

# Guidance on the use of CT colonography for suspected colorectal cancer

British Society of Gastrointestinal and Abdominal Radiology (BSGAR) and  
The Royal College of Radiologists



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## Foreword

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Colorectal cancer is the third most common cancer in both men and women with an incidence of 34,044 in England in 2011, accounting for 12.4% of all malignancies registered.<sup>1</sup> Approximately 700,000 adults with symptoms potentially attributable to colorectal cancer are investigated in England per annum, with 70% of new diagnoses made among those aged 65 and over. Early diagnosis of colorectal cancer results in cure in the majority of patients.<sup>2</sup> In the UK, we have seen the introduction of the NHS Bowel Cancer Screening Programme (NHSBCSP)<sup>3</sup> to identify asymptomatic patients with cancer and a public health initiative 'Be Clear on Cancer'<sup>4</sup> to encourage those with possible symptoms of colorectal cancer to seek prompt medical advice. On this background, the number of people needing colonic investigation is increasing. The two patient populations (screening and symptomatic) are different. However, while there are some differences in the patient pathway, there are common implications for providing a high-quality colonic imaging service.

The number of CT colonography examinations is increasing in the UK for suspected colon cancer, having now replaced the barium enema as the alternative imaging investigation of choice when colonoscopy is incomplete or the patient is considered unsuitable for colonoscopy. The British Society of Gastrointestinal and Abdominal Radiology (BSGAR) and The Royal College of Radiologists have produced this document to set out the key considerations in using CT colonography for suspected colorectal cancer as well as important guidance on all aspects of establishing a high-quality CT colonography service.

I would like to thank all those who have contributed to this important publication and commend it to you.

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## Introduction

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Computed tomography colonography (CTC) is an established and trusted radiological investigation for identifying colorectal cancer. It is safe,<sup>5,6</sup> accurate<sup>7-9</sup> and better tolerated by the patient compared with barium enema (BE) – the traditional radiological means of imaging the large bowel.<sup>10-14</sup>

CTC was first described in 1994 and has gained widespread acceptance as the best radiological means of identifying colorectal cancer and advanced colonic polyps (precursor of colorectal cancer). It is a high-resolution CT examination, typically performed in prone and supine positions, requiring pre-procedure bowel preparation and peri-procedure colonic insufflation.<sup>15</sup> The number of CTC examinations performed in the UK has increased with time, although defining this activity is difficult given the lack of a unique national code for the procedure. In many centres, CTC has entirely replaced the BE, the traditional radiological test, with numbers of the latter test falling year on year. However, a large number of BE are still performed, with 34,357 performed in 2012 in England alone.<sup>16</sup>

The recently published multicentre Special Interest Group in Gastrointestinal and Abdominal Radiology (SIGGAR) 1 trial has shown that CTC is significantly more sensitive for detecting cancers and large polyps than BE.<sup>8</sup> On the basis of preliminary results from the SIGGAR trial, the NHSBCSP advised that only CTC should be used as an alternative to colonoscopy. In light of this evidence, BE can no longer be supported as a suitable radiological investigation for patients with symptoms suspicious for colorectal cancer.

However, there are hurdles in instituting a change in UK practice from BE to CTC, not least that a BE service is largely delivered by radiographers, while CTC places additional pressure on CT workload and consultant reporting time. The purpose of this guidance is to set out some of the key considerations in the use of CTC for suspected colorectal cancer.

## Evidence

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The SIGGAR trials<sup>8,9</sup> were prospective, pragmatic, multicentre, randomised trials that compared the diagnostic accuracy of CTC with colonoscopy or BE in symptomatic patients in England. Compared with BE, CTC detected 30% more cancers and large polyps (overall detection rate for CTC 7.3% vs BE 5.6%,  $p=0.039$ ) whereas there was no significant difference in detection rates between CTC (10.7%) and colonoscopy (11.4%,  $p=0.69$ ).

For large polyps, the sensitivity of CTC relative to colonoscopy in the SIGGAR trial was in broad agreement with the average sensitivities of 85% (95% confidence interval [CI] 79–91)<sup>17</sup> and 93% (95% CI 73–98)<sup>18</sup> reported in two meta-analyses of CTC that used conventional colonoscopy as the reference standard. A recent meta-analysis of 25 studies (9,223 patients) comparing CTC with conventional colonoscopy reported a relative sensitivity of CTC for colorectal cancer of 96% (95% CI, 94–98%).<sup>7</sup>

Psychological reactions to the tests were recorded in a subset of patients in the SIGGAR trials. Patients undergoing BE were significantly less satisfied and experienced more physical discomfort than those undergoing CTC. They were also significantly more likely to experience post-procedural side-effects.<sup>8,13,14</sup> Serious adverse events were rare in both groups. It is concluded that CTC is, therefore, more suitable than BE for the investigation of frail elderly patients who constitute a large proportion of the symptomatic population.

## Population screening of asymptomatic men and women for colorectal cancer

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The NHSBCSP<sup>3</sup> was established to identify unsuspected cancers in asymptomatic screenees in who early diagnosis could result in cure and reduction in disease-specific mortality.

Screenees aged 60–75 are invited to participate in the Programme by returning stool samples via the post to screening centres. Patients with a positive faecal occult blood (FOB) test are offered whole colon visualisation. Colonoscopy is the primary means of achieving this, but CTC is presently the alternative when colonoscopy is incomplete or the patient is considered unsuitable for colonoscopy. In those patients who are FOB-positive in the first round (named 'prevalent round'), there is a high rate of polyp detection (approximately 4 in 10) and cancer detection (1 in 10). Since half of this group are likely to need biopsy or polypectomy, colonoscopy is preferred over CTC despite their apparently similar diagnostic performance for larger lesions. However, CTC could potentially assume a role in future screening rounds ('incident rounds') as the incidence of colonic neoplasia decreases.

Psychological surveys from the SIGGAR trials found that patients undergoing colonoscopy were significantly less satisfied and more worried than those undergoing CTC.<sup>14</sup> They also experienced more physical discomfort. However, at three months' post-testing, patients were more satisfied with how their results were received at colonoscopy, usually immediately after the test, compared with a relatively delayed result from CTC. This identifies where there is room for improvement in CTC reporting turnaround times and communication of results.

CTC uses ionising X-radiation and so should be used judiciously, particularly in younger patients. The potential harm of radiation decreases with age and so is less of a concern for screenees in the NHSBCSP who are a minimum of 60 years old in England. Moreover, those undergoing CTC in the NHSBCSP are frequently comorbid and diagnostic range radiation exposure is extremely unlikely to influence their life expectancy.

## The use of CTC in the NHSBCSP

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As a national screening service, high standards are demanded and the scheme is subject to rigorous quality assurance at each step in the process. The *Guidelines for the use of imaging in the NHS Bowel Cancer Screening Programme*, second edition<sup>19</sup> lay out in detail the requirements for providing CTC to the screening population.

### General principles

- CTC is the alternative imaging investigation of choice when colonoscopy is incomplete or the patient is considered unsuitable for colonoscopy.
- BE should not be performed as a firstline alternative to colonoscopy. Where high-quality CTC is not available locally, the patient should be referred elsewhere for examination.
- The technical quality of all screening CTC should meet the standards required for the NHSBCSP.
- Screening CTC should be performed by radiographers who satisfy the professional standards required by the NHSBCSP.
- Screening CTC should be interpreted by consultant radiologists who satisfy the professional standards required by the NHSBCSP.
- All departments offering a CTC service to the NHSBCSP must measure and monitor their activity and achievements in relation to patient safety, outcomes and experience. Screening, wherever performed, should always include formally agreed mechanisms for referral.
- A team approach is critical to the success of CTC. The skills and competencies of team members should be clearly defined in the screening centre's protocols.

## The use of CTC in the symptomatic population

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Any indication for total colonic imaging outside the NHSBCSP could be considered under the heading 'symptomatic'. Some patient groups at high risk of developing colorectal cancer, such as those with a strong family history or genetic predisposition to colorectal cancer, are imaged before they have symptoms as part of a colonoscopic surveillance programme, according to national guidelines.<sup>20</sup> Such patients would typically only be referred for CTC in cases of incomplete colonoscopy. Common symptoms potentially suggestive of colorectal cancer include recent change in bowel habit, palpable mass, rectal (PR) bleeding, abdominal pain, weight loss and unexplained anaemia. These patients are typically referred via the urgent 'two-week wait' pathway according to guidance from the National Institute for Health and Care Excellence.<sup>21</sup> However, the authors acknowledge that symptoms in patients with colorectal cancer are frequently non-specific and do not correlate closely with likelihood of underlying cancer.

The number of referrals for CT colonography has increased significantly in recent years in parallel with increasing demand for colonoscopy. CTC has the following advantages over colonoscopy; it is less invasive, safer, can use reduced laxative preparation regimens and enables review of extra-colonic organs. Approximately 10% of CTC examinations reveal major extra-colonic abnormalities. There will be local variation in referral pathways and close discussion with clinical teams is vital to ensure that the right test is performed in the right patient. The potential for increased radiological workload will need to be considered in any business case that that helps convert an existing BE service to CTC.

Increasingly patients are choosing CTC over colonoscopy when offered a choice by their doctor, but the appropriateness of CTC is contingent upon patient factors and CTC service quality. For example, patients are unable to choose CTC as part of the NHSBCSP.

In the symptomatic population, caution is needed in certain circumstances. CTC should not be routinely used in the context of inflammatory bowel disease<sup>22</sup> or for those with a strong genetic predisposition for colorectal cancer; for example, familial adenomatous polyposis or hereditary non-polyposis colorectal cancer (HNPCC or 'Lynch syndrome'), where the biological significance of very small or subtle polyps is greater. Colonic insufflation is generally avoided in patients with acute diverticulitis, particularly where luminal perforation is suspected.

In some symptomatic cases, a CTC may not be appropriate; for instance, where patient fitness precludes any active treatment subsequently if a cancer is diagnosed. In such situations, a minimal preparation CT colon without colonic insufflation (MPCT) might be a more appropriate alternative since only identification of gross pathology is needed. MPCT has been demonstrated to be reasonably sensitive (75–96%) and specific (82–94%) for detecting colonic malignancy.<sup>23,24</sup> Published data have shown that MPCT is well tolerated by the elderly population who are intolerant of bowel preparation.<sup>23</sup>



## CTC technique in screening and symptomatic populations

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The NHSBCSP sets the benchmark for delivering a high-quality endoscopic service and many of the recommendations are directly relevant for CTC in both asymptomatic and symptomatic patients (for example, imaging parameters and protocols, bowel distension techniques, scanning positions, patient safety and patient experience). The second European Society of Gastrointestinal and Abdominal Radiology (ESGAR) consensus statement on CTC also provides valuable guidance on the specific aspects of CTC acquisition and interpretation.<sup>25</sup> However, there are different approaches between the two patient groups worthy of consideration.

### Patient information and consent

All patients undergoing a CTC examination should be provided with appropriate verbal and written information. Patients must consent to the procedure, and while this is frequently verbal consent, an increasing number of centres are obtaining written consent both for the examination and use of patient data for retrospective audit. In the NHSBCSP, specialist screening practitioners (SSP) must be educated about CTC so they are able to initiate the consent process. In symptomatic practice, consent may be obtained by appropriately trained and experienced radiographers.

### Bowel preparation

The quality of bowel preparation can be optimised by recommending patients follow a low residue diet and by using faecal tagging which can improve diagnostic accuracy in both screening and symptomatic groups.

The use of full purgative bowel preparation is variable and usually dependent on the faecal-tagging agent used. Where full purgative laxatives are used (for example, use of picolax or Citramag [magnesium citrate, Sanochemia Diagnostics UK Ltd]), adherence to safety advice from the National Patient Safety Agency (NPSA) is mandatory.<sup>26</sup> Many UK centres use faecal tagging and low residue diet alone with excellent results; for example, a recent UK audit found examination adequacy rates of 99% with use of gastrografin alone and other centres have found similar results with other faecal tagging agents.<sup>27</sup> Use of reduced laxative regimens avoids the requirements of the National Patient Safety Agency (NPSA) alert and patient satisfaction is reported to be higher.<sup>27</sup>

### Intravenous contrast

Intravenously administered contrast does not significantly improve detection of advanced colonic polyps or colorectal cancer.<sup>25,28</sup> Consequently, CTC examinations can be performed without intravenously administered contrast, facilitating very low radiation dose examinations and avoiding contrast-associated risks and cost. However, extra-colonic organs can be more accurately interrogated with administration of intravenous contrast. Therefore the decision of when to use contrast will be based on a risk–benefit scenario influenced by patient factors such as age or co-morbidity. Routine use of intravenously administered contrast is not recommended for the NHSBCSP as screenees are generally asymptomatic and CTC is used as an alternative to colonoscopy for the detection of colonic neoplasia only.

Intravenous contrast is routinely used, unless contraindicated, when CTC is performed to both stage a neoplasm and complete assessment of the proximal colon following incomplete colonoscopy, or when a cancer is detected during a CTC examination. Ideally, the team performing the CTC should have the knowledge, skills and experience to identify most cancers at the time of examination to facilitate same-day CT staging, including CT chest.

## Same-day endoscopy

Consideration of referral for same-day endoscopy should be given when cancer is found at the time of CTC examination. The decision of whether to refer for same-day endoscopy should be made by a named and suitably experienced consultant radiologist supervising the CTC list. This decision will be based on factors associated with the suspected cancer (for example, its size, location, number of lesions, colonic tortuosity downstream, previous incomplete endoscopy); patient factors (co-morbidity, social circumstances, contraindications); and service factors (endoscopy expertise, availability).

## Same-day CTC for incomplete colonoscopy

Same-day CTC for incomplete colonoscopy should be considered to avoid the need for the patient to undergo further bowel preparation. This is particularly desirable when a colorectal neoplasm has been identified at colonoscopy, but may be precluded by patient factors (co-morbidity, contraindications, inadequate bowel preparation) and service factors (available scanner time and expertise). Consideration should be given to the oral administration of a small volume of iodinated faecal tagging agent before same-day CTC, to improve colonic visualisation in cases where the endoscopic preparation leaves a significant volume of residual fluid.<sup>29</sup>

## Further investigation

When a probable colorectal neoplasm is identified on CTC completion, CT staging is required, including the administration of intravenous contrast, unless contraindicated, and CT of the chest. Ideally this should occur at the same time as the diagnostic CTC. Patients diagnosed with rectal cancer should receive a staging MRI of the rectum, in addition to their staging CT/CTC.

## Communication of results

Robust mechanisms should be in place to ensure that the CTC result is made available to the referring clinical team in a timely fashion, particularly when a potential colorectal cancer has been detected. Important findings could be shared in the context of a multidisciplinary team (MDT) meeting or via an alternative robust and auditable means of communication.

## Professional standards

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Standards for CTC use in both screening and symptomatic groups are described in detail in the published NHSBCSP Guidelines and CT Colonography Standards.<sup>19,22</sup> Some of the key aspects are highlighted here with the main radiologist responsibilities summarised in Appendix 1. Both sets of documents acknowledge that CTC is a team-based service with training needed for every member of the team appropriate to their role. A radiologist with appropriate CTC expertise should provide leadership and primary responsibility for the CTC service.

### Training and professional development

Radiographers and radiologists responsible for CTC require training in CTC technique, including bowel preparation, patient information and consent, colonic insufflation, CT scan parameters patient/radiation safety. Performing radiographers should have the skills to recognise colonic under-distension and be empowered to perform additional series when necessary to achieve a diagnostic scan. Radiographers undertaking CTC review (for example, to recognise colonic perforation or identify large cancers to optimise service efficiency and patient experience) should be suitably trained and audited.

All members of the CTC team must be able to recognise complications arising before, during and immediately after the procedures, and should follow recognised protocols to manage any such complications.

CTC interpretation requires specialist skills additional to those needed for standard CT reporting. CTC standards for both the NHSBCSP and symptomatic groups recommend that basic training should include:

- Hands-on training with a minimum of 50 endoscopically validated cases
- Training on anatomy, pitfalls of interpretation (including accurate polyp size estimation), complications, and pathogenesis and epidemiology of colorectal cancer.<sup>19,22</sup>

Completion of training does not guarantee competence and there is evidence that interpretive performance continues to improve beyond this stipulated number.<sup>30</sup>

### CTC interpretation

CTC reading can be performed as primary 2D or 3D interrogations. Reporting radiologists should be competent in both 2D and 3D approaches and have access to the requisite software. 2D requires the use of multi-planar reformats (typically axial and coronal) in each patient position. 3D reading uses endoluminal reconstructions to create a virtual colonoscopy. The choice of reading method may vary within and between CTC datasets, depending on technical quality and the nature of the target lesion. Computer-aided detection (CAD) software is incorporated into several reading platforms and may increase the sensitivity of the interpretation. If CAD is utilised, it should be employed in a second read paradigm after the reporter has performed the initial primary read unaided.<sup>25</sup>

There is some evidence that CTC may be superior to optical colonoscopy for accuracy of polyp measurement.<sup>31–33</sup> The maximal diameter of flat or sessile lesions, or of the polyp head for pedunculated lesions should be measured. For CTC it is uncertain whether a 2D or a 3D measurement should be employed. Estimation of the maximal diameter of lesions using axial and MPR 2D views (considered to be the most reliable) is influenced by window level settings and current guidance recommends that a narrow CT window should be avoided. A 3D endoluminal rendering threshold of approximately -500HU has been suggested to avoid distortion of polyp measurements on 3D images. 2D measurements may be preferable if the colon is suboptimally distended.<sup>34</sup>

One aspect of performance that the SIGGAR trial highlighted was the relatively high proportion of referrals to colonoscopy from CTC where no subsequent significant polyp or cancer was identified (in the CTC vs colonoscopy trial, 30% had further testing, but only 11% had a cancer or large polyp). Adequate training of radiographers to acquire technically excellent image data and radiologists to interpret this appropriately, allied with quality assurance of the service, including correlation of positive CTC with endoscopic findings, is vital to maximise the contribution of CTC to safe and appropriate patient care.

## CTC reporting

Only appropriately trained consultant radiologists on the UK General Medical Council's specialist register should undertake CTC reporting. They must hold a national board certificate in radiology (Fellowship of The Royal College of Radiologists [FRCR] or equivalent).

Reporting radiologists must have a good knowledge of the NHSBCSP pathways and of strategies for managing polyps and masses of different sizes and morphologies. Diagnostic accuracy of CTC is lower for polyps with a maximal diameter <6 mm and previous publications have recommended that diminutive polyps identified on CTC should not be reported.<sup>17</sup> However, the ESGAR CT Colonography Working Group and NHSBCSP have recently offered guidance that, if detected with high confidence, and particularly if more than three in number, polyps <6 mm should still be reported.<sup>25</sup> Radiologists should report the probable biological significance of colonic findings, based on their size and morphology and should also indicate their degree of confidence (such as a percentage) that a reported abnormality is a true-positive finding. This will help to ensure that the patient is managed appropriately and will quantify the likelihood of a positive finding at endoscopic review.

The CTC report should include both colonic and extra-colonic findings. Where a low-dose, unenhanced CTC is acquired, the report should state explicitly that no contrast medium has been administered and should note that the ability to exclude potentially significant extra-colonic pathology is thereby diminished.

## Quality assurance

To promote the delivery of a high-quality service, the NHSBCSP specifies that CTC readers need to be designated as such by the lead screening radiologist and registered with the quality assurance reference centre. Designated screening radiologists are required to report a minimum of 100 CTCs per year and this should be performed in the context of a quality assured programme with audit of individual reporting outcomes. Screening radiologists must also participate in colorectal multidisciplinary team (MDT) activities.

Currently there is no consensus on minimum annual CT reporting figures required to maintain competency for those radiologists who only report symptomatic CTC, nor any quality assurance programme for non-screening centres. It is suggested that 50 scans per year is a reasonable minimum number needed to maintain the necessary skills while allowing some flexibility in departmental service delivery. Participation in colorectal MDT activities is recommended.

All departments offering a CTC service to the NHSBCSP must measure and monitor their NHSBCSP activity and their achievements in relation to patient safety, patient outcomes, and patient experience. Screening radiologists should be able to produce audit data of their performance over at least 100 NHS CTC examinations each year. Regular audit processes are also recommended in the symptomatic group to compare CTC findings with endoscopy, pathology and cancer registries. The development of a CTC database may aid the monitoring and audit of CTC activity and outcomes.

Patient safety audits should include:

- Clearly displayed protocols for managing complications and adverse reactions
- Documented monitoring of complications and adverse reactions (such as perforation, myocardial infarction, or hospitalisation)
- Demonstrable compliance with the standard acquisition and radiation protection protocols
- Quality control of CTC equipment, including the workstation and insufflators.

Patient outcome measures should include:

- Percentage of the NHSBCSP colonoscopy workload undergoing CTC
- Description of the reporting methods used for examinations, indicating whether examinations are double reported and, if so, by who
- Time interval between CTC examination and receipt of the report by the referrer
- Assessment of examination quality, including the proportion of inadequate examinations
- Positive predictive value (PPV) of CTC compared with endoscopy and/or pathology
- Negative predictive value of CTC (with reference to regional and MDT cancer registries on an annual basis)
- Polyp and cancer detection rate
- Percentage of examinations with extracolonic finding(s) requiring additional investigation work-up (including the number of examinations and method(s) used; for example, the imaging modality and PPV for individuals undergoing additional investigation).

Patient experience measures should include:

- Waiting times
- In-room examination time
- Results from the annual patient satisfaction survey
- Monitoring of complaints.

## Planning and delivering a CTC service

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A radiologist with appropriate CTC expertise should provide leadership and primary responsibility for the CTC service. A team approach is critical to the success of CTC and the skills and competencies of team members should be clearly defined in the CTC centre's protocols. There are workforce and cost implications of converting a BE to a CTC service for suspected colorectal cancer which should be considered in planning the service.

### Staff

#### Radiographer

Converting a BE to a CTC service needs planning with particular regard to the role of the existing barium radiographers who often play a central role in delivering a safe service. In many centres, they take responsibility for patient pre-assessment and consent while also performing and quality assuring the examination. The role for radiographer CTC reading is not yet established. A preliminary reading by a suitably trained radiographer might be possible, but the definitive CTC reading and radiological report should be undertaken and validated by an appropriately trained consultant radiologist.<sup>19,22,25</sup>

#### Radiologist

As well as the minimum training requirements described, CTC reporting is estimated to take an average of 20 minutes per case.<sup>22</sup> This is a considerably greater time commitment than is currently required for radiologists reporting a primarily radiographer-led barium enema service. Specifying a number of CTCs achievable within a business plan will help calculate costs for the department. Adequate allocation of specialist radiologist reporting time to achieve rapid reporting turnaround times and communication of results is desirable to improve the patient experience of CTC.

### Costs

#### Hardware

CTC should be performed on a multi-detector CT scanner capable of acquiring high-resolution, thin-slice datasets. Radiologists should have access to a dedicated CTC software package with 2D displays allowing multi-planar reformats and 3D endoluminal reconstruction. Computer-aided detection software is incorporated into several reading platforms and may increase the sensitivity of interpretation. An automated CO<sub>2</sub> insufflator is recommended.<sup>19,22</sup> A major challenge will be to create the extra CT capacity required to accommodate the conversion of a BE to a CTC service.

#### Consumables

The costs of materials can be calculated. One examination might require faecal tagging agent, laxative, rectal catheter, CO<sub>2</sub> for bowel insufflation, intravenous buscopan and intravenous contrast.

#### Performance time

Typically, a CTC examination requires a 30-minute appointment slot for the patient. Morning appointments are favoured since patients are fasted, with the earliest slots prioritised for patients with diabetes.

#### Numbers of examinations

As already noted, CTC referrals will tend to exceed those for BE since both radiological and referring clinician confidence in CTC is higher. In 2012, 34,357 BE were performed in England alone, while the Health and Social Care Information Centre Diagnostic Imaging Dataset (DID) recorded 14,043 CTC events occurring during the four-month period from April to July 2012.<sup>16,35</sup>

Additionally, we acknowledge that as endoscopy departments find themselves under pressure from increasing demand – both symptomatic and screening – one consequence might be a spillover of referrals to CTC. It is important to maintain a dialogue with endoscopy colleagues to ensure that the most appropriate test is being performed in any given patient.

## Economics

A specific national tariff that adequately reflects the complexity and cost of CTC does not currently exist. This likely underestimates the costs for a CTC business case. The authors' costings for consumables, staffing, hardware and software indicate a relative cost for a CTC examination of the order of approximately three times the national tariff for a BE and half that for colonoscopy. A price for CTC can be locally negotiated until a specific tariff becomes available.

Economic modelling within the SIGGAR trials suggests that the costs of primary investigation with CTC is comparable to colonoscopy, with the reduced unit cost of CTC being offset by downstream costs.<sup>9</sup> It is possible that more careful referral to endoscopy (for example, via widespread use of faecal tagging and well-trained radiologists) may reduce referrals to colonoscopy and sway the economic advantage towards CTC. There is also some evidence from the SIGGAR trials that a large proportion of symptomatic patients initially investigated by colonoscopy ultimately undergo comprehensive abdominopelvic CT scanning. If true, this increases the cost-effectiveness of CTC further.

## Conclusion

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CT colonography is now the gold standard when radiological imaging of the whole colon is required and should replace the barium enema. There is no significant difference between CTC and colonoscopy in detection rates of colorectal cancer and large polyps, and CTC complements the delivery of a patient-centred investigation service for suspected colorectal cancer. There are significant cost, training and workforce implications in delivering a CTC service, as well as a commitment to quality assurance in maintaining and improving CTC performance and outcomes.

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## Appendix 1. Radiologist responsibilities for the use of CTC for suspected colorectal cancer in screening and symptomatic patients

Bowel cancer screening programme (BCSP)	Symptomatic
<p><i>To gain and maintain expertise, each radiologist involved in reporting CTC in the BCSP should fulfill the following criteria.</i></p> <p><b>1. Training</b></p> <p>All radiologists interpreting CTC examinations for the NHSBCSP should be consultants on the UK General Medical Council's specialist register. Only practitioners with a national board certificate in radiology (FRCR or equivalent) should report CTC. This applies to both colonic and extracolonic findings.</p> <p>All interpreting radiologists must have undergone individual practical training involving at least 50 endoscopically validated CTC cases.</p> <p>Training via lectures or presentations on colonic anatomy, the pitfalls of CTC and its interpretation (including how to estimate accurately polyp diameter), the management of complications, and the pathogenesis/epidemiology of colorectal cancer.</p> <p>Bespoke NHSBCSP workshops to meet these needs are under development. In the interim, relevant training is available in the form of two-day practical CTC workshops, which are currently being offered in several countries. However, training alone cannot guarantee competence.</p> <p>All radiologists and radiographers who conduct examinations require specific training on examination technique. This must cover options for bowel preparation, how to provide patient information, gaining patient consent, colonic insufflation, CT scan parameters and radiation safety.</p>	<p><i>To gain and maintain expertise each radiologist involved in symptomatic CTC reporting should fulfill the following criteria.</i></p> <p><b>1. Training</b></p> <p>All radiologists interpreting CTC examinations should be consultants on the UK General Medical Council's specialist register. Only practitioners with a national board certificate in radiology (FRCR or equivalent) should report CTC. This applies to both colonic and extracolonic findings.</p> <p>All interpreting radiologists must have undergone individual practical training involving at least 50 endoscopically validated CTC cases.</p> <p>Training via lectures or presentations on colonic anatomy, the pitfalls of CTC and its interpretation (including how to estimate accurately polyp diameter), the management of complications, and the pathogenesis/epidemiology of colorectal cancer.</p> <p>Generic CTC workshops are available. However, training alone cannot guarantee competence.</p> <p>All radiologists and radiographers who conduct examinations require specific training on examination technique. This must cover options for bowel preparation, how to provide patient information, gaining patient consent, colonic insufflation, CT scan parameters and radiation safety.</p>
<p><b>2. Competencies</b></p> <p>Reporting radiologists should be competent in both 2D and 3D reading techniques.</p> <p>They should have good knowledge of the NHSBCSP pathways and of strategies for managing polyps and masses of different sizes and morphologies.</p> <p>Readers need to be designated to report CTC by the lead radiologist for the screening centre and registered as such with the screening centre's director and the QARC</p>	<p><b>2. Competencies</b></p> <p>Reporting radiologists should be competent in both 2D and 3D reading techniques. They should have good knowledge of strategies for managing polyps and masses of different sizes and morphologies.</p>
<p><b>3. Maintaining skills</b></p> <p>Radiologists should be able to produce audit data of their performance over at least 100 NHS CTC examinations each year.</p>	<p><b>3. Maintaining skills</b></p> <p>It is recommended that reporters read a minimum of 50 CTC per year to maintain skills.</p>

**4. Quality assurance**

Radiologists who are responsible for interpretation must participate in colorectal MDT activities in their hospital.

All departments offering a CTC service to the NHSBCSP must measure and monitor their NHSBCSP activity and their achievements in relation to patient safety, patient outcomes and patient experience.

Designated reporting radiologists must take part in national NHSBCSP audits when required to do so.

**4. Quality assurance**

Participation in colorectal MDT activities is recommended.

Regular audit processes should be in place to compare CTC findings with endoscopy, pathology and cancer registries.

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