Original research

Quality in colonoscopy: time to ensure national standards are implemented?

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ABSTRACT

Background High-quality colonoscopy is crucial to ensure complete mucosal visualisation and to maximise detection of pathology. Previous audits showing variable quality have prompted national and international colonoscopy improvement programmes, including the development of quality assurance standards and key performance indicators (KPIs). The most widely used marker of mucosal visualisation is the adenoma detection rate (ADR), however, histological confirmation is required to calculate this. We explored the relationship between core colonoscopy KPIs.

Methods Data were collected from colonoscopists in eight hospitals in North East England over a 6-month period, as part of a quality improvement study. Procedural information was collected including number of colonoscopies, caecal intubation rate (CIR), ADR and polyp detection rate (PDR). Associations between KPIs and colonoscopy performance were analysed.

Results 9265 colonoscopies performed by 118 endoscopists were included. Mean ADR and PDR per endoscopist were 16.6% (range 0–36.3, SD 7.4) and 27.2% (range 0–57.5, SD 9.3), respectively. Mean number of colonoscopies conducted in 6 months was 78.5 (range 4–334, SD 61). Mean CIR was 91.2% (range 55.5–100, SD 6.6). Total number of colonoscopies and ADR>15% were significantly associated (p=0.04). Undertaking fewer colonoscopies and using hyoscine butylbromide less frequently was significantly associated with ADR<15%. CIR, endoscopist grade, % male patients, mean patient age and CIR were not significantly related to ADR<15%. In adjusted analyses, factors which affected ADR were PDR and mean patient age.

Conclusion Colonoscopists who perform fewer than the nationally stipulated minimum of 100 procedures per year had significantly lower ADRs. This study demonstrates that PDR can be used as a marker of ADR; providing age is also considered.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ High-quality colonoscopy is crucial, however, previous audits have shown variable quality.
⇒ Adenoma detection rate (ADR) is a surrogate marker of mucosal visualisation, but histological confirmation is required to confirm this.

WHAT THIS STUDY ADDS

⇒ This study demonstrates that in adjusted analyses, polyp detection rate (PDR) and mean patient age affect ADR.
⇒ Low volume colonoscopists (performing <100 procedures per year) have significantly lower ADRs.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ It may be possible to produce ADR:PDR coefficients incorporating patient age to enable less onerous calculation of ADR at the endoscopist level.
⇒ This paper highlights that low volume colonoscopists should either increase annual number of procedures or cease undertaking colonoscopy.

BACKGROUND

Colonoscopy is the gold-standard investigation for assessing the large bowel, both in the symptomatic population and, in the UK, in those with a positive faecal immunochemical test as part of the national colorectal cancer screening programmes.[1 2] In addition to allowing direct mucosal visualisation, sampling and therapeutic interventions such as polypectomy, can be undertaken. High-quality colonoscopy is crucial to ensure

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patient safety and to maximise pathology detection. A previous audit of English colonoscopy practice demonstrated significant variation in quality across the country.[3] Studies such as this have prompted quality improvement programmes and the development of key performance indicators (KPIs).[1 4 5]

High-quality colonoscopy requires thorough mucosal inspection of the entire colon. The caecal intubation rate (CIR), defined as the proportion of procedures where the tip of the colonoscope is passed into the caecum (or terminal ileum), is the KPI used to assess completeness of the procedure. The British Society of Gastroenterology (BSG), Association of Coloproctology of Great Britain and Ireland and Joint Advisory Group on Gastrointestinal Endoscopy (JAG) recommend a CIR of 90%, with an aspirational target of 95%.[1] The European Society of Gastrointestinal Endoscopy and American Society for Gastrointestinal Endoscopy similarly advocate a minimum CIR of 90%.[5 6]

Adenoma detection rate (ADR, defined as the proportion of procedures where at least one adenoma is found, expressed as a percentage) is the most commonly used surrogate marker of colonic mucosal inspection.[1] Colonoscopists with lower ADRs have significantly higher rates of postcolonoscopy colorectal cancers (PCCRC) and worse outcomes.[7–9] The minimum ADR defined within the BSG standards is 15% with an aspirational target of 20%.[1] The calculation of ADR requires histology results, which are not always readily available at the time of the procedure, making ADR calculation for audit, quality assurance purposes or performance monitoring a sometimes arduous process requiring the interrogation of multiple different systems.[10]

Polyp detection rate (PDR, defined as the proportion of procedures where one or more polyps are detected, expressed as a percentage) has some benefits over ADR in that it can be calculated by simply interrogating the endoscopy reporting system. In view of this, a number of units calculate PDR rather than ADR. The use of PDR instead of ADR is deemed to be acceptable providing that the ratio between an endoscopist's PDR and ADR has been measured and validated.[1]

In the UK, a certification process governed by JAG exists to ensure that trainees in endoscopy have reached a minimum standard of competence before they can commence independent practice.[11] Prospective colonoscopists must attain certain criteria in order to achieve certification, including a total minimum lifetime number of 280 procedures and minimum CIR of 90%.[12] In order to maintain competence, it is recommended that an endoscopist performs a minimum of 100 colonoscopies per annum.[1] It has been show that CIR falls below the desired level (90%) when less than 100 procedures are performed per annum.[13]

The purpose of monitoring KPIs is to audit colonoscopy practice at a unit and individual colonoscopist level and ensure that high-quality colonoscopy is being delivered.[14] This process facilitates the identification of colonoscopists who fall short of the minimum standards, creating an opportunity to provide support or address specific areas of practice. Guidance on managing and supporting such colonoscopists has been published elsewhere.[15 16]

The aim of this study was to explore the relationship between core KPIs for colonoscopy.

METHODS

Procedural information, including number of colonoscopies performed, CIR, ADR, PDR and PDR excluding rectal hyperplastic polyps, was collected from 153 endoscopists in 8 hospitals in the North East of England.[17] Sessile serrated lesions were included as adenomas if they were histologically reported as having a dysplastic element. These data were collected as part of a quality improvement study. Other data items collected included colonoscopist grade, mean patient age, percentage of male patients and hyoscine butylbromide use. Data were collected using electronic endoscopy reporting systems supplemented by interrogation of histopathology reporting systems to allow calculation of ADR.

Data from NHS Bowel Cancer Screening Programme (BCSP) colonoscopists were excluded from this work because it was not feasible to easily differentiate BCSP procedures from symptomatic procedures performed by these colonoscopists.

Trainee endoscopists (n=29), endoscopists with unknown clinical roles (n=2) and 1 individual who had been recorded twice in the dataset due to performing colonoscopies in two locations were removed from analysis. The final dataset comprised aggregated procedure data for 118 individuals undertaking colonoscopy.

Statistical analysis

The associations between the following KPIs were tested pairwise using χ^2 tests: ≥50 colonoscopies in 6 months (which would equate to≥100 procedures in a year); CIR≥90% and ADR≥15%.

To identify which KPIs and other factors (PDR, patient characteristics, unit, colonoscopist grade) are predictors of ADR, multiple linear regression analysis was used. Then, multiple logistic regression was used to examine associations between these variables and low ADR specifically (<15%).

To investigate the relationship between ADR and PDR further, the ADR:PDR ratio (APDRQ) per endoscopist and Pearson correlations between ADR and PDR were computed, including and excluding rectal hyperplastic polyps.

The associations between predictor variables and the outcome of interest in both the linear and logistic regression models were first analysed using univariable regression. The variables which were statistically

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Table 1 Summary information for unit, colonoscopists and patients

Characteristic	Outcome
Unit	No of colonoscopists (%)
A	19 (16.10)
B	10 (8.47)
C	17 (14.41)
D	25 (21.19)
E	20 (16.95)
F	11 (9.32)
G	8 (6.78)
H	8 (6.78)
Colonoscopist grade	No (%)
Gastroenterologist	46 (38.98)
Nurse endoscopist	20 (16.95)
Surgeon	52 (44.07)
Patient age, mean (SD)	60.08 (4.14)
Percentage of male patients, mean (SD)	45.78 (10.27)
Hyoscine butylbromide use, mean (SD)	45.78 (31.92)

Table 2 ADR, PDR, APDRQ, total colonoscopies, CIR and colonoscopy KPIs

Characteristic	Outcome
ADR	Mean % (SD)
All patients	16.62 (7.37)
Patients aged ≥60 years	17.4 (7.4)
Patient aged <60 years	15.5 (7.2)
PDR	Mean % (SD)
All patients	27.2 (9.3)
Patients aged≥60 years	27.7 (9.5)
Patients aged<60 years	26.5 (8.9)
APDRQ	Mean (SD)
All patients	0.60 (0.21)
RHPs excluded, mean (SD)	0.64 (0.21)
Total colonoscopies, mean (SD)	78.5 (61.0)
CIR, mean (SD)	91.2 (6.6)
KPIs	N (%)
≥15% ADR	72 (61.0)
≥90% CIR	77 (65.3)
≥50 total colonoscopies	75 (63.6)
Met all 3 of above KPIs	34 (28.8)

ADR, adenoma detection rate; APDRQ, ADR:PDR ratio; CIR, caecal intubation rate; KPIs, key performance indicators; PDR, polyp detection rate; RHP, rectal hyperplastic polyps.

significant ($p<0.05$) were included in the final models. Model fit was assessed, and homoscedasticity, multicollinearity, influence indicators and distance measures were checked. Data were analysed using STATA V.16.

RESULTS

A total of 9265 colonoscopies performed by 118 endoscopists from 8 units in a 6-month period were included (table 1). 39% of colonoscopists were medical gastroenterologists, 17% were nurse endoscopists and 44% were surgeons. Mean patient age was 60 years, 46% of patients were male and hyoscine butylbromide was used in 46% of procedures.

Colonoscopy quality

The mean number of colonoscopies conducted in 6 months was 78.5 (range 4–334, SD 61.0), and the mean CIR was 91.2% (range 55.5–100, SD 6.6) (table 2). Overall, 61% of colonoscopists achieved an ADR≥15%, 65% had CIR≥90% and 64% performed≥50 colonoscopies in 6 months. Almost one-third (29%) of endoscopists met all 3 KPIs.

Over one-third (36%) of colonoscopists performed <50 colonoscopies in 6 months. The mean number of procedures performed by this group was 27.6 (SD 12.5) compared with 107.7 (58.5) performed by those who performed ≥50 procedures (table 3). The mean ADR and CIR were lower in the group that completed <50 compared with ≥50 procedures (ADR: 18.5, SD 6.19 vs 13.2, SD 8.1; CIR: 92.5, SD 4.17 vs 89.0, SD 9.6).

Colonoscopists who performed ≥50 colonoscopies in 6 months were more likely to achieve both the ADR and CIR KPIs. Of those who performed ≥50 colonoscopies, 68% and 69% met ADR and CIR performance metrics. Of those who performed <50 colonoscopies, only half (49%) had an ADR of≥15%, and 58% attained a CIR of ≥90%. In this group, 33% met both KPIs for ADR and CIR, compared with 45% of those who completed ≥50 colonoscopies. Completing ≥50 colonoscopies and achieving an ADR of ≥15% were significantly associated ($p=0.040$). However, performing ≥50 colonoscopies and achieving a CIR≥90% were not associated ($p=0.219$); neither were a CIR≥90% and an ADR≥15% ($p=0.687$).

Factors associated with low ADR

In multiple regression analyses of factors associated with low ADR (<15%), there were significant associations at the colonoscopist level with those undertaking fewer colonoscopies (OR 0.99, 95% CIs 0.98 to 1.00) and with less frequent use of hyoscine butylbromide (OR 0.98, 95% CIs 0.97 to 0.99). Unit where procedures were undertaken, lower CIR, endoscopist grade, percentage of male patients and mean patient age were not significantly related to ADR<15% after adjusting for total number of colonoscopies and hyoscine butylbromide use (table 4).

ADR and PDR

The mean ADR and PDR were 16.6% (range 0–36.3, SD 7.4) and 27.2% (range 0–57.5, SD 9.3), respectively (table 2). Endoscopists colonoscoping patients with a mean age of 60 years or greater had a higher mean ADR than those colonoscoping patients with a mean age of younger than 60 years (≥60 years: 17.4%, SD 7.4; <60 years: 15.5%, SD 7.2). A similar

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Table 3 Colonoscopy performance and KPIs

KPI	Colonoscopy performance	
	Performed ≥50 procedures in 6 months (n=75 colonoscopists)	Performed <50 procedures in 6 months (n=43 colonoscopists)
Total colonoscopies, mean (SD)	107.69 (58.54)	27.60 (12.5)
ADR, mean (SD)	18.56 (6.19)	13.20 (8.1)
CIR, mean (SD)	92.45 (4.17)	89.0 (9.6)
≥15% ADR, N (%)	51.00 (68.0)	21.00 (48.8)
≥90% CIR, N (%)	52.00 (69.3)	25.00 (58.1)
Met both ADR and CIR KPIs, N (%)	34.00 (45.3)	14.00 (32.6)

ADR, adenoma detection rate; CIR, caecal intubation rate; KPI, key performance indicator.

trend was seen for PDR (mean patient age <60 years: 26.5%, SD 8.9; ≥60 years: 27.7%, SD 9.5).

ADR and PDR were strongly correlated (r=0.75, p<0.001 overall; r=0.80, p<0.001 after excluding rectal hyperplastic polyps). The mean APDRQ was 0.60 (range 0–1.00, SD 0.21), and increased to 0.64 (range 0–1.17, SD 0.21) when rectal hyperplastic polyps were excluded (table 2).

Factors found to predict ADR in unadjusted regression models were PDR, colonoscopist grade, patient mean age, total colonoscopies in a 6-month period, CIR and hyoscine butylbromide use (all p<0.05, table 4). In the adjusted analysis the factors that statistically significantly predicted ADR were PDR and the mean age of patients.

DISCUSSION

High-quality colonoscopy is essential in order to ensure good patient outcomes. High-quality colonoscopy should involve completion to the caecum (CIR) and good visualisation of the mucosa (measured by ADR) as a bare minimum. Historically, much of the emphasis on colonoscopy quality measures has focused on completion rates, however, it is the association between low ADR and PCCRC that is clear.[7 8] Endoscopists with low detection rates are more likely to miss lesions and thus put their patients at risk of developing PCCRCs.

This study demonstrates that colonoscopists who undertake less than 50 colonoscopies (low volume colonoscopists) in a 6-month period (UK standards advice >100 per year) have lower CIRs and ADRs than those performing >50 per 6 months. Low colonoscopy numbers were significantly associated with ADR independently but not with CIR alone. Previous literature has often focused on the association between CIR and number of procedures but less so on ADR. There is evidence for a learning curve effect with CIR and procedural numbers however the evidence for correlation between procedural numbers and ADR is more limited.[18] The current study shows a very clear correlation between procedural numbers and ADR though other studies have shown conflicting results.[19–23]

Minimal standards for colonoscopy have been set in the UK and more widely in Europe.[5] The data published demonstrate that significant numbers of colonoscopists fail to meet these quality standards with a small number falling well below the standards. This is reflected in the current study where only 61% of colonoscopists achieved an ADR≥15%, 65% a CIR≥90% and 64% a total of ≥50 colonoscopies in 6 months, with less than one-third of colonoscopists meeting all 3 KPIs. Frameworks for managing underperformance have been published. These include a number of steps—verifying the accuracy of data, identifying potential causative factors, providing support and then reassessment.[15 24] This framework should be applied to these colonoscopists. The cause for underperformance in this setting suggests strongly that doing low numbers of colonoscopies is a major issue. The association between case volume and outcome is recognised in other fields of medicine and is not solely an issue with colonoscopy. In surgery, it has been shown that as case volume increases, postoperative adverse events reduce and long-term outcomes are better.[25 26] Minimum numbers for surgical procedures have been recommended both internationally and in the UK.[27 28] In the UK, for example, it is recommended that surgeons managing oesophageal and gastric cancer should perform at least 20 oesophageal and gastric resections annually and surgeons performing major resection for rectal cancer should perform at least 5 per year.[29 30]

There are a number of measures which may improve ADR including but not limited to training, improving the quality of colonoscopes, using antispasmodics, patient position change, use of mechanical aids, scheduling of lists.[14] However, the obvious remediable factor here is to ensure that those colonoscopists performing low numbers do more procedures. If this is not possible then those individuals should be encouraged to cease performing colonoscopy.

Ensuring that KPIs are easily measurable, without the need for cross-system interrogation, is useful in allowing widespread monitoring of quality measures. Although deemed the most accepted marker of thorough mucosal visualisation, ADR requires individual

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Table 4 Regression models of associations between colonoscopist and patient factors and ADR and ADR performance metric (<15%)

	ADR*				ADR <15%†			
	Unadjusted analysis		Adjusted analysis		Unadjusted analysis		Adjusted analysis	
Predictor variable	Coefficient	P value	Coefficient	P value	OR	P value	OR	P value
	0.40 (–0.26, 1.05)	0.236			0.86 (0.71, 1.03)	0.108		
Unit								
A	ref	ref			ref	ref		
B	–3.58 (–8.96, 1.80)	0.190			3.60 (0.60, 21.6)	0.161		
C	4.60 (0.00, 9.20)	0.050			**0.19 (0.04, 0.90)**	**0.036**		
D	3.64 (-0.55, 7.83)	0.088			0.60 (0.18, 2.00)	0.406		
E	6.61 (2.19, 11.0)	**0.004**			0.30 (0.08, 1.16)	0.082		
F	0.19 (–5.03, 5.41)	0.943			0.51 (0.11, 2.36)	0.392		
G	0.15 (–5.65, 5.96)	0.958			0.90 (0.17, 4.70)	0.901		
H	2.21 (–3.59, 8.02)	0.452			0.30 (0.05, 1.89)	0.199		
Colonoscopist grade								
Consultant gastroenterologist	ref	ref	ref		ref	ref		
Nurse endoscopist	–2.60 (–6.46, 1.26)	0.185	–1.33 (–4.01, 1.34)	0.325	1.52 (0.51, 4.54)	0.450		
Surgeon	**–3.15 (–6.06, –0.22)**	**0.035**	–1.56 (–3.55, 0.43)	0.123	1.96 (0.85, 4.50)	0.113		
Mean patient age‡	**0.35 (0.03, 0.67)**	**0.032**	**0.26 (0.05, 0.47)**	**0.018**	0.93 (0.84, 1.02)	0.104		
Total colonoscopies§	**0.02 (0.00, 0.05)**	**0.026**	0.01 (–0.01, 0.02)	0.281	**0.99**	**0.029**	**0.99 (0.98, 1.00)**	**0.028**
CIR¶	**0.26 (0.06, 0.46)**	**0.010**	0.13 (–0.00, 0.27)	0.057	0.97 (0.91, 1.02)	0.221		
Hyoscine butylbromide use**	**0.07 (0.03, 0.11)**	**<0.001**	0.02 (0.01, 0.04)	0.314	**0.98**	**0.001**	**0.98 (0.97, 0.99)**	**0.001**
Mean number of male patients††	0.06 (-0.07, 0.19)	0.399			0.99 (0.95, 1.02)	0.493		
PDR‡‡	**0.60 (0.50, 0.69)**	**<0.001**	**0.54 (0.44, 0.64)**	**<0.001**				

Bold values indicate statistical significance.
*Treated as a continuous outcome variable.
†Binomial outcome variable.
‡Mean age of patients in years colonoscoped by colonoscopist in a 6-month time period.
§Total number of colonoscopies in a 6-month time period.
¶CIR per colonoscopist in a 6-month time period.
**Total number of procedures in which colonoscopist used hyoscine in a 6-month time period.
††Proportion of male patients colonoscoped by colonoscopist in a 6-month time period.
‡‡PDR—number of procedures where a polyp was detected per colonoscopist in a 6-month time period.
ADR, adenoma detection rate; CIR, caecal intubation rate; PDR, polyp detection rate.

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polyp histopathological confirmation. We recommend that developing a calculation to predict ADR based on PDR and mean patient age would be a useful future research avenue. Where ADR is not readily available, PDR is a useful surrogate. In our study, we note an ADR:PDR ration of 0.6, however, the SD is wide due to the nature of this grouped data and is not intended as a standardised conversion factor.

Conflicting evidence on use of hyoscine butylbromide exists. Large datasets have demonstrated a strong association with higher ADR, however, trials and meta-analyses have not supported this association.[31–34] In this study, we have demonstrated that hyoscine butylbromide use is associated with higher ADRs in routine clinical practice. However, the possibility of reverse causation should not be ignored; while this association may reflect a direct effect of the hyoscine butylbromide it may also be that higher performing colonoscopists are more likely to use this drug.

There are limitations to this analysis, most notably we did not have access to individual patient-level data, therefore, we could only categorise patient characteristics when adjusting for case-mix. Although we lacked information on patient indication for procedure, by excluding colonoscopists who worked within the BCSP, we excluded patients with an indication of a positive screening test, and in whom ADR would be expected to be substantially higher.[31 35] In terms of strengths, the study included a mix of centres and endoscopists, that is, gastroenterologists, surgeons and nurse endoscopists, all of whom undertake colonoscopy routinely in England.

CONCLUSIONS

Low volume colonoscopists (those performing <50 colonoscopies in a 6-month period) have lower ADRs. Those individuals should follow national guidance and either increase the number of procedures they are performing or cease undertaking colonoscopy. While ADR remains the most important quality marker of mucosal visualisation, PDR can be used where collection of histological data is difficult, providing mean patient age is taken into consideration.

What does this paper add to the literature?

Low colonoscopy volume is associated with worse colonoscopy quality, reaffirming that national guidance on the minimum number of procedures performed annually should be followed. Although ADR remains the most important quality marker of mucosal visualisation, PDR (in conjunction with age) can be used where collection of histological data is difficult.

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