radiographer led service and that this service could include providing a PCE of intraluminal pathology.

However, it should be recognised that this survey only invited responses from radiographers currently undertaking CTC and would have attracted the attention of those interested and enthusiastic enough to take the time to contribute. Such respondents are likely to work with radiologists who also understand the requirements of the examination and the importance of getting each stage of the procedure right; it is unlikely to reflect the views or working practice of others who may not be in this position. It is assumed that this, in combination with a relatively small sample size (74 respondents) and no knowledge of how many hospitals were represented would have resulted in some degree of sampling error. For any future work the researcher would give consideration to using direct invitation to complete a survey in an attempt to gain a good range of respondents from a variety of different Trusts and working environments. The potential power of this work has been reduced as it is not possible to determine how many multiple responses have been made from a single Trust and therefore it is not possible to determine whether results truly represent the national picture.

Future work on the role of radiographers in CTC would also include interviewing of staff to obtain more robust qualitative data. The format of the survey used for this work attempted to give respondents as much choice as possible in their responses but in doing so produced results which were only able to offer general trends in practice.

Further research is needed to gather information from all sites providing CTC along with others not yet able to support a service, not just those keen to volunteer information on invitation. Purposive qualitative sampling through maximum variation sampling would allow selection across all categories(89) by selecting a range of hospital sites offering a variety of models of practice. For any future work the researcher would give consideration to using direct invitation to complete a survey in an attempt to gain a good range of respondents from a variety of different Trusts and working environments.

In depth interviews of individuals working at these sites would provide a less biased opinion and give a more realistic view of the current role of radiographers undertaking CTC and the barriers to ongoing development. The qualitative data collected would then represent a full range of working practices. Qualitative research would be more appropriate in this situation as it allows individuals to explain their experiences and actions and will provide evidence on how roles have evolved and give an opportunity for respondents to voice their personal opinions. It provides

> *"systematic evidence for gaining insights into other people's view of the world"* (89).

This data would enhance the work done and could be used to inform the development of guidance on the scope of practice for CTC radiographers at each employed grade along with guidance on the academic and clinical requirement of those radiographers. Combined with national data on radiographer PCE collected by roll out of the validated audit tool and workforce analysis through PenCLAHRC it might be possible to encourage sites currently disengaged with supporting the advancing role of the radiographer in CTC to reconsider their position.

Such guidance would need to look at –

- Developing consistency within job roles to ensure parity between sites and within and across specialties.
- Defining the role and the scope of practice of the CTC radiographer for specialist and advanced practice roles.
- HEI provision of accredited academic course for CTC radiographers to include all aspects of providing the service and offering a primary clinical evaluation of intraluminal pathology.
- Supporting the transfer of colorectal imaging from BE to CTC across all sites in the UK.
- Defining and challenging the current barriers to providing a radiographer led CTC service and radiographer PCE.

5.4 Conclusions

There are many UK radiographers playing a key role in providing CTC services in the UK, some chose to participate in this survey and it is likely that they represent a group of people who are most interested in the service.Without further evidence to include poor practice as well as good it is difficult to determine a level for accepted or expected practice for radiographers at different grades and from different specialties.

There is clearly scope for radiographers to develop beyond their role in scanning and patient care to undertake tasks such as managing the service and offering a PCE of images. This would be reliant on appropriate support from radiologists, be underpinned by relevent academic qualifications and clinical expertise and the autonomy of the role should be reflected in the employed band of the radiographer.

This survey identified a clear relationship between the complexity of tasks undertaken by the radiographer and their employed grade with grades appropraitely reflecting the work undertaken but there was less consistency in the range of tasks

undertaken at each employed grade. There was also some disparity in the employed grade of CT and GI radiographers with GI radiographers more likely to be employed at a higher grade than their CT colleagues when undertaking the same work.
All this suggests a requirement for further research to gain national consensus on the roles of the radiographer within a CTC service and a need to develop guidance to support departments planning to provide colonic imaging through CTC.

Finally the survey identified a workforce mostly trained “on the job” and through attendance at study days and short courses. Few had formal academic qualifications and where they were identified they tended not to be directly linked to CTC. There is a need to address this and for HEI’s to provide appropriate post-graduate courses to a group of staff who are keen to develop. However, it was clear that the focus of the radiographer was to improve and enhance the service and not to replace the radiologist who all respondents felt to be essential to provide support, to manage complex cases and to provide the final definitive report on images.

Chapter 6

6.1 Study conclusions and future work

This research study collected data to inform the current role of UK radiographers in providing a CTC service and in reporting on CTC studies.

6.1.1 Audit conclusions

Through the development and testing of a data audit tool to measure the report accuracy of radiographers issuing a PCE, findings described a robust tool which demonstrated high inter-user agreement. The tool enabled a study to assess the competency and accuracy of experienced radiographer's offering PCE of intraluminal pathology. The comprehensive data sets reviewed indicated the high level of competence of the radiographers in intra-luminal PCE and underpinned the important role radiographers have to play as CTC services expand. The results demonstrated that radiographers were capable of producing PCE's with accuracy comparable to that of radiologists offering the final report. Further research using more expansive datasets and including a number of hospital sites would generate more useful data on PCE accuracy, the minimum requirements for the training of staff and the advantages of providing a double report strategy for CTC.

6.1.2 Survey conclusions

Data collected through an online survey provided the platform to collate information on radiographers taking on a procedural role in CTC.

Results of the survey indicated the essential role radiographers undertake in scanning, patient care and image evaluation during the examination. Traditional radiographer roles such as patient care and image acquisition were described by all participants but there were significant variations in other tasks undertaken, especially those involving advanced practice.

Some respondents described excellent models for service delivery which used highly trained and experienced radiographers, employed at advanced and consultant practitioner level to provide a radiographer led service requiring minimal involvement from radiologists. This model of role development used in other areas of radiology has previously shown clear resource benefits to service delivery with improvements in capacity and throughput, more effective use of medical staff time and enhancement in staff fulfilment, engagement and team working (137).
Others had some way to go to achieve this with a need described for further training for staff and more involvement in role development.
Disparity in the services provided was noted and the survey also highlighted consistent discrepancies between the relative grading of staff employed as CT or GI specialists; with GI radiographers appearing to have the advantage in terms of recognition of skills and reward through employed grade and job title. GI radiographers also had more opportunity to undertake formal training when compared with their CT colleagues who were more likely to be trained on the job or through local study days.
All of the discussion points raised by this work need further investigation and research with the suggested outcome to provide national guidance on the role of the radiographer in providing a CTC service. This should include looking towards the provision of a radiographer reporting service, involvement from HEI's on the provision of accredited post graduate courses and guidance on job profiling and appropriate grading of the skilled radiographic workforce.

To summarise, these studies have developed a robust audit tool which has been used to audit a large number of radiographer PCE's. This has demonstrated high levels of competence with the reporting radiographers in the department audited. The survey has demonstrated a range of practices within CTC across the UK and shown a clear potential for widespread role development and advanced practice for radiographers to ease the burden on the radiologists without detriment to services.

6.2 Future work

The results of this study raise further questions and within each phase of this study there are key points raised by this work which would benefit from the further development, promotion or research as described below –

- Dissemination of the validated audit tool to other sites through active promotion and sharing of good practice
- Expansion of the radiographer PCE audit to include a number of sites to determine whether the results are replicable in other hospitals and to provide more comprehensive data for further audit
- Interrogation of radiographer PCE audit data from multiple sites with numerous users to establish benchmark levels of competence for reporting radiographers.
- A qualitative study to review different training models for radiographers inputting data for the wider PCE audit to inform design of effective training models.
- A qualitative study to understand the current barriers to radiographer reporting or providing a PCE for CTC
- A qualitative study to explore the disparity between CT and GI radiographer grades, including their competencies, practices, educational levels and scope of practice.
- The development of models for best practice and sharing of information with the wider workforce

It is essential that the good practice identified in this document becomes disseminated across the profession. To quote Professor Sir Muir Gray, speaking at the United Kingdom Radiology Congress 2015

"the future is here, just not evenly distributed"(138)

If the recommended work is undertaken radiographers will be in a position to take the lead in the provision of a CTC service which is capable of meeting capacity demands in the future and who, as a profession, will be better prepared should CTC become the primary bowel cancer screening tool.

References

1. Rimes SJ, Fox D, Knapp KM, Meertens R. *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)*. Radiography. 2015;21(3):264-8.
2. Rimes S. Fox D, Knapp K, Meertens R. *Radiographer preliminary clinical evaluation of intraluminal pathology for computed tomography colonography (CTC*) (presentation); February 2015 2015 Bowel Cancer Screening Programme, Southwest Regional Meeting. Bristol 2015.
3. Rimes S, Fox D, Knapp K, Meertens R. *Radiographer preliminary clinical evaluation of intraluminal pathology for computed tomography colonography (CTC)* (poster); United Kingdom Radiology Congress. June 2015. ACC Liverpool.
4. Rimes S, Fox D, Knapp K, Meertens R. Survey of current practice of CTC radiographers (presentation); United Kingdom Radiology Congress. June 2015. ACC Liverpool.

5. Halligan S, Wooldrage K, Dadswell E, Kralj-Hans I, von Wagner C, Edwards R, et al. *Computed tomographic colonography versus barium enema for diagnosis of colorectal cancer or large polyps in symptomatic patients (SIGGAR): a multicentre randomised trial.* The Lancet. 2013;381(9873):1185-93.
6. Plumb AA, Halligan S, Nickerson C, Bassett P, Goddard AF, Taylor SA, et al. *Use of CT colonography in the English Bowel Cancer Screening Programme.* Gut. 2014;63(6):964-73.
7. National Institute for Health and Care Excellence (2011) *Colorectal Cancer, the diagnosis and management of Colorectal Cancer.* NICE clinical guideline 131. Available from http://www.nice.org.uk/guidance/CG131 (updated July 2014; accessed August 2015). National Institute for Health and Care Excellence
8. Gandon Y. *Screening for colorectal cancer: the role of CT colonography. Diagnostic and interventional imaging.* 2014;95(5):467-74.
9. Cancer Research UK (2014). *Key Facts Bowel Cancer.* Updated May 2014. Available from: http://www.cancerresearchuk.org/cancer-info/cancerstats/keyfacts/bowel-cancer/. Accessed June 2014.
10. Coleman MP, Forman D, Bryant H, Butler J, Rachet B, Maringe C, et al. *Cancer survival in Australia, Canada, Denmark, Norway, Sweden, and the UK, 1995–2007 (the International Cancer Benchmarking Partnership): an analysis of population-based cancer registry data.* The Lancet.377(9760):127-38.
11. Office for national Statistics (2014). *Cancer Survival in England: Patients diagnosed 2008 - 2012 and followed up to 2012.* Available from http://www.ons.gov.uk/ons/rel/cancer-unit/cancer-survival-in-england--adults-diagnosed/2008-to-2012--followed-up-to-2013/stb-cancer-survival.html. Accessed August 2014.
12. Collins D, Winter DC. *Modern concepts in diverticular disease.* Journal of clinical gastroenterology. 2015;49(5):358-69.
13. Lips LM, Cremers PT, Pickhardt PJ, Cremers SE, Janssen-Heijnen ML, de Witte MT, et al. *Sigmoid cancer versus chronic diverticular disease: differentiating features at CT colonography*. Radiology. 2015;275(1):127-35.
14. National Institute for Health and Care Excellence (2015). *Suspected Cancer: recognition and referral NICE Guidelines (NG12)*. Available from https://www.nice.org.uk/guidance/ng12. Accessed July 2015.

15. Cancer Research UK (2014) *Bowel cancer Symptoms.* Updated April 2014. Available from: http://www.cancerresearchuk.org/about-cancer/type/bowel-cancer/about/bowel-cancer-symptoms. Accessed August 2015.

16. NHS choices (2013). *Bowel Cancer Symptom checker.* Available from: http://www.nhs.uk/Tools/Pages/Bowel-cancer-self-assessment.aspx. Updated 19.07.13, Accessed August 2015.
17. The Department of Health (2000). *The NHS Plan: A plan for investment A plan for reform*. Available from: http://webarchive.nationalarchives.gov.uk/+/www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4002960. Accessed October 2014.Health
18. Sale D. (2005) *Understanding Clinical Governence and Quality Assurance. Making It Happen*. Palgrave Macmillan.
19. Public health England (2014). *Public health England; about us.* Available at https://www.gov.uk/government/organisations/public-health-england/about. Accessed August 2015.
20. Bevan G. *Have targets done more harm than good in the English NHS? No.* British Medical Journal. 2009;338:a3129.
21. Bevan G, Hood C. *Have targets improved performance in the English NHS?* British Medical Journal. 2006;332(7538):419-22.
22. House of Commons (2013). *Report of the Mid Staffordshire NHS Foundation Trust Public Enquiry. Executive Summary; chaired by Robert Francis QC.*The Stationary Office:
23. Public Health England (2008) *NHSBCSP 4: Evidence summary: patient information for the NHS Bowel Cancer Screening Programme.* Available at http://www.cancerscreening.nhs.uk/bowel/publications/index.html. Accessed August 2015
24. Public Health England (2015). *NHS Bowel Scope Screening.* Available at http://www.cancerscreening.nhs.uk/bowel/bowel-scope-screening.html NHS Bowel Cancer Screening Programme. Accessed May 2015.
25. Atkin WS, Edwards R, Kralj-Hans I, Wooldrage K, Hart AR, Northover JM, et al. *Once-only flexible sigmoidoscopy screening in prevention of colorectal cancer: a multicentre randomised controlled trial.* Lancet. 2010;375(9726):1624-33.
26. Bevan R, Rubin G, Sofianopoulou E, Patnick J, Rees CJ. *Implementing a national flexible sigmoidoscopy screening program: results of the English early pilot.* Endoscopy. 2015;47(3):225-31.
27. Cancer Research UK (2014) *Bowel Cancer Incidence Statistics.* Available at http://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/bowel-cancer/incidence#heading-One. Accessed August 2015
28. Tappenden P, Nixon R, Chilcott J, Sakai H, Karnon J. *Colorectal cancer screening options appraisal. Cost-effectiveness, cost-utility and resource impact of alternative screening options for colorectal cancer.* University of Sheffield. School of Health and Related Research, 2004.
29. Pellatt AJ, Wolff RK, Lundgreen A, Cawthon R, Slattery ML. *Genetic and lifestyle influence on telomere length and subsequent risk of colon cancer in a case control study.* Int J Mol Epidemiol Genet. 2012;3(3):184-94.
30. Haggar FA, Boushey RP. *Colorectal cancer epidemiology: incidence, mortality, survival, and risk factors. Clinics in colon and rectal surgery.* 2009;22(4):191-7.
31. Key TJ, Allen NE, Spencer EA, Travis RC. *The effect of diet on risk of cancer.* The Lancet. 2002;360(9336):861-8.

32. The Department of Health (2011). *Improving Outcomes: A Strategy for Cancer.* The Department of health.
33. Public Health England (2014). *Improving Outcomes: A Strategy for cancer, Fourth Annual report.* Department of Health.
34. Vargas AJ, Thompson PA. *Diet and nutrient factors in colorectal cancer risk. Nutrition in clinical practice.* The American Society for Parenteral and Enteral Nutrition. 2012;27(5):613-23.
35. Atkin W, Dadswell E, Wooldrage K, Kralj-Hans I, von Wagner C, Edwards R, et al. *Computed tomographic colonography versus colonoscopy for investigation of patients with symptoms suggestive of colorectal cancer (SIGGAR): a multicentre randomised trial.* The Lancet. 2013;381(9873):1194-202.
36. Cancer Research UK (2012) *Bowel cancer incidence statistics, Distribution of bowel cancer cases.* Available at http://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/bowel-cancer/incidence#heading-Five. (updated 2012; accessed July 2015). Cancer Research UK
37. Berrington de Gonzalez A, Kim KP, Yee J. *CT colonography: perforation rates and potential radiation risks.* Gastrointestinal endoscopy clinics of North America. 2010;20(2):279-91.
38. National Patient Safety Agency (2009) *Rapid Response Report NPSA/2009/RRR012: Reducing risk of harm from oral bowel cleansing solutions.* Available at http://www.nrls.npsa.nhs.uk/resources/?entryid45=59869 (accessed September 2014) National Patient Safety Agency.
39. Connor A, Tolan D, Hughes S, Carr N, Tomson C. *Consensus guidelines for the safe prescription and administration of oral bowel-cleansing agents.* Gut. 2012;61(11):1525-32.
40. Blakeborough A, Sheridan MB, Chapman AH. *Complications of barium enema examinations: a survey of UK Consultant Radiologists 1992 to 1994.* Clinical radiology. 1997;52(2):142-8.
41. National Institute for Health and Care Excellence (2005) Computed tomographic colonography (virtual colonoscopy) IPG129. Available at https://www.nice.org.uk/guidance/ipg129 (accessed April 2014).
42. Sosna J, Blachar A, Amitai M, Barmeir E, Peled N, Goldberg SN, et al. *Colonic perforation at CT colonography: assessment of risk in a multicenter large cohort.* Radiology. 2006;239(2):457-63.
43. Burling D, Halligan S, Slater A, Noakes MJ, Taylor SA. *Potentially serious adverse events at CT colonography in symptomatic patients: national survey of the United Kingdom.* Radiology. 2006;239(2):464-71.
44. Pickhardt PJ. *Incidence of colonic perforation at CT colonography: review of existing data and implications for screening of asymptomatic adults.* Radiology. 2006;239(2):313-6.
45. Electronic Medicines Compendium (eMC). *Summaries of product characteristics Niopam.* Updated July 2015, accessed March 2016. Available from: http://www.medicines.org.uk/emc/medicine/15880
46. Burling D. on behalf of the International Collaboration for CT colonography Standards. *CT colonography standards.* Clinical radiology. 2010;65(6):474-80.
47. Rao QA, Newhouse JH. *Risk of nephropathy after intravenous administration of contrast material: a critical literature analysis*. Radiology. 2006;239(2):392-7.
48. Berland LL. *Incidental extracolonic findings on CT colonography: the impending deluge and its implications.* Journal of the American College of Radiology : JACR. 2009;6(1):14-20.
49. Halligan S. *CT colonography for investigation of patients with symptoms potentially suggestive of colorectal cancer: a review of the UK SIGGAR trials*. British Journal of Radiology. 2013;86(1026):20130137.

50. Murphy R, M, Slater A, Uberoi R, Bungay H, Ferrett C. *Reduction of perception error by double reporting of minimal preparation CT colon.* British Journal of Radiology. 2010;April 2010(83(988)):331-5.
51. Domjan J, Blaquiere R, Odurny A. *Is minimal preparation computed tomography comparable with barium enema in elderly patients with colonic symptoms?* Clinical radiology. 1998;53(12):894-8.
52. Sali L, Grazzini G, Ventura L, Falchini M, Borgheresi A, Castiglione G, et al. *Computed tomographic colonography in subjects with positive faecal occult blood test refusing optical colonoscopy.* Digestive and liver disease : official journal of the Italian Society of Gastroenterology and the Italian Association for the Study of the Liver. 2013;45(4):285-9.
53. Culpan DG, Mitchell AJ, Hughes S, Nutman M, Chapman AH. *Double contrast barium enema sensitivity: a comparison of studies by radiographers and radiologists.* Clinical radiology. 2002;57(7):604-7.
54. Law RL, Slack NF, Harvey RF. *An evaluation of a radiographer-led barium enema service in the diagnosis of colorectal cancer.* Radiography. 2008;14(2):105-10.
55. Royal College of Radiologists (2014) Clinical Radiology UK workforce census 2014 report. Available at Royal College of Radiologists https://www.rcr.ac.uk/publication/clinical-radiology-uk-workforce-census-2014-report (accessed July 15)
56. Vining DJ, Gelfand D, *Noninvasive colonoscopy using helical CT scanning, 3D reconstruction, and virtual reality.* 23rd Annual Meeting and Postgraduate Course of the Society of Gastrointestinal Radiologists; 1994; Maui, Hawaii.
57. Amin Z, Boulos PB, Lees WR. *Technical report: spiral CT pneumocolon for suspected colonic neoplasms.* Clinical radiology. 1996;51(1):56-61.
58. Nagata K, Fujiwara M, Kanazawa H, Mogi T, Iida N, Mitsushima T, et al. *Evaluation of dose reduction and image quality in CT colonography: Comparison of low-dose CT with iterative reconstruction and routine-dose CT with filtered back projection.* European radiology. 2014.
59. Liu Y, Leng S, Michalak GJ, Vrieze TJ, Duan X, Qu M, et al. *Reducing image noise in computed tomography (CT) colonography: effect of an integrated circuit CT detector*. Journal of computer assisted tomography. 2014;38(3):398-403.
60. Johnson CD, Dachman AH. *CT colonography: the next colon screening examination?* Radiology. 2000;216(2):331-41.
61. Shirley L, Nightingale JM. *Establishing the role of CT colonography within the Bowel Cancer Screening Programme.* Radiography. 2013;19(3):246-50.
62. Neri E, Halligan S, Hellstrom M, Lefere P, Mang T, Regge D, et al. *The second ESGAR consensus statement on CT colonography.* European radiology. 2013;23(3):720-9.
63. Taylor SA, Laghi A, Lefere P, Halligan S, Stoker J. *European Society of Gastrointestinal and Abdominal Radiology (ESGAR): consensus statement on CT colonography.* European radiology. 2007;17(2):575-9.
64. Public Health England NHS Bowel Cancer Screening Programme (2012) *Guidelines for the use of imaging in the Bowel Cancer Screening Programme, Second Edition NHSBCSP Publication No 5*. Available at http://www.cancerscreening.nhs.uk/bowel/publications/ (June 2015) NHS Bowel Cancer Screening Programme.
65. Halligan S, Altman DG, Taylor SA, Mallett S, Deeks JJ, Bartram CI, et al. *CT colonography in the detection of colorectal polyps and cancer: systematic review, meta-analysis, and proposed minimum data set for study level reporting.* Radiology. 2005;237(3):893-904.
66. Summers RM. *Improving the accuracy of CTC interpretation: computer-aided detection.* Gastrointestinal endoscopy clinics of North America. 2010;20(2):245-57.

67. Liedenbaum MH, de Vries AH, van Rijn AF, Dekker HM, Willemssen FE, van Leerdam ME, et al. *CT colonography with limited bowel preparation for the detection of colorectal neoplasia in an FOBT positive screening population.* Abdominal imaging. 2010;35(6):661-8.
68. Keeling AN, Slattery MM, Leong S, McCarthy E, Susanto M, Lee MJ, et al. *Limited-preparation CT colonography in frail elderly patients: a feasibility study.* AJR American journal of roentgenology. 2010;194(5):1279-87.
69. British Society of Gastrointestinal and Abdominal Radiologists and the Royal College of Radiologists. *Guidance on the use of CT colonography for suspected colorectal cancer.* London: The Royal College of Radiologists. September 2014. Report No.: BFCR(14)9.
70. National Institute for Health and Care Excellence. (2013) *Good Practice Guidance Patient Group Directions* (MPG2). Available at https://www.nice.org.uk/guidance/mpg2 (accessed Oct 2014) National Institute for health and Care Excellence.
71. Society and College of Radiographers (2014). *The supply and administration of medicines and contrast agents: results of survey into current practice in imaging and radiotherapy departments.* Available at http://www.sor.org/learning/document-library/supply-and-administration-medicines-and-contrast-agents-results-survey-current-practice-imaging-and. (accessed July 2015). Society and College of Radiographers
72. Plumb AA, Halligan S, Taylor SA, Burling D, Nickerson C, Patnick J. CT *colonography in the English Bowel Cancer Screening Programme: national survey of current practice.* Clinical Radiology. 2013;68(5):479-87.
73. Barrett J CP, Johnson S, Patterson A. *Team Working in Clinical Imaging.* The Royal College of Radiologists. 2012(BFCR(12)9).
74. Burling D, Wylie P, Gupta A, Illangovan R, Muckian J, Ahmad R, et al. *CT colonography: accuracy of initial interpretation by radiographers in routine clinical practice.* Clinical radiology. 2010;65(2):126-32.
75. Burling D, Halligan S, Atchley J, Dhingsar R, Guest P, Hayward S, et al. *CT colonography: interpretative performance in a non-academic environment.* Clinical Radiology. 2007;62(5):424-9; discussion 30-1.
76. Meertens R, Brealey S, Nightingale J, McCoubrie P. *Diagnostic accuracy of radiographer reporting of computed tomography colonography examinations: a systematic review*. Clinical radiology. 2013;68(4):e177-90.
77. McFarland EG, Fletcher JG, Pickhardt P, Dachman A, Yee J, McCollough CH, et al. *ACR Colon Cancer Committee white paper: status of CT colonography 2009.* Journal of the American College of Radiology : JACR. 2009;6(11):756-72 e4.
78. Miller L, Price R, Vosper M.Training and development for radiographers' extended roles: a case of ad hoc implementation. . Health Services Management Research 2011;24(2):60-8.
79. Paterson AM, Price RC, Thomas A, Nuttall L. *Reporting by radiographers: a policy and practice guide.* Radiography. 2004;10(3):205-12.
80. The Royal College of Radiologists, Board of the Faculty of Clinical Radiology. Medical Image *Interpretation by Radiographers. Guidance for Radiologists and Healthcare Providers.* London: The Royal College of Radiologists. 2010.
81. Department of Health (1999). Clinical governance in the new NHS. Available at; http://webarchive.nationalarchives.gov.uk/+/www.dh.gov.uk/en/Publicationsandstatistics/Lettersandcirculars/Healthservicecirculars/DH_4004883 (Accessed May 2014). Department of Health
82. Department of Health (2008). High Quality Care for all. NHS Next Stage Review. Final report. London: TSO(The Stationary Office).

83. Health and Social Care Act 2012. Sect. 2 (2012). Available at; http://www.legislation.gov.uk/ukpga/2012/7/contents/enacted (Accessed May 2014). London.
84. Department of health (2013).*Quality in the new health system-Maintaining and improving quality from April 2013.* Available at https://www.gov.uk/government/publications/quality-in-the-new-health-system-maintaining-and-improving-quality-from-april-2013 (Accessed May 2014) Department of Health.
85. National Institute for Health and Care Excellence.(2013) *National Institute for Health and Care Excellence NICE Charter*. Available at http://www.nice.org.uk/Media/Default/About/Who-we-are/NICE_Charter.pdf (Accessed May 2015). National Institute for Health and Care Excellence.
86. Haycock A, Burling D, Wylie P, Muckian J, Ilangovan R, Thomas-Gibson S. CT colonography training for radiographers--a formal evaluation. Clinical radiology. 2010;65(12):997-1004.
87. Field A. (2013) *Discovering Statistics using IBM SPSS Statistics.* Fourth Edition ed. London: SAGE Publications Ltd
88. Summers RM. *Polyp Size Measurement at CT Colonography: What do we know and what do we need to know?* Radiology. 2010;255(3)(June):707-20.
89. Stephen Polgar, Thomas S. (2013) Introduction to research in the health sciences. Sixth ed: Churchill Livingstone.
90. Altman D. (1991) Practical statistics for Medical Research. London: Chapman and Hall.
91. Viera AJ, Garrett JM. Understanding interobserver agreement; The kappa statistic. Family Medicine. 2005(37):360-3.
92. Cicchetti DV, Feinstein AR. *High agreement but low kappa: II. Resolving the paradoxes*. Journal of Clinical Epidemiology. 1990(43):551-8.
93. Allison R, Knapp K. *Spasticity Management with Botulinum Toxin: Development and evaluation of a tool for audit.* Journal of Rehabilitation Medicine. 2012;44:558-61.
94. Moore A MH, Derry S, Moore M. (updated 2009) *What is critical appraisal.* Available at: http://www.medicine.ox.ac.uk/bandolier/learnzone. (Accessed May 2015)
95. Smith FG, Smith JE (editors) (2003) *Key topics in Clinical research.* Oxford: BIOS Scientific Publishers Limited.
96. Burling D, Halligan S, Taylor S, Brennand DJ, Altman DG, Bassett P, et al. *Polyp measurement using CT colonography: agreement with colonoscopy and effect of viewing conditions on interobserver and intraobserver agreement.* American journal of roentgenology. 2006;186(6):1597-604.
97. Pannucci CJ, Wilkins EG. *Identifying and avoiding bias in research. Plastic and reconstructive surgery.* 2010;126(2):619-25.
98. Phillips J, Simmonds L. *Change management tools 3: use of process mapping in service improvement.* Nursing Times. 2013;109(17/18):24-6.
99. Pope C, Mays N (edited by)(2008). Qualitative research in healthcare. Oxford: Blackwell Publishing Ltd.; 2008.
100.SurveyMonkey. survey monkey security policy 2013 [updated 09.09.2013; cited 2015 21.01.15]. Available from: https://www.surveymonkey.com/mp/policy/security/
101. The Economic and Social research Council (2010). *Framework for Research Ethics (FRE)*. Available from: http://www.esrc.ac.uk/_images/framework-for-research-ethics-09-12_tcm8-4586.pdf. (Accessed July 2015). Economic and Social Research Council.
102. Eysenbach G, Wyatt J. *Using the Internet for Surveys and Health Research.* J Med Internet Res. 2002;4(2):e13.

103. Wyatt JC. *When to Use Web-based Surveys.* Journal of the American Medical Informatics Association : JAMIA. 2000;7(4):426-9.
104. Stieger S, Reips UD, Voracek M. *Forced-response in online surveys: Bias from reactance and an increase in sex-specific dropout.* Journal of the Association for Information Science and Technology. 2007;58(11):pages 1653–60.
105. Bullivant J, Corbett-Nolan A (2010) *Clinical Audit: A simple guide for NHS boards and partners.* Available at; http://www.hqip.org.uk/assets/Guidance/HQIP-Clinical-Audit-Simple-Guide-online1.pdf (accessed May 2015). Health Quality Improvement Partnership.
106. Dixon N, Pearce M. (2010) *Guide to ensuring data quality in clinical audits.* Available at; http://www.hqip.org.uk/assets/LQIT-uploads/Guide-to-ensuring-data-quality-in-clinical-audits-8-Sep-10.pdf (accessed May 2015). Health Quality Improvement Partnership.
107. Health Quality Improvement Partnership (2012) *Criteria and indicatiors of best practice in clinical audit.* Available at; http://www.hqip.org.uk/assets/Guidance/HQIP-Clinical-Audit-Report-Summary-2012-small.pdfhttp://www.hqip.org.uk/assets/Guidance/HQIP-Clinical-Audit-Report-Summary-2012-small.pdf (Accessed May 2015) Health quality Improvement Partnership.
108. Burling D, Moore A, Taylor S, La Porte S, Marshall M. *Virtual colonoscopy training and accreditation: a national survey of radiologist experience and attitudes in the UK.* Clinical radiology. 2007;62(7):651-9.
109. Anderson ED, Muir BB, Walsh JS, Kirkpatrick AE. *The efficacy of double reading mammograms in breast screening.* Clinical radiology. 1994;49(4):248-51.
110. The Royal College of Radiologists (2006, reviewed 2014) *Standards for the Reporting and Interpretation of Imaging Investigations. BFCR(06)1*. Available at; https://www.rcr.ac.uk/publication/standards-reporting-and-interpretation-imaging-investigations (Accessed June 2015). The Royal College of Radiologists.
111. Brady A, Laoide RO, McCarthy P, McDermott R. *Discrepancy and error in radiology: concepts, causes and consequences.* The Ulster medical journal. 2012;81(1):3-9.
112. Zalis ME BM, Choio JR, DAchman AH, Fenlon HM, Ferrucci JT et al. CT colonography reporting and data system: a consensus proposal. Radiology. 2005;236(1):3-9.
113. McHugh ML. *Interrater reliability: the kappa statistic.* Biochemia medica. 2012;22(3):276-82.
114. Pickhardt PJ, Hain KS, Kim DH, Hassan C. *Low rates of cancer or high-grade dysplasia in colorectal polyps collected from computed tomography colonography screening.* Clinical Gastroenterology & Hepatology. 2010;8(7):610-5.
115. Pickhardt PJ, Hassan C, Halligan S, Marmo R. Colorectal cancer: *CT colonography and colonoscopy for detection--systematic review and meta-analysis.* Radiology. 2011;259(2):393-405.
116. Chaput U Alberto SF, Terris B, Beuvon F, Audureau E, Coriat R et al. *Risk factors for advanced adenomas amongst small and diminutive colorectal polyps: a prospective monocenter study.* Digestive & Liver Disease. 2011;43(8):609-12.
117. Pooler BD, Kim DH, Lam VP, Burnside ES, Pickhardt PJ. *CT Colonography Reporting and Data System (C-RADS): benchmark values from a clinical screening program.* AJR American Journal of Roentgenology. 2014;202(6):1232-7.
118. Lauridsen C, Lefere P, Gerke O, Hageman S, Karstoft J, Gryspeerdt S. *Comparison of the diagnostic performance of CT colonography interpreted by radiologists and radiographers.* Insights into Imaging. 2013;4(4):491-7.
119. Bodily KD, Fletcher JG, Engelby T, Percival M, Christensen JA, Young B et al. *Nonradiologists as second readers for intraluminal findings at CT colonography*. Acad Radiol 2005;Jan(12(1)):67-73.

120. NHS England Clinical Audit (2015). *Our Work - Clinical audit*. Available from: http://www.england.nhs.uk/ourwork/qual-clin-lead/clinaudit/#clinical-audit. (Accessed June 2015) NHS England.
121. Health and Care professions Council (revised 2013). *Standards of proficiency Radiographers.* Available at http://www.hpc-uk.org/assets/documents/10000dbdstandards_of_proficiency_radiographers.pdf (Accessed August 2015)
122. Royal College of Radiologists (2014). *Audit Live* (updated 2014). Available at: https://www.rcr.ac.uk/audittemplate.aspx?PageID=1016. (Accessed June 2014).
123. Barter S.(2010) Peer review - using double reporting as a tool for revalidation Available at: https://www.rcr.ac.uk/audittemplate.aspx?PageID=1020&AuditTemplateID=142. (Accessed May 2014) Royal College of Radiologists
124. Grant Lee BS, Griffin Nyree (updated 2010). CT Colonography Practice: The sensitivity and specificity of CT Colonography (CTC); Available at https://www.rcr.ac.uk/audittemplate.aspx?PageID=1020&AuditTemplateID=281 (Accessed May 2014) Royal College of Radiologists.
125. Duncan KA. (2008) *Single reader hit and miss rates in the breast screening service: Audit to assess efficiacy of double reading practice in breast screening units and to allow identification of any worrying trends*.(2008) Available at https://www.rcr.ac.uk/audittemplate.aspx?PageID=1020&AuditTemplateID=111. (Updated 2012, accessed May 2014)Royal College of Radiologists.
126. Rowena W. (2010) *An audit of radiology report quality: This audit attempts to audit the clinical quality of the content of radiologiscal reports from a group of radiologists or department by structured peer review. It does not identify individuals.* Available at https://www.rcr.ac.uk/audittemplate.aspx?PageID=1020&AuditTemplateID=141 (Updated 2010, accessed May 2014) Royal College of Radiologists
127. Royal College of Radiologists. *Quality assurance in radiology reporting: peer feedback*. London: Royal College of Radiologists; 2014.
128. de Haan MC, Nio CY, Thomeer M, de Vries AH, Bossuyt PM, Kuipers EJ, et al. Comparing the diagnostic yields of technologists and radiologists in an invitational colorectal cancer screening program performed with CT colonography. Radiology. 2012;264(3):771-8.
129. Harris R. Research and the Radiography profession: A strategy for research 2010 - 2015. London: The Society and College of Radiographers; 2010.
130. Lafrate F, Hassan C, Zullo A, Stagnitti A, Ferrari R, Spagnuolo A, et al. *CT colonography with reduced bowel preparation after incomplete colonoscopy in the elderly*. European radiology. 2008;18(7):1385-95.
131. National Institute for Health and Care Excellence. *Nice Clinical Guidelines (NG5) Medicines optimisation: the safe and effective use of medicines to enable the best possible outcomes.* March 2015; accessed March 2016. Available from: https://www.nice.org.uk/guidance/ng5.
132. Electroninc Medicine Compendium (eMC). Summaries of Product Characteristics Gastrografin. Updated January 2013, accessed October 2014;
Available from: http://www.medicines.org.uk/emc/medicine/1820.
133. Department of Health. Human Medicines Regulations, (2012). Available from http://www.legislation.gov.uk/uksi/2012/1916/contents/made (Accessed: October 2014).

134. Electronic Medicines Compendium (eMC). Summaries of product characteristics Buscopan. Updated June 2014; accessed October 2014. Available from: http://www.medicines.org.uk/emc/medicine/281
135. Dumbleton C. *Diagnostic Radiography UK Workforce Report 2014.* Society of Radiographers: Available from (https://www.sor.org); 2014.
136. Freeman C. *Scope of Radiographic Practice Survey 2012*. Society of Radiographers. Available from (https://www.sor.org): (Accessed May 2015).
137. Harris R. An evaluation of the impact of implementation of consultant practitioners in clinical imaging 2010 (accessed July 2015). Available from: https://www.sor.org/learning/document-library/evaluation-impact-implementation-consultant-practitioners-clinical-imaging. Society of Radiographers 2015.
138. Gray M. *The Mayneord Lecture: From quality to value - population and personalised imaging.* United Kingdom Radiology Congress; 2015 29.06.2015; ACC Liverpool.

Appendix 1.1

Policy for Radiographer Led CT colonography in Diagnostic Imaging

NHS Musgrove Park Hospital	Trust Policy Diagnostic Imaging Department
Title: CT Colonography protocol	
Authors: Sue Rimes, Dr Danial Fox	
Policy Lead: Dr Danial Fox	
Ratified by: Radiography SMT	**Active date:** 5th October 2011
Ratification date: January 2011	**Review date:** 5th October 2014
Applies to: All clinical departments	**Exclusions:** None
Purpose: To support a radiographer led CT colonography service	
VERSION CONTROL - This document can only be considered current when viewed via the Policies and Guidance database via the Trust intranet. If this document is printed or saved to another location, you are advised to check that the version you use remains current and valid, with reference to the active date.	

1 Introduction

CT colonography is a well established technique for diagnosing bowel cancer and polyps in symptomatic patients.

CT colonography is undertaken by a specialist team of radiographers and radiologists. CT and GI radiographers are trained to perform the examination and check the initial images. Trained GI radiographers will provide a "first read" of the images. Radiographers will attend a recognised training course and will complete a period of supported reporting before commencing in this role.

Consultant radiologists take responsibility for the service, offer support as required and issue the final radiology report.

All radiologists in the Diagnostic Imaging Department are aware of the delegation of these responsibilities

All referrers are informed that radiographers may perform or report on the examinations they request.

Referral

Capacity for CT colonography is limited, as a result only the following referrals can be accepted. All requests should be accompanied by a bowel cleansing declaration form completed by the referring clinician.

http://intranet.tsft.nhs.uk/gastroendo/DepartmentHome/tabid/6317/language/en-GB/Default.aspx

Musgrove Park Hospital is part of Taunton & Somerset NHS Foundation Trust
Page 1 of 6

Policy for Radiographer Led CT colonography in Diagnostic Imaging

Please complete page 2 of the colonoscopy request form.

1) Stenosing tumour at endoscopy where the bowel more proximally has not been imaged. CTC (including CT chest) will replace the usual staging CT.

2) Patients in whom barium enema is not feasible due to significant co-morbidity or immobility.

3) Patients unsuitable for cathartic bowel preparation and thus excluded from colonoscopy or barium enema (identified through Oral Bowel Prep Assessment).

4) Patients aged over 80 years

5) Patients referred from the Bowel Cancer Screening Programme (BCSP) as unsuitable for cathartic bowel prep or unwilling to undergo colonoscopy. *"Where imaging is indicated, CT colonography is the preferred method". (NHS BCSP September 2010)*. Patients unsuitable for colonoscopy to be identified through Oral Bowel Prep Assessment

http://intranet.tsft.nhs.uk/portals/GastroenterologyEndoscopy/SiteAssets/documents/Checklist%20for%20Oral%20Bowel%20Preparation%20-%20v1-11.pdf

6) Patients in which there is a high suspicion of an additional extra-colonic pathology.

Discussion with the referring consultant is required for any requests submitted outside of these guidelines.

A radiographer will check all referrals and will contact the requesting doctor for any additional information.

The radiographer may make the decision to offer an alternative examination. The referring consultant will be informed of this decision, usually by email. A generic GI email address

Policy for Radiographer Led CT colonography in Diagnostic Imaging

The radiographer will contact the patient to determine whether fit for bowel preparation at home. Picolax and Gastrografin or Senna and Gastrografin, as appropriate, will be prescribed by the radiographer working under a Patient Group Direction (PGD).
A patient assessment form will be completed by the radiographer (see Appendix A).

2 Indications

Stenosing tumour (see above)

Iron deficiency anaemia *"Men with unexplained iron deficiency anaemia and haemoglobin of 11g/100ml or below, Non-menstruating women with unexplained iron deficiency anaemia and haemoglobin of 10g/100ml or below" (GP referral proforma for suspected colon cancer).*

Altered bowel habit *"patient 60 years and older with change in bowel habit for 6 weeks or more"*

Abdominal mass, pain, significant weight loss. *"Lower abdominal mass consistent with involvement of the large bowel"*

Patients must also comply with the referral criteria listed above. Excluded patients will be offered a barium enema or endoscopy.

3. Contra-indications

Acute inflammatory bowel disease
Colonic perforation
Toxic megacolon
Recent endoscopic biopsy or polypectomy.

4. Bowel preparation

Patient to follow a 2 day low residue diet
Patient to be given full preparation (Picolax with Gastrografin tagging) or reduced preparation (Senna with Gastrografin tagging) prior to scanning.

Policy for Radiographer Led CT colonography in Diagnostic Imaging

5. Method

Positively identify the patient, ascertain that the bowel preparation has been taken and has had an effect.

Interview the patient and complete first two sections of the pre-report sheet (appendix 1) if not already completed following a telephone assessment.

Warn the patient that buscopan may cause blurred vision and to seek urgent medical advice if they develop seriously blurred vision or painful eyes within 12 hours.

Explain the procedure to the patient

6. Examination sequence

Place venflon if IV Contrast media is required.

Place rectal catheter and inflate balloon. The balloon should not be inflated if there is a high suspicion of a rectal tumour.

Start CO2 insufflation, remain with patient and reassure during bowel insufflation.

Give 20mg Buscopan IV, radiographer to prescribe and administer under a Patient Group Directive.

Prone scan (low dose) initiated after insufflation of approximately 3L of CO2. This will be adjusted at the discretion of the radiographer if gas is clearly not being retained or if the patient describes discomfort and a "feeling of fullness".

Supine scan with or without IV contrast. 50mls Ultravist 300 to be prescribed and administered by a radiographer working under a PGD.

Scans reviewed and additional imaging undertaken as required. The patient may require decubitus views if bowel distension is poor. If malignancy is proven or highly suspected a CT chest scan with IV contrast should be performed.

The radiographer will seek advice from the supervising radiologist for any complex cases or difficult to interpret images.

7. Aftercare

The patient should be taken to a cubicle to change and encouraged to have a drink before leaving the department.

All patients having IV contrast should remain in the department, under supervision for a minimum of 15 minutes following injection of contrast.

Contrast reactions

All contrast reactions should be reported to the supervising radiologist immediately.

Patients' symptoms to be managed appropriately and the scan completed wherever possible.

Patients should be observed in recovery until symptoms settle and must stay in the department under direct observation for a minimum of 1 hr.

All adverse reactions should be recorded under "ALARMS" on the "CRIS" system and in the patient's notes if available.

The patient must be seen by the supervising radiologist before leaving the department.

8 Report

A GI radiographer will review the CT colon images on the day of the study and issue a r adiographer pre-report.

A radiologist report will be issued for out-patients within 48hrs of the study. Any in-patient examinations will be reported within 1 working day in line with department policy.

9 Audit

Audit to be undertaken for

- Accuracy of radiologist report and radiographer 1st read
- Missed pathologies

To facilitate this the GI radiographer undertaking the examination will scan the pre-assessment sheet onto CRIS and enter patient demographics onto the CT colon database.

The GI radiographer undertaking the first read of the images will enter a report onto the CT colon database.

The radiologist completing the final report will document any discrepancies or relevant additional information onto the CT colon database.

Policy for Radiographer Led CT colonography in Diagnostic Imaging

DEPARTMENT OF DIAGNOSTIC IMAGING

Pre-examination form for radiographer performed CT Colonography

Patient's Name:
Radiology No:
Date of Birth:
Date of Examination:

Pre-assessment telephone conversation:

PRE-EXAMINATION CHECKLIST		
Diabetic:	Yes/No	Creatinine:
Glaucoma:	Yes/No	GFR:
Heart Failure:	Yes/No	
Allergies:	Yes/No	

BOWEL PREPARATION		
Picolax only (COL1):	Picolax and tagging (COL2):	Senna and tagging (COL3):

Assessment of preparation:
Clarity of information given:

Tolerance of preparation:

Explanation of examination: Yes/No
Any complications:

After Care:
Helped to toilet/dress etc Yes/No Given drink Yes/No

Signature of Radiographer:

PLEASE FORWARD THIS FORM TO SUE RIMES FOR AUDIT PURPOSES, THANKS

Musgrove Park Hospital is part of Taunton & Somerset NHS Foundation Trust
Page 6 of 6

Appendix 2.1

NHS

Musgrove Park Hospital

Taunton and Somerset R&D Consortium
Department of Clinical Research
Musgrove Park Hospital
TAUNTON
TA1 5DA

Administrator: Ms Dulcie
Tel: 01823 342799
Email: r.andrews@tsh.nhs.uk

Mrs S Rimes
Principal Radiographer
Radiography Department
Musgrove Park Hospital
Taunton

17 April 2014

Dear Mrs Rimes

RE: THE ROLE OF THE RADIOGRAPHER IN A COMPUTED TOMOGRAPHY COLONOGRAPHY (CTC) SERVICE - TO LOOK AT SERVICE PROVISION AND THE REPORTING OF INTRA-LUMINAL PATHOLOGY (2355) [S]

The R&D Executive Group considered this project at its meeting on 11 April 2014 and on behalf of Taunton and Somerset NHS Foundation Trust was happy to grant it approval.

Approval is given subject to the following standard conditions:

a) Compliance with conditions specified by Ethics Committee(s)
b) All amendments to the project to be notified to the R&D Executive Group
c) Full co-operation with requests for information for monitoring purposes, including possible audit of the project to assess compliance with research governance standards
d) There is an intention to publish, whatever the results
e) Notification of local study specific SAEs (Serious Adverse Events) and SUSARs (Suspected Unexpected Serious Adverse Reactions) to the R&D Executive Group
f) Compliance with the Research Governance Framework for Health and Social Care (For information and guidance on the Research Governance Framework for England, please see - www.dh.gov.uk/Policyandguidance/researchanddevelopment/g/researchgovernance/en)

Yours sincerely

DR R ANDREWS
Chair
Taunton and Somerset R&D Consortium

cc: Dr K Knapp, Senior Lecturer, College of Engineering, Mathematics and Physical Sciences, University of Exeter, Physics Building, Stocker Road, EXETER EX4 4QL
Enc. List of documents reviewed

Musgrove Park Hospital is part of Taunton and Somerset NHS Foundation Trust
Taunton and Somerset NHS Foundation Trust
www.tsh.nhs.uk

Page 1 of 1

Appendix 2.2

RESEARCH & KNOWLEDGE TRANSFER

The Innovation Centre
Rennes Drive
University of Exeter
Exeter EX4 4RN

Telephone +44 (0)1392 262366
Fax +44 (0)1392 263846
Email [illegible]
Web www.exeter.ac.uk

3rd March 2014

Study title: 'The role of the Radiographer in a Computed Tomography Colonography (CTC) service – to look at service provision and the reporting of intra-luminal pathology'

Chief Investigator: Dr Karen Knapp, College of Engineering, Maths and Physical Sciences, University of Exeter

Dear Sir/Madam,

The University of Exeter will act as sponsor for the proposed study. The University will undertake its responsibilities in this role as outlined in the Department of Health's Research Governance Framework for Health and Social Care (second Edition, 2005). In addition, the University will ensure that the necessary approvals and insurance cover for professional indemnity and public liability are in place before the study commences.

Yours faithfully,

GSeymour

Gail Seymour
Research & Knowledge Transfer

University of Exeter
Tel: 01392 726621
Email: g.m.seymour@exeter.ac.uk

Appendix 2.3

Clinical Audit Proposal and Registration Form	NHS Musgrove Park Hospital

This form is for the use of all staff wishing to undertake a clinical audit.
This form **must** be completed whether or not support is required from the Clinical Audit & Measurement Team

AUDIT TITLE

(This should clearly reflect the aims of the project and be understandable to non-clinical staff from outside your specialty)

The role of the Radiographer in a Computed Tomography Colonography (CTC) service – to look at service provision and the reporting of intra-luminal pathology. Diag61

PROJECT LEAD CONTACT DETAILS *Please use block capitals*

Full name	SUE RIMES	Telephone No.:	Ext 3038
Job title	PRINCIPAL RADIOGRAPHER	Bleep No.:	
Speciality/ward/dept	DIAGNOSTIC IMAGING	Email:	Susan.Rimes@tst.nhs.uk

TYPE OF AUDIT

National guidance –*e.g. NICE* (please state)	X	National Bowel Cancer Screening Program CRAD RSR/SCoR-Royal society of Radiologist/Society and college of Radiographers.- Document Standards
Trust protocol/guideline - (please state)	☐	
Risks/incidents/complaints- (please state)	☐	
Other - (please state)	☐	

AUDIT OBJECTIVE

What is the intention for doing the clinical audit? What does the audit focus on? What is the clinical subject of the audit?

To evaluate the accuracy of the radiographer in reporting the lumen of the bowel using a previously validated audit tool.
The study will look at overall accuracy involving the entire current database (2000 studies)
It will also consider two subsets looking at accuracy of reports with 1,2 and 3 years' reporting experience and accuracy of reports after experience of reporting 50, 100 and 500 studies.

WHO ELSE NEEDS TO BE INVOLVED

Who will need to be consulted in order for the audit to be completed and for any changes/interventions to be implemented?

Stakeholders and their involvement	Data capture tool design	Data collection	Data Entry	Data Analysis	Plan & make improvement	Report	Remeasure
S. Rimes	X	X	X	X	X	X	X
T. Gamble	☐	X	☐	☐	☐	☐	☐
P. Winterson	☐	X	☐	☐	☐	☐	☐
D. Fox	X	X	☐	☐	X	☐	☐
P. Burn	X	X	☐	☐	☐	☐	☐
G. Kamati	☐	X	☐	☐	☐	☐	☐
J Brown	☐	X	☐	☐	☐	☐	☐

WHAT WILL YOU MEASURE & SAMPLE

What are the key things you will measure to achieve your aims?

Measure	Source
Number of reports in agreement / clinically insignificant disagreement / moderate disagreement / major disagreement	CT colon database
Anticipated sample size?	2000

AUDIT TIMEFRAME/WORK PLAN

Unless otherwise stated please provide an approximate target month against each stage. This is indicative and must be realistic. Re-measurement of any changes made should be anticipated and planned for.	**Please provide dates below:**
Design, planning and piloting complete by (date)	01/03/14
Audit data collection complete by (date)	01/10/2014
Input and analysis complete by (date)	01/10/2014
Initial reporting/presenting , including recommendations complete by (date)	01/09/2015
Aim for action plan produced by (date)	01/09/2015
Action plan monitoring group/committee (please state)	RAT
Re-measurement to be led by (person not date)	Sue Rimes

Project Support and Declarations:

Project Lead:

I agree to follow all relevant policies (clinical audit, data protection etc).I will ensure that this project is completed, the results disseminated and (either with or without support) a full report with recommendations, plus action plan of agreed changes to be implemented, is reported to the relevant specialty or directorate as appropriate. All relevant information will be forwarded to the Clinical Audit & Measurement Team.

Signature of Project Lead	Sue Rimes	Date	02/02/2014

Clinical Director/Directorate Manager:*

I confirm that this clinical audit project is worthwhile and that the priority and resource implications have been considered and discussed with relevant clinicians and managers. I agree that the time identified for the project to be successful is available to the project lead. I also agree that should the project lead not be able to complete the project I will be responsible for ensuring it is completed by another member of staff.

Signature of Clinical Director or Directorate Manager	Dr Jo Brown	Date	
Printed Name			

** For clinical support, the department lead/department manager will usually be the appropriate signatory*

CAMT Facilitator:

I have reviewed the proposal and confirm that the reasons for and method for the project are clear. The level of support identified can be delivered by the Clinical Audit & Measurement Team.

Signature of Clinical Audit & Measurement Facilitator		Date	

Please return this form to the Clinical Audit & Measurement Team

Audit Tittle: CTC MbyRes (phase 1) 13/01/14

This template provides a structure for defining the detail of the measures for a clinical audit. Using this template at the planning stage will clarify the content for the audit tool and help at the reporting stage to specify clear agreed standards. All members of the project team should be involved.

Measure no.	Evidence of quality of care or service *(criterion)*	Standard *(% compliance)*	Exception(s)	Definitions and instructions for data collection
1	Major discrepancy – missed cancer, missed polyp 1cm or larger. (ref Paterson et al 2004)	95%	None	Each report evaluated for discrepancy and scored for most significant pathology only. Standard to be met over audit cohort rather than each report.
2	Significant discrepancy – missed polyp 5-10mm (ref D. Burling et al 2007)	90%	None	Each report evaluated for discrepancy and scored for most significant pathology only. Standard to be met over audit cohort rather than each report.
3	Slight discrepancy - missed polyp 5mm or less (ref D. Burling et al 2007)	75%	None	Each report evaluated for discrepancy and scored for most significant pathology only. Standard to be met over audit cohort rather than each report.
4	No discrepancy – report match (ref D. Burling et al 2007)	88%	None	Each report evaluated for discrepancy and scored for most significant pathology only. Standard to be met over audit cohort rather than each report.

Appendix 2.4

Radiographer Role in Computed Tomography Colonography (CTC) –Phase 2

Participant Information Sheet

Introduction

Thank you for agreeing to take part in this study. I am completing a Masters by Research with Exeter University and this survey represents part of a bigger research project. You have been invited to take part because you are involved in the CTC service in your hospital.

The research will look at the roles undertaken by radiographers in providing a computed tomography colonography (CTC) service.

About the study

Phase 1 will look at CTC reporting by radiographers by conducting a retrospective audit of radiographer reports and phase 2 will look at the roles and responsibilities of radiographers in managing the service and undertaking the procedure. It is hoped that by gaining information on current practice it will be possible to inform on future radiographer role development in CTC. By completing this online survey you will be helping with phase 2.

Phase 1 of the project has been reviewed and approved by Taunton & Somerset NHS Foundation Trust Clinical Audit Department.

Phase 2 has been reviewed and approved by Taunton & Somerset NHS Foundation Trust Clinical Research Department and by the University of Exeter College of Engineering, Mathematics and Physical Sciences Ethics Department.

What you need to do

Participation is voluntary and you are under no obligation to take part. If you want more information before you start I am happy to discuss the project with you. You can email me at Susan.Rimes@tst.nhs.uk or phone me on (01832) 343038.

If you start the survey but decide not to continue you can withdraw at any time by simply not completing or not sending your survey responses.

The survey can be completed online and will take 10 -15 minutes to complete. You can start the survey, stop and save your results and come back to complete it another time if you need to.

Consent and confidentiality

When you start the survey you will be asked to tick to give consent. You will not be able to continue to the questions without completing this section.

Questions will be asked about the hospital you work in, about the job you do and your current grade but no individual will be identified by name, job role or employer.

More than one radiographer from the same Trust can complete this survey as roles and responsibilities will be different.

By ticking the consent box you are –

- Consenting to take part in the survey
- Consenting for the data produced to be shared in an anonymous form by a third party for future research
- Aware that you may withdraw from the project at any time without giving a reason
- Aware that participation is entirely voluntary
- Agreeing that your survey answers are your own personal opinions and need not reflect the view of you colleagues or your employer
- Aware that all data will be anonymous and confidential

Thank you very much for contributing to this project. I appreciate the time you have taken and hope the information gained will benefit our patients and our profession.

Sue Rimes

(Principal Radiographer, Taunton & Somerset NHS Foundation Trust)

Appendix 2.5

UNIVERSITY OF EXETER

NHS

Musgrove Park Hospital

Are you a radiographer involved in CT colonography?

Would you be able to help with some research to benchmark the current role of radiographers in CTC?

I am a GI radiographer undertaking a Masters by Research to look at the role of the radiographer in providing a CTC service.

I'd like as many radiographers as possible to complete an online survey which will be available soon but you do need to be directly involved in providing a CT service in your hospital to take part.

To complete the survey please follow this link https://www.surveymonkey.com/s/radiographers-ctc2014

Your responses will be anonymous and I will not ask for any information which might identify you.

It should only take 10-15 minutes of your time and the survey can be accessed anytime, anywhere.

Thanks for your help, it's really appreciated,

Sue

Ethics approval is granted by the College of Engineering, Mathematics and Physical Sciences Research Ethics Committee, University of Exeter and R&D approval granted by Taunton & Somerset NHS Foundation Trust

Appendix 2.6

Thank you for agreeing to complete this survey. Please only continue if you offer CT colonography scanning in the hospital you work in and if you are a radiographer directly involved in providing this service.

Section 1- general information to start

2.6 How big is your Trust?
Up to 400 beds
400 – 800 beds
Over 800 beds

If CTC is not undertaken in your hospital please do not complete or submit this survey. Thank you.

2.6 What imaging of the bowel do you offer? Please choose all that apply
CT colonography
Barium enema
Colonoscopy
Flexible sigmoidoscopy

2.6 If CTC is offered – how many scans do you perform a year?
Less than 100
100 – 500
More than 500

Section 2 – managing referrals

2.6 Who does your department take referrals from? Please choose all that apply
GP's
Outpatient clinics
In-patient referrals
BCSP referrals

2.6 Who agrees / accepts referrals? Please choose all that apply
Radiologist – always / often / sometimes / never
Radiographer using clinical judgement – always / often / sometimes / never
Radiographer using protocol guidance – always / often / sometimes / never
Decision made by the team (radiologist / radiographer) – always / often / sometimes / never

2.6 Who challenges inappropriate requests? Please choose all that apply

Radiologist – always / often / sometimes / never
Radiographer using clinical judgement – always / often / sometimes / never
Radiographer using protocol guidance – always / often / sometimes / never
Decision made by the team (radiologist / radiographer) – always / often / sometimes / never

Section 3 – managing bowel preparation

3.0 Which bowel preparation do you use? Please choose all that apply
Picolax
Senna
Moviprep
None
Other – if other please comment

3.1 What faecal tagging do you use? Please choose all that apply
Barium
Gastrografin
Other – if other please comment
None

3.2 Who decides on the bowel prep and faecal tagging regime? Please score all that apply
Radiologist – always / often / sometimes / never
Referrer – always / often / sometimes / never
Radiographer using clinical judgement – always / often / sometimes / never
Radiographer working to protocol – always / often / sometimes / never
Decision made by the team (radiologist / radiographer) – always / often / sometimes / never
Or All patients get the same

3.3 Who ensures compliance with NPSA Guidelines – Reducing risk of harm from oral bowel cleansing solutions? Please score all that apply
Referrer when requesting the examination – always / often / sometimes / never
Radiologist – always / often / sometimes / never
Radiographer using clinical judgement – always / often / sometimes / never
Radiographer working to protocol – always / often / sometimes / never
Decision made by the team (radiologist / radiographer) – always / often / sometimes / never

3.4 Do radiographers prescribe drugs under a PGD?
Yes
No
If no, go straight to section 4

3.5 What do you give under PGD? Please choose all that apply
Laxatives
Tagging agents
Antispasmodic
Iodinated contrast

3.6 Who writes the PGD's you work under? Please score all that apply
Radiologist – always / often / sometimes / never
Radiographer – always / often / sometimes / never

If a radiographer writes your PGD's what is their grade? Please choose all that apply
GI radiographer grade 5, 6, 7, 8a, 8b, 8c, 8d

CT radiographer grade 5, 6, 7, 8a, 8b, 8c, 8d
Other

Section 4 – undertaking the scan

4.0 Who takes clinical responsibility for the patient during the scan? Please score all that apply.
Radiologist – always / often / sometimes / never
Radiographer – always / often / sometimes / never

If a radiographer takes responsibility for the patient during the procedure what is their grade? Please choose all that apply
GI radiographer grade 5, 6, 7, 8a, 8b, 8c, 8d
CT radiographer grade 5, 6, 7, 8a, 8b, 8c, 8d

4.1 Who manages patient care during the procedure? Please score all that apply.
Radiologist – always / often / sometimes / never
Radiographer – always / often / sometimes / never
Nurse – always / often / sometimes / never
Health Care Assistant – always / often / sometimes / never

If a radiographer cares for the patient during the procedure what is their grade? Please choose all that apply
GI radiographer grade 5, 6, 7, 8a, 8b, 8c, 8d
CT radiographer grade 5, 6, 7, 8a, 8b, 8c, 8d

4.2 Who manages patient care after the procedure? Please score all that apply.
Radiologist – always / often / sometimes / never
Radiographer – always / often / sometimes / never
Nurse – always / often / sometimes / never
Health Care Assistant – always / often / sometimes / never

If a radiographer cares for the patient after the procedure what is their grade? Please choose all that apply
GI radiographer grade 5, 6, 7, 8a, 8b, 8c, 8d
CT radiographer grade 5, 6, 7, 8a, 8b, 8c, 8d

2.6 Who makes decisions on scanning – need for additional views? Please score all that apply
Radiographer using clinical judgment – always / often / sometimes / never
Radiographer following protocol- always / often / sometimes / never
Radiologist – always / often / sometimes / never
Decision made by the team (radiologist / radiographer) – always / often / sometimes / never

2.6 Who makes decisions on scanning –need to give IVCM? Please score all that apply
Radiographer using clinical judgment – always / often / sometimes / never
Radiographer following protocol – always / often / sometimes / never

Radiologist – always / often / sometimes / never
Decision made by the team (radiologist / radiographer) – always / often / sometimes / never

4.5 Who makes decisions on scanning –need to perform a staging scan? Please score all that apply
Radiographer using clinical judgment – always / often / sometimes / never
Radiographer following protocol – always / often / sometimes / never
Radiologist – always / often / sometimes / never
Decision made by the team (radiologist / radiographer) – always / often / sometimes / never

Section 5 – reporting the images

5.0 Who reports on the lumen of the colon?
Radiographer – 1st read
Radiographer – final report
Radiologist – double reporting with two radiologists
Radiologist – independent report
Radiologist / radiographer double report

Other – please comment

5.1 Who reports on the extra colonic findings?
Radiographer – first read
Radiographer – final report
Radiologist – double reporting offered
Radiologist – independent report

Other – please comment

6.0 What qualifications do you have?
Degree / DCR
Post Graduate qualification
Masters Level qualification

6.1 What is the highest qualification you have relating to CTC?
Degree / DCR
Post Graduate qualification
Masters Level qualification
Doctorate
6.2 What other specific CTC training have you received? Please choose all that apply
Attended a CTC course
Completed in-house training
No training given
6.3 Does your training in CTC meet your needs?
Yes, I feel adequately trained
No, I require more training

Comments welcome

6.4 What A4C band are you employed in?
5
6
7
8
8a
8b
8c
8d

6.5 What is your clinical specialty?
CT
GI
None
Both

Other - please comment

6.6 Do you report as part of your job?
Yes, I report barium enemas

Yes, I report CTC's (intraluminal findings only)
Yes, I report CTC intraluminal and extra luminal findings
No I don't report

Comments welcome

Thank you very much for completing this survey. If you would like to be informed of the results please leave your email address.
This will not be used for any other purpose and all the information you have provided will remain anonymous

N.B These questions will be transferred to online survey software for delivery to participants.