RESEARCH

Bowel cancer screening is safe, detects earlier stage cancer and adenomas in 50% of cases: experience of the prevalent round of screening from two first wave centres in the North East of England

P T Rajasekhar,^{1,2} G M Clifford,¹ T J W Lee,^{2,3} M D Rutter,^{2,3} G Waddup,³ M Ritchie,¹ D Nylander,^{1,2} J Painter,^{1,2} J Singh,^{1,2} I Ward,⁴ N Dempsey,¹ J Bowes,¹ G Handley,⁴ J Henry,¹ C J Rees^{1,2}

¹South of Tyne Bowel Cancer Screening Centre, South Shields, UK

²The Northern Region Endoscopy Group, South Shields, UK

³Tees Bowel Cancer Screening Centre, Stockton-on-Tees, UK

⁴North of England Screening Hub, Gateshead, UK

Paper submitted in collaboration with the Northern Region Endoscopy Group.

Correspondence to

Dr C J Rees, South Tyneside NHS Foundation Trust, Harton Lane, South Shields NE34 0PL, UK; colin.rees@stft.nhs.uk

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Abstract

Objective The NHS Bowel Cancer Screening Programme (BCSP) began roll-out in 2006 aiming to reduce cancer mortality through detection at an earlier stage. We report results from the prevalent round of screening at two first wave centres and compare with the UK pilot study.

Design This is a service evaluation study. Data were collected prospectively for all individuals undergoing faecal occult blood testing (FOBT) and colonoscopy including: uptake and outcomes of FOBT, colonoscopic performance, findings, histological data and complications. Continuous data were compared using a two-tailed test of two proportions.

Setting The South of Tyne and Tees Bowel Cancer Screening centres.

Patients Participants of the BCSP.

Main Outcome Measures 1) Colonoscopy Quality Assurance and 2) Cancer stage shift.

Results 195,772 individuals were invited to participate. Uptake was 54% and FOBT positivity 1.7%. 1524 underwent colonoscopy with caecal intubation in 1485 (97%). 180 (12%) cancers were detected. Dukes stages were: 76 (42%) A; 47 (26%) B; 47 (26%) C; 8 (4%) D and 2 (1%) unknown. This demonstrates a significantly earlier stage at diagnosis compared with data from 2867 non-screening detected cancers ($p < 0.001$). Adenomas were detected in 758 (50%). One perforation occurred (0.07%) and two intermediate bleeds requiring transfusion only (0.12%). Both caecal intubation and adenoma detection were significantly

higher than in the UK pilot study ($p < 0.001$).

Conclusions The prevalent round of screening demonstrates a high adenoma and cancer detection rate and significantly earlier stage at diagnosis. Complications were few providing reassurance regarding safety. Efforts are required to improve uptake.

Introduction

Bowel cancer is a common disease in the UK and is the second commonest cause of cancer death.^{1,2} Most patients present when symptomatic. This is associated with a more advanced cancer stage and reduced success of treatment.³ The NHS Bowel Cancer Screening Programme (BCSP) is the third national cancer screening programme to be introduced in England. The primary aim is to reduce bowel cancer mortality by detecting cancers at an earlier stage. A secondary aim is to detect and remove premalignant colorectal adenomas, potentially reducing bowel cancer incidence.

The BCSP is based on a strategy of biennial faecal occult blood testing (FOBT). The efficacy of population-based FOBT has been demonstrated in randomised controlled trials that report reductions in bowel cancer mortality ranging from 13% to 21%.⁴⁻⁶ The first round of the UK pilot study of bowel cancer screening (BCS) was undertaken between March 2000 and May 2003.⁷ FOBT was undertaken using a

Table 1 Classification of FOBt results

	Criteria	Action
Normal	No positive windows	Discharge to next screening round
Unclear	1–4 positive windows	Patient given up to two further kits If either subsequent FOBt is unclear or abnormal, patient is referred for colonoscopy. These are classified as a weak positive result If both subsequent FOBt kits are normal, discharge to next screening round
Abnormal	5–6 positive windows	Patient referred for colonoscopy
Technical failure or spoilt kit	Lab processing problem or unreadable kit due to incorrect use	Further FOBt kit sent

FOBt, faecal occult blood testing.

non-rehydrated guaiac-based Hema-screen test offered to 50–69-year-old adults. Uptake was 57% overall (59% in England). The overall positivity rate was 1.9% with 19% having a strongly positive FOBt on initial screen and 81% positive after repeat testing. Colonoscopy uptake rate was 81.5%. Of individuals who underwent colonoscopy, 13% were diagnosed with bowel cancer: 48% Dukes' A or within polyp; 25% Dukes' B; 26% Dukes' C; 1% disseminated malignancy. Adenomatous polyps were detected in 34% of the individuals.

As a result of the pilot, the NHS BCSP for England commenced roll-out in 2006 with full population coverage completed in England in 2010. The BCSP invites all individuals aged 60–69 years (expanded to the age of 74 years in January 2010) to participate in FOBt every 2 years. The administration of FOBt kits is undertaken by five hubs located throughout England. Potential participants are identified from centrally held electronic general practice records. Individuals receive a letter inviting them to participate and unless they decline they are sent a FOBt kit. Information on bowel cancer, the BCSP and instructions for kit completion are included.

A non-rehydrated guaiac based FOBt (Hema-screen; Immunostics, Ocean, New Jersey, USA) is used. Individuals are required to complete six windows on each FOBt kit, two for each of three consecutive stools. The kit should be mailed to the hub in a WHO-approved postage paid envelope provided within 14 days of the first sample. No dietary restriction is required. Results are classified as shown in table 1.

Individuals with a positive FOBt are invited to a clinic appointment with a trained bowel cancer specialist screening practitioner (SSP). During this appointment, a description of the colonoscopy procedure and information on the risks and benefits are given to allow individuals to decide whether to continue in the programme.

The South of Tyne and Tees BCS centres are two first wave centres in the North East of England that

commenced screening in February 2007 and completed the prevalent round 2 years later. Neither of the centres were part of the UK pilot study. The two centres also belong to the Northern Region Endoscopy Group, a network committed to collaborative endoscopy-related research. We report the results from the prevalent round of screening in these centres and compare the results with those from the UK pilot study.⁷

Methods

Data were collected prospectively by SSPs for all individuals undergoing a FOBt in both the centres. All individuals undergoing subsequent lower gastrointestinal investigation had further data collected at the clinic appointment and during the colonoscopy procedure. These included data on the uptake and outcomes of FOBt, colonoscopic performance, findings at colonoscopy and histological data. Information was recorded securely both locally and on a dedicated national database.

Bowel preparation consisted of a combination of two sachets of sodium picosulphate (Picolax; Ferring, West Drayton, UK) and 4–6 tablets of senna. The administration schedule varied depending on the time of colonoscopy. Individuals were required to take a low-residue diet and no dairy products for the 2 days preceding the procedure and to take clear fluids only from 14:00 the day before. Detailed counselling as to the importance of good quality bowel preparation and advice regarding how this was best achieved was given at their clinic appointment.

All screening colonoscopies were performed by BCSP-accredited colonoscopists. For accreditation, colonoscopists must have a lifetime experience of at least 1000 colonoscopies with a caecal intubation rate of $\geq 90\%$ and an adenoma detection rate (ADR) of $\geq 20\%$ in the preceding 12 months. Sedation levels must have been in keeping with the National Patient Safety Agency guidance and complication rate has to be declared and deemed acceptable. The accreditation process involves completion of an examination comprising a multiple-choice question exam and two directly observed colonoscopic procedures by two independent examiners. Each BCSP colonoscopic procedure was given a time slot of 45 min.

Histological examination of polyps and other endoscopic specimens were undertaken at three histopathology laboratories accredited by Clinical Pathology Accreditation (UK) Ltd in accordance with BCSP guidelines. Pathological examination of surgically resected tumours was completed using the RCPATH dataset.⁸

Complications were prospectively recorded. These were classified as minor, intermediate and major in accordance with the recently published BCS guidelines,⁹ modified from the American Society for Gastrointestinal Endoscopy classification.¹⁰

The results of all procedures performed within the BCSP in the prevalent round were analysed, which

Table 2 Procedure time, withdrawal time, sedation dose, ADR and comfort score by colonoscopist in the prevalent round of screening

Endoscopist	Mean procedure time (min)	Mean CWT (min)	Median sedation dose			ADR (%)	Median comfort score
			Midazolam (mg)	Fentanyl (µg)	Pethidine (mg)		
A	29.0	9.3	2	NA	25	49	2
B	25.7	7.2	2	NA	25	53	1
C	29.4	9.7	4	NA	50	57	1
D	31.2	9.0	2	NA	25	51	2
E	22.0	7.5	2	50	NA	54	1
F	20.2	7.6	2	50	NA	42	1
G	26.2	8.3	2	50	NA	63	1

ADR, adenoma detection rate; CWT, colonoscopy withdrawal time; NA, not applicable.

Table 3 Stage of cancer diagnosed with comparable data from non-screening population

Stage	BCSP	Non-screening population*	p Value
Dukes' A [†]	76 (42%)	394 (13%)	p<0.001
Dukes' B	47 (26%)	1021 (36%)	p=0.010
Dukes' C	47 (26%)	912 (32%)	p=0.010
Dukes' D	8 (4%)	540 (19%)	p<0.001
No staging	2 (1%)	–	

*Mills S, personal communication, 2010.

[†]Includes polyp cancers.

BCSP, Bowel Cancer Screening Programme.

included surveillance colonoscopies performed within this period. The mean procedure times for each colonoscopist were calculated for all the procedures. To ensure that colonoscopy withdrawal times (CWTs) reflected only diagnostic mucosal inspection time (ie, not reflecting time for therapeutic procedures), these were calculated from completed normal colonoscopies only. ADR was defined as the percentage of individuals in whom one or more histologically confirmed adenomas were detected. Comfort was assessed by SSPs using the modified Gloucester comfort score.⁹

The Dukes stages at diagnosis of BCSP-detected cancers were compared with cancers diagnosed in the non-screening population from the Northern Region Colorectal Cancer Audit Group database (Mills S, personal communication, 2010). Continuous data were compared using a two-tailed test of two proportions. A p value of <0.05 was considered significant. Data were analysed using Stata (V.10; Statcorp, College Station, Texas, USA).

Results

The South of Tyne and Tees BCS centres serve a combined population of approximately 1 500 000 of which approximately 10% fall within screening age. In the 2-year prevalent round, 195 772 individuals were invited to participate with an uptake of 54%. A total of 1553 individuals were aged over 70 years and opted in to screening. FOBt positivity rate was 1.7%,

Table 4 Haggitt stages of pedunculated polyp cancers and methods of management

Haggitt level	Number of polyps	Endoscopic resection	Surgical resection
1	5	5	0
2	7	7	0
3	9	4	5

comprising 18.9% with abnormal results and 81.1% with weak positive results. Of the 1668 patients assessed for colonoscopy, 1665 were assessed at SSP clinics and 3 by telephone following referral from another screening centre. Of those assessed, 1524 individuals (91%) underwent colonoscopy; 93 individuals declined colonoscopy and 51 individuals were not offered colonoscopy because they were either already part of an adenoma surveillance programme or were currently under investigation for gastrointestinal symptoms and extensive co-morbidities.

Colonoscopies were undertaken by seven accredited colonoscopists. The procedure was completed to the caecum (demonstrated by photograph) in 97% (1485/1524) of cases. Reasons for failure were obstructing cancer (20.5%), patient discomfort (35.9%), poor bowel preparation (35.9%), tortuous bowel (5.1%) and a tight rectosigmoid angulation (2.6%).

The mean procedure time was 26.2 min (range of means 20.2–31.2 min) and mean CWT was 8.4 min (range of mean CWTs 7.2–9.7 min). Median sedation dose was 2 mg midazolam (range 2–4 mg) and median analgesia dose was 25 mg pethidine (range 25–50 mg) or 50 µg fentanyl (only 50 µg dose used). The ADR was 50% (range 42–63%). Bowel preparation was rated as excellent in 64%, adequate in 33% and inadequate in 3% of the procedures. Results for the individual colonoscopists are summarised in table 2.

Bowel cancer was detected in 180 individuals (12%). Complete histological and clinical staging was available for 178 (99%). Complete staging was not performed in two individuals as they were not considered fit for further treatment. These results were compared with the stage at diagnosis of 2867 non-screening detected

Table 5 Kikuchi stages of flat polyps cancers and methods of management

Kikuchi level	Number of polyps	Endoscopic resection	Surgical resection
1	2	1	1
2	4	4	0
3	0	0	0

cancers (table 3). All cancers were managed through local multi-disciplinary team meetings.

Of the Dukes' A cancers, 32 were polyp cancers of which 21 were pedunculated and 11 were flat. The respective Haggitt (for pedunculated polyps) and Kikuchi (for flat polyps) stages along with the methods of management are shown in tables 4 and 5. There were five polyps that were ungraded of which three were managed surgically and two endoscopically.

Adenomas were detected in 50% (range 1–16 adenomas per individual). They were risk stratified and managed according to British Society of Gastroenterology surveillance guidelines.¹¹ One hundred and sixty-six individuals were high risk, 317 were intermediate risk and 275 were low risk. This resulted in surveillance colonoscopies being arranged for 166 individuals at 12 months and for 317 individuals at 36 months. Low risk individuals do not undergo surveillance and are discharged to the next round of FOBt screening.

Three hundred and fifty-three colonoscopies were reported as normal and 233 abnormal not polyps. These abnormal results included a range of diagnoses such as inflammatory bowel disease, severe diverticular disease and angiodysplasia.

Complications

One perforation occurred (0.07%) following removal of a 40 mm pedunculated polyp at the splenic flexure which was removed by hot snare and tattooed. The polyp would have been a Dukes' B adenocarcinoma on histology if perforation had not occurred. The patient was managed surgically. There were two intermediate severity bleeding adverse events (0.12%). One occurred immediately after removal of a 15 mm pedunculated polyp in the sigmoid colon, which was removed by hot snare. The bleeding was controlled successfully by the placement of two endoclips. The second event was a delayed bleed in an individual in whom six polyps had been removed varying from 2 to 25 mm in size. Both individuals required blood transfusion but were otherwise managed conservatively without the need for further endoscopic, radiological or surgical intervention. There were no other unplanned admissions, episodes of over sedation or unforeseen adverse events.

Results of uptake, colonoscopy performance, adenoma and cancer detection and complications from the South of Tyne and Tees centres compared with those from the UK pilot study are shown in table 6.

Table 6 Comparison of colonoscopy performance and complications between the South of Tyne and Tees and UK Pilot Study

	South of Tyne and Tees	Pilot study	p Value
Uptake	54%	57%	–
Caecal intubation rate	1491/1524 (98%)	3700/4116 (90%)	p<0.001
Adenomas	758/1524 (50%)	1388/4116 (34%)	p<0.001
Cancers	180/1524 (12%)	552/4116 (13%)	p=0.112
Perforation	1/1524 (0.07%)	2/4116 (0.05%)	p=0.806
Bleeding and abdominal pain	2/1524 (0.12%)	23/4116 (0.56%)*	p=0.032

*Includes both immediate and delayed bleeding or abdominal pain.

Discussion

The uptake of FOBt in these two centres was 54%. This is lower than the UK pilot study. The South of Tyne and Tees centres serve populations with some of the UK's highest levels of socioeconomic deprivation. Uptake of all forms of screening is lower among deprived populations.¹²

The FOBt positivity rate of 1.7% compares with 1.9% for the pilot study. The uptake of colonoscopy following positive FOB result was 92% compared with 82% in the pilot study. This may reflect a change in the population's attitude towards colonoscopy since the pilot study conducted 10 years ago. The opportunity for a detailed discussion regarding bowel cancer and colonoscopy in a supportive environment at the screening clinic may also account for the high colonoscopy acceptance rate. We agree that there may be an unconscious tendency to persuade individuals to undergo colonoscopy if no contraindications exist. The uptake of BCS in the pilot study and in our centres is lower than for breast (75%)¹³ or cervical screening (80%)¹⁴ highlighting the need for development of strategies to increase population uptake.

In the two centres considered in this study, colonoscopy completion rate was 98%. All colonoscopists achieved standards well above the minimum standard of 90% set by the BCSP and were significantly higher than the results achieved within the pilot study. This indicates the high standard of colonoscopy expertise in these centres. Another contributing factor may be the scheduling of BCSP colonoscopy lists allowing plenty of time for thorough examination of the colon.

The cancer detection rate of 12% in this study was comparable with that in the pilot study. A significant shift in the stage of cancer diagnosed is demonstrated with 68% of cancers diagnosed as Dukes' A, B or polyp cancers as compared with only 49% of cancers diagnosed in the same geographical region in the non-screening population.

The ADR of 50% is significantly higher than the pilot study figure of 34%. Several factors may have influenced this. The BCSP provides a prolonged time

What is known on this subject?

The UK pilot study demonstrated that bowel cancer screening was effective in detecting earlier stage bowel cancer.

What this study adds?

We demonstrate that the results of the pilot study can not only be replicated during general roll out, but can be improved upon whilst maintaining safety.

How might it impact on clinical practice in the foreseeable future?

These results provide reassurance that roll out of bowel cancer screening delivers a high quality and safe service. We should aim to continue and where possible improve the quality of service delivered in bowel cancer screening and additionally look to reproduce these standards in non screening services.

period (45 min per procedure) as well as high levels of colonoscopy expertise ensuring maximal mucosal visualisation. Bowel preparation was good within the screening environment with detailed counselling regarding its importance at the screening clinic contributing to this. In addition there are high standards of endoscopic equipment. The high adenoma detection levels may also reflect the fact that the individuals screened in these centres come from areas of high socioeconomic deprivation. Obesity, insulin resistance and cigarette smoking have been shown to be risk factors for colorectal adenomas,¹⁵ the rates of which are higher among the socioeconomically deprived¹⁶ and may therefore contribute.

The high detection rates of adenomas and polyp cancers mean that many screening colonoscopies involve polypectomy. This is commonly for multiple polyps or large or complex lesions. This again supports the necessity of adequate time to be available to undertake these procedures and the high standards of practice for colonoscopists.

Significant numbers of surveillance colonoscopies were generated, 483 of the 1524 colonoscopies (32%) generated a minimum of two further colonoscopy procedures. Despite this additional workload there has been no adverse effect on colonoscopy waiting times for the symptomatic population in these centres achieved by hard work to ensure targets are met as a priority with occasional need for support between trusts. Resource implications of this workload need constant review.

A low complication rate (perforation 0.07%, bleeding 0.12%) is comparable with other series.^{17–20} Given the therapeutic nature of screening colonoscopies, the complication rates are low. These data are again likely to reflect the high standards of colonoscopy set for the BCSP examination and the ongoing high standards of quality assurance within the programme.

Conclusions

Experience of the prevalent round of BCS in these two centres has demonstrated high adenoma and cancer detection rates. Screening has resulted in a stage shift in comparison with the non-screening population with more of the cancers being polyp cancers or early treatable cancers. The high adenoma detection rate generates a significant workload with 32% of procedures generating the need for at least two further colonoscopies. Caecal intubation rates of 98% associated with a perforation rate of 0.07% and bleeding rates of 0.2% suggest a high level of colonoscopy expertise with significant reassurance about procedure safety. The findings demonstrate the high standards from the UK pilot study are not only reproducible but can be improved upon in national rollout.

Uptake of BCS is lower than that for the other cancer screening programmes. The success of the programme is demonstrated and further efforts to improve population uptake are required.

Correction notice This article has been corrected since it was published Online First. The author name G Hanley has been amended to G Handley. This sentence has been amended: 'non-screening detected cancers ($p < 0.001$).'

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Competing interests None.

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References

1. Cancer Research UK. CancerStats Key Facts on Bowel Cancer 2006. <http://info.cancerresearchuk.org/cancerstats/types/bowel/?a=5441> (accessed 15 Jul 2011).
2. Office of Population Censuses and Surveys. Mortality Statistics by Cause: England and Wales 1992. Series DH2, no 20. London: HM Stationery Office, 1995.
3. NBOCAP. National Bowel Cancer Audit 2009. http://www.acpgbi.org.uk/assets/documents/National_Bowel_Cancer_Audit_2009_Interactive_for_web.pdf (accessed 20 Jun 2011).
4. Hardcastle JD, Chamberlain JO, Robinson MH, *et al.* Randomised controlled trial of faecal-occult-blood screening for colorectal cancer. *Lancet* 1996;348:1472–7.
5. Kronborg O, Jørgensen OD, Fenger C, *et al.* Randomized study of biennial screening with a faecal occult blood test: results after nine screening rounds. *Scand J Gastroenterol* 2004;39:846–51.
6. Mandel JS, Church TR, Ederer F, *et al.* Colorectal cancer mortality: effectiveness of biennial screening for fecal occult blood. *J Natl Cancer Inst* 1999;91:434–7.
7. UK Colorectal Cancer Screening Pilot Group. Results of the first round of a demonstration pilot of screening for colorectal cancer in the United Kingdom. *BMJ* 2004;329:133. <http://www.bmj.com/cgi/content/abstract/329/7458/133> (accessed 20 Jun 2011).
8. The Royal College of Pathologists. Standards and Datasets for Reporting Cancers: Dataset for Colorectal Cancer (Second edition). London: The Royal College of Pathologists, 2007. <http://www.rcpath.org/resources/pdf/G049-ColorectalDataset-Sep07.pdf> (accessed 22 Mar 2011).

9. NHS Bowel Cancer Screening Programme. Quality Assurance Guidelines for Colonoscopy, 2010. <http://www.cancerscreening.nhs.uk/bowel/publications/nhsbcsp06.html> (accessed 15 Jul 2011).
10. Cotton PB, Eisen GM, Aabakken L, *et al.* A lexicon for endoscopic adverse events: report of an ASGE workshop. *Gastrointest Endosc* 2010;71:446–54.
11. Atkin WS, Saunders BP. Surveillance guidelines after removal of colorectal adenomatous polyps. *Gut* 2002;51(Suppl 5):V6–9.
12. Maheswaran R, Pearson T, Jordan H, *et al.* Socioeconomic deprivation, travel distance, location of service, and uptake of breast cancer screening in North Derbyshire, UK. *J Epidemiol Community Health* 2006;60:208–12.
13. NHS Breast Screening Annual Review 2009. <http://www.cancerscreening.nhs.uk/breastscreen/publications/nhsbsp-annualreview2009.pdf> (accessed 25 Mar 2011).
14. NHS Cervical Screening Annual Review 2009. <http://www.cancerscreening.nhs.uk/cervical/publications/cervical-annual-review-2009.pdf>
15. Stafford M, Brunner EJ, Head J, *et al.* Deprivation and the development of obesity a multilevel, longitudinal study in England. *Am J Prev Med* 2010;39:130–9.
16. Laaksonen M, Rahkonen O, Karvonen S, *et al.* Socioeconomic status and smoking: analysing inequalities with multiple indicators. *Eur J Public Health* 2005;15:262–9.
17. Rabeneck L, Paszat LF, Hilsden RJ, *et al.* Bleeding and perforation after outpatient colonoscopy and their risk factors in usual clinical practice. *Gastroenterology* 2008;135:1899–1906, 1906.e1.
18. Iqbal CW, Chun YS, Farley DR. Colonoscopic perforations: a retrospective review. *J Gastrointest Surg* 2005;9:1229–35: discussion 1236.
19. Rosen L, Bub DS, Reed JF 3rd, *et al.* Hemorrhage following colonoscopic polypectomy. *Dis Colon Rectum* 1993;36:1126–31.
20. Nelson DB, McQuaid KR, Bond JH, *et al.* Procedural success and complications of large-scale screening colonoscopy. *Gastrointest Endosc* 2002;55:307–14.