ORIGINAL ARTICLE

The national colonoscopy audit: a nationwide assessment of the quality and safety of colonoscopy in the UK

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ABSTRACT

Objective To perform a comprehensive audit of all colonoscopy undertaken in the UK over a 2-week period.

Design Multi-centre survey. All adult (≥16 years of age) colonoscopies that took place in participating National Health Service hospitals between 28 February 2011 and 11 March 2011 were included.

Results Data on 20 085 colonoscopies and 2681 colonoscopists were collected from 302 units. A validation exercise indicated that data were collected on over 94% of all procedures performed nationally. The unadjusted caecal intubation rate (CIR) was 92.3%. When adjusted for impassable strictures and poor bowel preparation the CIR was 95.8%. The polyp detection rate was 32.1%. The polyp detection rate for larger polyps (≥10mm diameter) was 11.7%. 92.3% of resected polyps were retrieved. 90.2% of procedures achieved acceptable levels of patient comfort. A total of eight perforations and 52 significant haemorrhages were reported. Eight patients underwent surgery as a consequence of a complication.

Conclusions This is the first national audit of colonoscopy that has successfully captured the majority of adult colonoscopies performed across an entire nation during a defined time period. The data confirm that there has been a significant improvement in the performance of colonoscopy in the UK since the last study reported seven years ago (CIR 76.9%) and that performance is above the required national standards.

Significance of this study

What is already known on this subject?
- Colonoscopy is important in the diagnosis and therapy of colonic disease.
- Performance of colonoscopy in the UK was poor when last surveyed in 1999.
- Investment has been made in quality improvement and training with the aim of improving performance.

What are the new findings?
- It is possible to perform a nationwide snapshot of colonoscopy practice.
- Performance is much improved from 1999 and largely meets the British Society of Gastroenterology standards.
- It is possible to improve performance across a nation.
- It is challenging to capture late complications after a colonoscopy.

How might it impact on clinical practice in the foreseeable future?
- Current standards and performance criteria need to be adjusted.
- Photo-documentation of caecal intubation should form part of normal practice.
- The frequency of uncomfortable colonoscopy should be reduced.
- The quality of bowel preparation should be improved.
- The use of alternative methods to identify and record major adverse events following colonoscopy should be considered.

INTRODUCTION

Colonoscopy is the gold standard investigation for the colon.[1–3] It provides a non-surgical means of removing polyps from the colon. Removal of polyps has been shown to reduce the subsequent risk of colorectal cancer.[4–6] Colonoscopy can be a challenging procedure to perform and it is associated with infrequent but serious complications.[7–15] There are documented quality indicators for colonoscopy.[16–18] Poor quality colonoscopy may have significant consequences such as missed cancer and perforation. Postcolonoscopy colorectal cancer rates vary significantly.[1–3 19 20] There is also evidence that colonoscopy fails to protect against right sided colorectal cancer in some populations and protects incompletely in others, suggesting significant differences in quality.[21 22]

In 1999, a large survey of colonoscopy performed in three regions of the UK demonstrated poor performance with low caecal intubation rates.[8] The study identified that many colonoscopists had received inadequate training. In response, the UK government provided funding to support and improve endoscopy training, and implement a quality improvement programme. At the core of the improvement strategy was the introduction of a web-based self-assessment tool for endoscopy units called the Endoscopy Global Rating Scale (GRS).[23] A major catalyst for change was the implementation of the National Bowel Cancer Screening Programme (BCSP), which required

a quality assurance framework and incorporated a formal accreditation test for participating colonoscopists.[24]

The quality of endoscopy services and training is overseen by the Joint Advisory Group on Gastrointestinal Endoscopy (JAG), a multi-professional stakeholder group established under the auspices of the Academy of Medical Royal Colleges. While the JAG has a remit for the entire UK, the rate of adoption of change within the four nations of the UK (England, Wales, Scotland and Northern Ireland) is influenced by differences in the commissioning and delivery of healthcare in each country. It is estimated that 90% of colonoscopy in the UK takes place in National Health Service (NHS) facilities.

The aim was to perform a comprehensive audit of adult colonoscopy occurring in the NHS throughout the UK over a 2-week period. The purpose of the audit was to determine the quality and safety of contemporary colonoscopy, to assess the level of activity and to determine whether there are differences in performance between the four countries of the UK.

METHODS

Overview

The objectives of the audit were to:

- Map and register all NHS endoscopy units performing ≥100 colonoscopies annually.
- Identify and register all colonoscopists performing colonoscopy independently in these units.
- Collect key performance data for all colonoscopies performed on adults (≥16 years of age) in these units over a fixed period, aiming for data on >18 000 procedures.

A specific website was created at http://www.endoaudit.com to enable communication with colonoscopists and endoscopy units and to provide a means of data collection.

A steering group (the authors) guided the development of the project and website, and managed the progress of the audit. It was not considered necessary to seek ethical approval for this study because no patient or operator identifiable information was collected.

A regional leadership structure was created in each of the 10 regions in England and the three other UK nations to assist with the audit process. Each region was allocated a medical, surgical and at least one trainee lead.

Identification of endoscopy units

Three methods were used to identify units performing ≥100 colonoscopies annually in the NHS: units participating in the annual GRS census; the Hospital Episode Statistics (HES) database for England and Wales; and local knowledge, through the regional leadership structure.

Data collection

The dataset to be collected was agreed following consultation with the Endoscopy Committees of the British Society of Gastroenterology (BSG) and the Association of Coloproctology of Great Britain and Ireland, representing the majority of physician and surgeon colonoscopists.

The website was open for 10 weeks prior to the audit period to enable units to familiarise themselves with the audit process. This preparation phase provided an opportunity for endoscopy staff and endoscopists to provide feedback allowing it to be modified prior to the actual audit.

The audit took place in two phases.

Phase 1

All endoscopy units registered information about their facility and all colonoscopists practising independently there. A nominated Unit Lead was responsible for the audit process. Unit registration required information on the size of the population served, activity levels in the previous 12 months and the number of procedure rooms.

Only independently practising colonoscopists were registered. An independently practising colonoscopist was defined as one practising colonoscopy independently and without supervision; this includes senior accredited trainees. Registration was anonymous. Details of specialty, grade, experience level, exposure to training and participation in the BCSP were collected.

During this phase, each unit was required to perform a pilot audit, to familiarise staff with the audit process and to test the method of data collection.

Phase 2

The second phase was the main audit data collection. The aim was to collect as full a dataset as possible. It was expected that participation and completeness would reduce if the data collection process continued for too long. Thus, the 2-week period was a compromise between desirability and achievability. The aim was to obtain double the volume of data of the Bowles study (ie, >18 000 procedures). Review of historical HES data (and assuming 90% data capture) indicated a 2-week data collection would provide this. A 2-week period in February/March 2011 was chosen to avoid school and national holidays and major educational meetings. The nursing team was responsible for collection of the key performance indicators at the time of colonoscopy on a datasheet specifically designed for the purpose. Nurses were utilised for data recording to reduce the risk of selective reporting. Units were encouraged to upload data to the website as soon as possible. No patient identifying information was recorded.

Key performance indicators

The key performance indicators included all those used in the previous study.[8]

In the UK, an 'unadjusted' rate is used for the caecal intubation standard (CIR intention to examine). To enable comparisons with other reports that exclude incomplete procedures due to impassable strictures or inadequate bowel preparation, the reason for incomplete colonoscopy was recorded allowing subsequent adjustments to be made.

Prior to indicating which landmark was used to confirm completion, the endoscopist and nurse had to agree that the procedure was complete to the caecum. There were four options available for confirmation of completion, in descending order of reliability:

- terminal ileal intubation (or neo-terminal ileal visualisation)
- visualisation of the Ileo-caecal valve (ICV)
- visualisation of the appendiceal orifice/tri-radiate fold
- unsatisfactory confirmation.

Unsatisfactory confirmation methods included finger indentation of the right iliac fossa and transillumination in the right iliac fossa.

As data were collected at the time of colonoscopy, it was not possible to capture adenoma detection, and thus polyp detection was used as a surrogate. Small sessile polyps in the rectum were not to be reported in the data collection. To provide an estimate of the proportion of 'significant' polyps (≥10 mm diameter), the size of the largest polyp was recorded. The polyp size was estimated clinically at the time of colonoscopy. The retrieval rate of excised polyps was recorded. The principle indication for the procedure and the main diagnosis were recorded.

The common modalities used for sedation in the UK were recorded: no sedation, on demand nitrous oxide, conscious sedation (including specific drugs and doses), deep sedation with propofol and general anaesthesia.

The BCSP quality of bowel preparation scale was used: excellent, adequate and poor.[24]

A key auditable outcome for UK endoscopic practice is an assessment of patient comfort.[17] In this study, patient comfort was recorded using the Gloucester comfort scale (box 1). This is a nurse-assessed measure of comfort, with a defined 5-point scale.

Immediate complications were captured prior to discharge from the endoscopy unit. In order to assess the impact of complications, further information about the consequences of the complication was collected: discharged, returned to ward with no unplanned care (for inpatient procedures), unplanned admission or unplanned care, and death. A significant haemorrhage was defined as any haemorrhage requiring endoscopic therapy to achieve haemostasis or any haemorrhage requiring medical review or admission. Significant abdominal pain was defined as any abdominal pain that required medical review or delayed the discharge of a patient by more than 1 h.

Engagement and communication

The regional leadership structure was utilised to maximise engagement and to facilitate communication with the service. Unit leads, as identified from the GRS census, were contacted electronically. In addition, communications were sent to all BSG and Association of Coloproctology of Great Britain and Ireland members via their respective e-newsletters, informing them of the audit and the website address.

Monitoring of the audit

To facilitate monitoring of the audit process, an electronic, web-based 'dashboard' was created. This displayed a real-time indication of data entry by units (colour-coded according to completeness). This enabled the steering group and regional leads to identify and encourage units that were not performing optimally. There were target deadlines for each stage of the process.

Validation

An endoscopy reporting system (ERS) provides the most reliable source of data, both of activity and performance, against which audit data can be compared. This is because the ERS generates reports for the patient and their records, as well as storing performance data generated from the report inputs. A 10% sample (n=29) of participating units was randomly selected to submit activity and CIR data recorded on their ERS for comparison with that uploaded to the audit website. There was further validation for another 20 units using a commercially available ERS (Ascribe-Scorpio).

To further validate the activity data in England, comparison was made with HES data for the year 2010/2011.

There was direct communication with units reporting haemorrhages and perforations to confirm the occurrence of the complication and collect details of subsequent outcome. Validation of each event occurred locally within the unit where the complication occurred, thus maintaining confidentiality. The severity of the validated adverse events was graded using a recognised scale.[25]

Box 1 Gloucester comfort score with definitions

1. Comfortable: Talking/comfortable throughout
2. Minimal: One or two episodes of mild discomfort without distress
3. Mild: More than two episodes of mild discomfort without distress
4. Moderate: Significant discomfort experienced several times with some distress
5. Severe: Frequent discomfort with significant distress

Statistics

Binomial proportion CIs were calculated for key performance indicators. The Wilson Score Interval was utilised to calculate the CIs.

RESULTS

Endoscopy units and colonoscopy activity

The audit identified 302 endoscopy units performing >100 colonoscopies/year on NHS patients and 2681 colonoscopists. Performance data were captured on 20 085 colonoscopies performed in these units throughout the UK during the 2-week audit (28 February 2011 to 11 March 2011). Table 1 summarises these data and shows significant variations in activity levels between the nations of the UK during the audit period, ranging from 23.3 to 46.8 procedures per 100 000 of population.

Participation, data completeness and validation

Table 1 confirms a very high level of engagement and participation. All the units identified, engaged and registered to participate in the audit. No units refused to participate. All the identified units completed the audit.

In all, 47 sites (15.6% of the total) submitted validation data on 3648 procedures (18.2% of the total). From this validation exercise, it is estimated that 94.1% of colonoscopy activity was captured.

HES data indicate that 428 632 colonoscopies were performed in England in the year 2010/11. There are 260 working days in the year of which eight are statutory holidays leaving 252 working days. The HES activity equates to 1701 procedures per working day or 17 010 procedures for the 10 working days of the audit period. Data were uploaded on 16 043 colonoscopies in England during the audit, indicating 94.3% of activity was captured.

Indication for colonoscopy and diagnosis

Table 2 illustrates the relationship between primary indication and primary diagnosis. Overall, 65.4% of procedures were performed for diagnostic purposes, 9.7% of procedures occurred within the respective BCSPs and 17.7% of procedures were for surveillance. Colorectal cancer was the principle diagnosis in 4.1% of procedures and polyps in 27.5%; 41.8% of procedures were normal.

Key performance indicators

Table 3 summarises the key performance data. Results from the 1999 study are included for comparison.

The UK unadjusted CIR was 92.3%. Unadjusted completion rates achieved the BSG target of 90% in all nations with the exception of Wales, which was just below (89.8%). Analysis of validated CIR data shows that 29.8% of units achieved a higher CIR than was reported in the audit; 36.2% of units reported an

Table 1 Colonoscopy activity levels and site participation by nation

	UK	England	Northern Ireland	Scotland	Wales
Colonoscopies	20 085	16 043	780	2564	698
Population	62 400 000	52 000 000	1 900 000	5 500 000	3 000 000
Rate/100 000	32.2	30.9	41.1	46.8	23.3
Sites identified	302	236	17	31	18
Sites registration complete	302	236	17	31	18
Sites participated in Phase II	302	236	17	31	18
Colonoscopists	2681	2163	99	290	129

identical CIR and 34% a lower CIR. In only two of the 47 sites was the discrepancy in CIR >5%.

To enable comparison of this data with previously published international series, adjusted rates of procedure completeness are included. The UK adjusted CIR was 95.8%.

Caecal intubation was confirmed by ileal intubation in 39.0% of procedures (giving an overall ileal intubation rate of 35.6%), visualisation of the ICV in 52.1% and visualisation of the appendix orifice or tri-radiate fold in 8.2%. Caecal intubation was claimed but not satisfactorily confirmed in 0.6%. Caecal intubation was confirmed by photography in 50.2% of cases.

There is variation in unadjusted CIR between endoscopy units (figure 1), though some of this variation can be attributed to sample size. In all, 37 units (12.3%) were outside the 95% CI for an unadjusted caecal intubation rate of 90%; 29 units (9.8%) above the CI; and 8 units (2.7%) below. There is no evidence that units with small throughput perform poorly.

The reasons for incomplete colonoscopy are shown in table 4. Pain or uncontrolled looping of the colonoscope is the most common cause of failure. A stricture was the reason in 403 procedures (25.9%), of which 270 had a diagnosis of cancer (177), diverticular disease (71) or IBD (22). Poor bowel preparation was the reason in 22.2%.

Polyp detection rates (PDR) exceed the current UK standard of 15%.[17] The overall PDR for the UK is 32.1%. The standard was exceeded in all countries and by all professional groups. In all, 11.7% of patients had larger polyps, ≥1 cm in diameter; 92.3% of resected polyps were retrieved for histological examination.

Sedation practice is presented in table 3. The majority of procedures (88.9%) were performed under conscious sedation and >10% of procedures were performed with no sedation. Nitrous oxide was used in 8.4% of procedures as the sole agent in 4.2% or as an adjunct to conscious sedation. In all, <1% of procedures were performed using either deep propofol sedation or general anaesthesia. The majority of patients experienced acceptable levels of comfort between 1 and 3 on the Gloucester Scale.

An opiate and midazolam were the most popular drug combination. Pethidine is the most commonly used opiate (56%), followed by fentanyl (35%). The dosages used complied with BSG guidelines in >90% of cases.[26] Reversal agents were used in 0.1% of procedures.

Physicians and surgeons performed the majority of procedures (table 5). Nurse colonoscopists performed 11% of procedures and independently practising trainees 4%. Non-independently practising trainees performed 27% of procedures under the supervision of an independent colonoscopist. In total, 6366 procedures (31.6% of the total) involved trainees, either as independent colonoscopists or as part of their training. All groups performed well, with unadjusted CIR exceeding the national standard of 90%.

Table 6 summarises safety data. In total, there were 29 admissions or episodes of unplanned care (0.14% or 1:693) for any reason following colonoscopy. A total of eight perforations were reported (0.04% or 1:2511 procedures), of which seven were reviewed. Five occurred during diagnostic colonoscopy and two following polypectomy. Perforations occurred in two patients with inflammatory bowel disease and in one with diverticulosis. All seven underwent surgery and were subsequently discharged from hospital. Fifty-two haemorrhages (0.26% or 1:386 procedures) were reported and 50 were reviewed. Most haemorrhages (39) were self-limiting or controlled endoscopically and the patient was discharged without need for admission. Eleven were admitted, of whom three received a blood transfusion and one underwent surgery. Eight of the 57 validated complications were defined as severe.[25] There were no deaths associated with these complications.

One death was reported, occurring after an uncomplicated, day-case colonoscopy. The patient presented 2 days later as an emergency with vomiting and abdominal pain. He died following aspiration of vomitus due to small bowel obstruction. A coroner's postmortem identified the cause of death as an incarcerated incisional hernia and concluded the death was unrelated to the colonoscopy.

Table 2 Indications for colonoscopy and subsequent diagnoses

	Total		Diagnostic		Therapeutic		BCSP		Screening		Surveillance	
	n	%	n	%	n	%	n	%	n	%	n	%
Total	20 085		13 128		656		1944		799		3558	
Normal	8400	41.8	6089	46.4	62	9.5	519	26.7	349	43.7	1381	38.8
Cancer	822	4.1	596	4.5	25	3.8	108	5.6	28	3.5	65	1.8
Polyp	5525	27.5	2661	20.3	490	74.7	1012	52.1	274	34.3	1088	30.6
IBD	1445	7.2	749	5.7	21	3.2	29	1.5	35	4.4	611	17.2
Diverticulosis	2741	13.6	2163	16.5	28	4.3	193	9.9	85	10.6	272	7.6
Other	1152	5.7	870	6.6	30	4.6	83	4.3	28	3.5	141	4.0

BCSP, National Bowel Cancer Screening Programme; IBD, inflammatory bowel disease; Screening, high risk asymptomatic groups excluding BCSP; Surveillance, follow-up procedures with previously diagnosed colonic pathology.

Table 3 Key performance indicators with data from the previous audit for comparison

	Bowles 1999	UK 2011	England	Northern Ireland	Scotland	Wales
Procedures	9223	20 085	16 043	780	2564	698
Caecal intubation rate (CIR) (95% CI)	76.9%	92.3% (91.9 to 92.6)	92.6% (92.2 to 93.0)	91.5% (89.4 to 93.3)	91.1% (90.0 to 92.5)	89.8% (87.4 to 91.9)
Adjusted CIR		95.8%	96.1%	95.6%	94.7%	94.1%
Polyp detection rate (95% CI)	22.5%	32.1% (31.4 to 32.7)	32.3% (31.6 to 33.1)	30.9% (30.4 to 37.3)	30.2% (28.5 to 32.0)	35.4% (31.9 to 39.0)
Procedures with polyps ≥1 cm		11.7%	12.1%	7.4%	10.7%	12.0%
Polyp retrieval rate		92.3%	92.1%	94.7%	93.0%	91.3%
No sedation		10.7%	11.2%	13.8%	4.3%	18.1%
General anaesthetic (GA)/propofol		0.4%	0.3%	2.4%	0.3%	0.6%
Conscious sedation	94.6%	88.9%	88.5%	83.7%	95.4%	81.4%
Nitrous oxide		8.4%	9.7%	7.2%	1.4%	6.0%
Comfort score ≥4		9.8%	9.5%	6.9%	12.1%	13.3%
Excellent or adequate prep		88.2%	88.6%	87.8%	85.9%	88.4%

DISCUSSION

This audit, undertaken between 28 February 2011 and 11 March 2011, has demonstrated an improvement in the quality of colonoscopy in the UK when compared with the previous study undertaken in 1999.[8] The performance data reported from this audit are comparable with other series in the literature.[9 12 15 27–34] This audit is the first attempt to capture all colonoscopy activity in a defined period across an entire, large (60 million inhabitants) nation. It is estimated, on the basis of the validation sample, that 94.1% of all activity during the audit period was captured. In addition, validation of CIR indicates the reported rate is accurate with no evidence of selective exclusion of data. This audit confirms that it is possible to achieve large-scale clinical datasets, without the bias inherent in reporting single-centre data, or possible bias due to incomplete data collection or a case mix skewed by screening cases.

The universal participation in this audit demonstrates a widespread commitment to high quality and safe colonoscopy, a desire for improvement and an ability to engage in a large audit project. It is important to note that this audit differs from the previous study in several ways and thus direct comparison should be interpreted with care. Notably, the previous study was regional, included independent sector and paediatric practice, and no attempt was made to validate the accuracy or completeness of data.

It is only possible to speculate on which factors have contributed to the substantial improvement in performance. It seems unlikely that this change would have occurred without the nationally driven interventions of training and quality improvement. The audit has identified small variations between nations and professional groups and these differences may provide clues to what has impacted on performance.

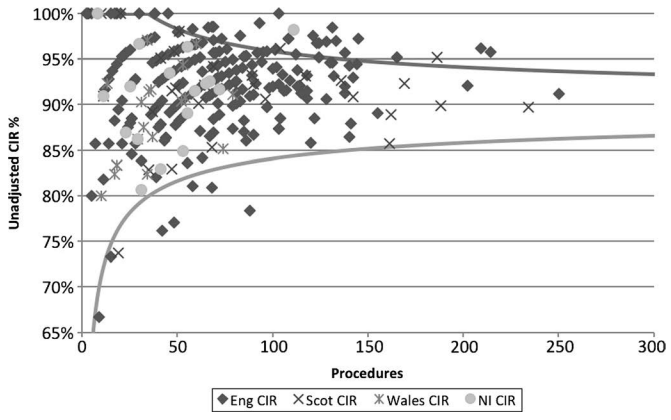

Figure 1 Funnel plot of unit performance with 95% CI for an unadjusted caecal intubation rate (CIR) of 90%. Eng, England; NI, Northern Ireland; Scot, Scotland.

The best performance is observed in England. England has provided a lead in quality improvement and training. All acute sites have been self-assessing and reporting their GRS to JAG biannually for 7 years and 90% of units have been through a peer review assessment. Scotland, Wales and Northern Ireland have been self-assessing with the GRS, but for a shorter period than England and only Northern Ireland has been subject to peer-reviewed JAG accreditation.

There have been differences in the delivery and uptake of colonoscopy training. England (largely through greater funding) has had a more structured and thorough approach to the delivery of hands-on colonoscopy skills training for both trainees and trainers. An assessment of the quality of training is part of the GRS peer-review process; therefore, the English training units have been more exposed to the rigours of peer-review.

This is not the first study to report improvements in performance over time. The utilisation of the audit cycle with appropriate interventions is associated with improvement in colonoscopy performance; this has been demonstrated in two single-centre studies.[35 36] Similarly, the specific intervention of measuring and subsequently increasing colonoscope withdrawal time is associated with increased rates of detecting small adenomas.[37]

All professional groups undertaking colonoscopy performed well, with unadjusted CIRs above the national standard. Performance is best in the physician group, with surgeons performing slightly less well. Table 5 confirms that surgeons encounter more impassable strictures. However, the main difference in performance between surgeons and physicians is the number of procedures incomplete due to pain or uncontrolled loops. While there is increasing participation of surgeons in national training courses and training locally, their involvement as trainees or trainers is still less than physicians. Surgeons also tend to perform less colonoscopy because of their other contract commitments. These factors may impact on their performance as a group. Differences in case mix can explain variation in performance; however, the factors that are known to impact on performance (age, gender and the presence of diverticular disease) were explored and no significant difference in case mix was identified.[38 39] The performance of nurse endoscopists meets national standards and the frequency of uncomfortable colonoscopy is less than physicians and surgeons.

Table 4 Reasons for incomplete procedures

	UK	England	Northern Ireland	Scotland	Wales
Incomplete procedures	1553	1188	66	228	71
Pain or uncontrolled loops (%)	763 (49.0)	570 (47.9)	31 (47.0)	125 (54.8)	37 (52.1)
Stricture or obstruction (%)	403 (25.9)	318 (26.7)	23 (34.8)	48 (21.1)	14 (19.7)
Poor bowel preparation (%)	345 (22.2)	268 (22.5)	10 (15.2)	49 (21.5)	18 (25.4)
Cardiorespiratory instability (%)	24 (1.5)	18 (1.5)	2 (3.0)	3 (1.3)	1 (1.4)
Severe colitis/IBD (%)	16 (1.0)	12 (1.0)	0 (0)	3 (1.3)	1 (1.4)
Equipment failure (%)	2 (0.1)	2 (0.1)	0 (0)	0 (0)	0 (0)

IBD, inflammatory bowel disease.

It is difficult to comment in detail on the performance of staff grade and associate specialist doctors and general practitioners due to the relatively small sample size.

In this study, PDRs were used as a key performance indicator because it was not considered possible to capture adenoma detection rates. It is recognised that polyp detection is an inferior indicator to adenoma detection: adenomas are clearly linked to colorectal cancer and non-adenomatous polyps of <1 cm will, except in special situations such as hyperplastic polyp syndromes, not be clinically significant. However, adenoma detection rates are still just a proxy for adequate visualisation of the mucosa, and for miss rates for colorectal cancer. In this study, we used polyp detection as a proxy for adequate visualisation on the basis that PDRs are predictive of adenoma detection[40] and the size of polyps as a proxy for missed cancer on the basis that polyps >1 cm (regardless of histology) are regarded to have prognostic significance for cancer.

In the UK, a standard was set for polyp detection rather than adenoma detection because it was recognised that most services would find it difficult to measure adenoma detection. There was a stated aspiration in the BSG colonoscopy quality indicators to move to adenoma detection when data base linkage improved. The rate was set at a low level of 15% because there was no standard for the wide variation in case mix when the standard was set. In the current study, PDRs (32.1%) exceed the current UK standard by a large margin.[17] If only 60% of those patients with polyps had an adenoma, then the adenoma detection rate in this study would be 20% (the threshold that predicted differences in rates of postcolonoscopy colorectal cancer in a Polish study).[41] The rate of detection of polyps ≥1 cm in diameter (11.7%) is in line with that reported in the literature.[22 27 31]

It is clear from this study that the UK standard for polyp detection needs to be changed, at least to 20%, and possibly higher. In time, there need to be standards for different case mixes (as there are currently for screened patients). Finally, the time has come to require services to collect adenoma detection rates; despite the difficulties of data linkages, it is no longer acceptable to rely on polyp detection as a proxy for adenoma detection. Other series from institutions and programmes (including all the UK BCSPs) are able to report adenoma rates and so there is no reason why this should not be possible for every unit in the UK.[15 31 41–44]

The majority of procedures were performed under conscious sedation. The most frequently used combination was an opiate with a short-acting benzodiazepine. In the UK, standards have been set for conscious sedation with midazolam, pethidine and fentanyl.[26] These were designed to reduce oversedation and its potential consequences. Guideline doses for sedation were exceeded in <10% of procedures. The majority of these were older patients receiving pethidine at a dose greater than recommended. The use of reversal agents (naloxone or flumazenil), which may be considered a surrogate marker of significant over sedation, occurred in 0.1% of procedures. These findings suggest that current conscious sedation practice is safe.

The comfort of a procedure is an important part of the patient experience. The EU Guidelines on Quality Assurance of Colorectal Cancer Screening recommend that patient comfort should be an auditable outcome of colonoscopy.[45] Assessing patient comfort is a key requirement of the GRS.[23] Few other series report patient experience measures. In Norway, the importance of assessment of comfort has been recognised and included in the Gastronet quality assurance programme.[46] This audit demonstrates that it is possible to capture a measure of patient comfort and to provide comfortable and complete colonoscopy for the majority of patients with relatively low levels of sedation. At present, there are no validated scales for assessing patient comfort in the context of colonoscopy. A patient assessment of comfort was not used, as sedative drugs may affect patients' perception and recollection of discomfort. The

Table 5 Performance by specialty (95% CI in brackets)

	Physician	Surgeon	Nurse	SAS	GP
Procedures	10 690	6003	2287	713	257
Caecal intubation rate (CIR)	93.5% (93.1–94.0)	90.2% (89.3–90.8)	91.3% (90.0–92.3)	93.3% (91.2–94.9)	94.9% (91.5–97.0)
Adjusted CIR	96.6% (96.2–97.0)	95.4% (94.8–95.9)	95.5% (94.6–96.3)	96.7% (95.0–97.8)	96.8% (93.9–98.4)
Incomplete: pain or uncontrolled loops	3.0% (2.7–3.4)	5.1% (4.6–5.7)	4.3% (3.5–5.2)	3.5% (2.4–5.1)	1.6% (0.6–3.9)
Incomplete: stricture or obstruction	1.7% (1.5–2.0)	2.7% (2.3–3.1)	2.0% (1.5–2.7)	0.6% (0.2–1.4)	0.8% (0.2–2.8)
Incomplete: poor bowel preparation	1.6% (1.3–1.8)	1.7% (1.4–2.0)	2.3% (1.7–3.0)	2.7% (1.7–4.1)	2.3% (1.1–5.0)
Polyp detection rate	33.5% (32.6–34.4)	31.9% (30.7–33.2)	30.0% (28.1–31.9)	23.3% (20.3–26.5)	30.0% (24.7–35.8)
Comfort score ≥4	9.0%	11.9%	8.7%	10.0%	8.2%
<70 Years, pethidine >50 mg	0.3%	0.4%	0.0%	0.6%	0.0%
≥70 Years, pethidine >25 mg	3.3%	7.0%	3.0%	3.7%	6.1%
<70 Years, midazolam >5.0 mg	0.7%	0.9%	0.4%	0.8%	0.9%

SAS, associate specialist or staff grade; GP, general practitioner or family doctor.

Table 6 Complications with adverse event severity assessment of validated complications

	n (validated)	Rate (%) (95% CI)	Admissions or unplanned care	AE severity			Discharge	Mean LOS
				Mild	Moderate	Severe		
Abdominal pain	124	0.62 (0.52 to 0.74)	8					
Bleeding	52 (50)	0.26 (0.2 to 0.36)	11	47	2	1	11	1.7
Perforation	8 (7)	0.04 (0.02 to 0.08)	7	0	0	7	7	9.1
Cardiorespiratory	4	0.02 (0.01 to 0.05)	1					
Reversal agent use	20	0.10 (0.06 to 0.15)	2					

AE, adverse event; LOS, length of hospital stay in days.

Gloucester Scale (box 1) was chosen as it is based on a nurse assessment of three components of the patient experience: severity of pain, frequency of painful episodes and any associated distress. Different hospitals use different scales in their daily practice, and lack of familiarity with the Gloucester Scale might have affected comfort assessments. However, the scale is simple and clearly defined and all units had the opportunity to become familiar with the scale during the pilot study.

The improvement in completion rates has not been achieved at the expense of patient safety. Complications occurred in a total of 215 procedures. Eight perforations and 52 significant haemorrhages occurred. Of these, eight required surgery. The majority of haemorrhages were managed endoscopically without a need for admission. In total, there were 29 episodes of admission or unplanned inpatient care resulting from colonoscopy during the audit period. There were no deaths related to these complications. One death was reported following an uncomplicated colonoscopy. It is well recognised that adverse events become apparent after the patient leaves the endoscopy unit. Endoscopy units were asked to identify and review all cases of unplanned admission within 8 days of a procedure and all deaths within 30 days of procedure to capture late events. However, despite these processes being a requirement of the GRS the dataset is too incomplete to draw unbiased conclusions and is not presented in the current report. The JAG accreditation process ensures 8- and 30-day reviews are taking place according to GRS recommendations. However, the UK needs to learn from other nations that have created national reporting systems for adverse events such as the Dutch nationwide online complication registry for all endoscopic procedures.[47]

Despite the change in performance there remains room for further improvement. The 10% incidence of level 4 or 5 (moderate or severe discomfort) on the comfort scale indicates that an unacceptable proportion of patients are experiencing significant distress during their colonoscopy. There is likely to be room for improved technique and optimising sedation for some patients. A 10% rate of poor bowel preparation is also unacceptable. Poor bowel preparation will increase the chance of missing lesions, lead to more incomplete procedures (22% of incomplete procedures in this study were due to poor bowel preparation) and therefore more repeat procedures.[48 49]

In this study, nurses were requested to confirm completion of the procedure with the endoscopist and subsequently completion rates were validated against data in ERSs. Despite its shortcomings, it is now widely accepted that there should be photographic documentation of procedure completeness.[50] In the EU Guidelines on Quality Assurance of Colorectal Cancer Screening it is recommended: 'There should be auditable photo documentation of completion, preferably a panoramic image of the ileo-caecal valve and caecum, or a video clip with a respective snapshot'.[45] In this study, only 50.2% of complete procedures had photographic documentation. This is well below rates reported in other series and is clearly an area in need of improvement for UK colonoscopists.[15 34]

It is estimated that 6% of colonoscopy activity was not captured and it is possible there was selective reporting with omission of data when performance was suboptimal. In order to prevent this happening, nurses were charged with data collection and encouraged to reach agreement with the colonoscopists about whether the procedure was complete. To examine whether there had been selective reporting a validation exercise was undertaken. This used data (from the same period) from the ERS (the legally-binding record) of a randomly selected sample of sites and compared it with the audit data. This did not identify any differences in reported rates of CIR; therefore, selective reporting of CIR is considered to be unlikely. Despite the results of the validation exercise, it still remains possible that poor performance was selectively excluded. The caecal intubation rate of the 6% of procedures not captured by the audit would have to be 54% for the overall CIR to drop from 92.3% to the standard of 90%. It is concluded that systematic selective reporting, enough to materially invalidate the overall CIR, is highly unlikely to have occurred.

Colonoscopies performed in units with very low activity levels (<100 annually) may have been missed, though low volume sites tend to be satellites of larger sites and thus would have been captured. Keeping the data collection process simple and quick impacted on the level of detail it was possible to record, particularly the recording of histological diagnoses. The fact that only the principle diagnosis could be recorded will result in an underestimation of some diagnoses, as demonstrated by the discrepancy between PDR and a diagnosis of polyps. The incidence of complications relating to colonoscopy in the current report will be underestimated because late complications and outcomes are not included.

In summary, this is the first national audit of colonoscopy that has successfully captured the majority of adult colonoscopy performed during a defined time period. The validation exercise indicates that performance data on 94.1% of procedures were collected and that there was no detectable bias as a result of failure to report poor performance. The data suggest that there has been a significant improvement in performance in colonoscopy practice in the UK since the last study was undertaken 12 years ago and that performance is above the required national standards.[17]

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Correction notice This article has been corrected since it was published online First. The Abstract has been amended to read: All adult (≥16 years of age) colonoscopies that took place in participating National Health Service hospitals between 28 February 2011 and 11 March 2011 were included. The Discussion has been amended to read: Other series from institutions and programmes (including all the UK BCSPs) are able to report adenoma rates and so there is no reason why this should not be possible for every unit in the UK.[15 31 41–44]

Competing interests RV is a director of a medical quality improvement company, Quality Solutions for Healthcare (www.qsfh.co.uk).

Ethics approval This was an audit of current NHS colonoscopy practice. No patient or endoscopist identifying data were captured.

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