Monitoring of colonoscopy quality indicators in an academic endoscopy facility reveals adherence to international recommendations

Stefanos Karamaroudis, Aliki Stamou, Stamatia C. Vorri, Paraskevas Gkolfakis, Vasilios Papadopoulos, Georgios Tziatzios, Aikaterini Karagouni, Panagiota Katsouli, George D. Dimitriadis, Konstantinos Triantafyllou

Hepatogastroenterology Unit, Second Department of Internal Medicine Research Institute and Diabetes Center, Attikon University General Hospital, Medical School, National and Kapodistrian University of Athens, Athens, Greece

Contributions: (I) Conception and design: K Triantafyllou, GD Dimitriadis; (II) Administrative support: K Triantafyllou; (III) Provision of study materials or patients: K Triantafyllou, GD Dimitriadis; (IV) Collection and assembly of data: S Karamaroudis, SC Vorri, A Stamou, A Karagouni, P Katsouli; (V) Data analysis and interpretation: P Gkolfakis, V Papadopoulos, G Tziatzios; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Konstantinos Triantafyllou. Associate Professor of Gastroenterology, Hepatogastroenterology Unit, Second Department of Internal Medicine Research Institute and Diabetes Center, Attikon University General Hospital, Medical School, National and Kapodistrian University of Athens, 1, Rimini Street, 124 62 Athens, Greece. Email: ktriant@med.uoa.gr.

Background: We monitor colonoscopy service quality biannually, by measuring sedation administration, colonoscopy completion, adenoma detection and early complications rates (CR). We herein present our audit results for the years 2013 and 2015.

Methods: In our endoscopy facility, five rotating senior gastroenterologists perform colonoscopies, on a daily basis. We measured the quality indicators in three cohorts: A, intention for total colonoscopy cases; B, cohort A excluding bowel obstruction cases; C, colorectal cancer (CRC) screening cases.

Results: In 2015, overall sedation administration rate (SAR) was 93.0% (91.6–94.4%), achieving our target to give conscious sedation to >90% of patients undergoing colonoscopy in all three cohorts. Colonoscopy completion rate (CCR) increased significantly (P<0.0001) from 94.8% (93.4–96.2%) to 98.1% (97.3–98.9%) in cohort B and numerically from 96.6% (94.4–98.8%) to 98.6% (97.4–99.7%) in cohort C, at the same periods. In cohort C, adenoma detection rates (ADR) were similar—27.1% (21.7–32.5%) and 27% (22.7–31.3%)—in the two periods. There were only two serious early complications: one cardiorespiratory event and one perforation in 2013 and 2015, respectively. While significant variability regarding SAR (ranging from 80% to 100%) was detected among the participating endoscopists, all but one of them constantly achieved [judged by the lower confidence interval (CI) of the quality indicator] CCRs higher than the recommended by international guidelines. On the contrary ADR was variable among endoscopists during the studied periods.

Conclusions: Although there is certain variability in endoscopists' performance, the overall colonoscopy quality indicators meet or exceed the internationally recommended standards, in our endoscopy facility.

Keywords: Colonoscopy, quality, indicators, colonoscopy completion rate (CCR), adenoma detection rate (ADR)

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Introduction

Colonoscopy is the most widely used examination for colorectal cancer (CRC) screening and follow-up. Given its ability to remove pro-malignant lesions, it has significantly reduced the incidence and the mortality of CRC (1). That being the case, a low detection rate of these lesions could increase the risk for a subsequent CRC. At the same time, variations among endoscopists in the performance of colonoscopy have been documented (2,3), indicating the need of measuring quality in colonoscopy and optimizing its effectiveness, when needed.

Several societies such as European Society of Gastrointestinal Endoscopy (ESGE), the American College of Gastroenterology (ACG), and the American Society for Gastrointestinal Endoscopy (ASGE) have proposed more than 40 quality indicators (4-6) for colonoscopy. The most widely used quality indicator for screening endoscopy, adenoma detection rate (ADR), defined as the proportion of screening colonoscopies that detect at least one adenoma has been correlated with the risk for interval cancers (2). Other important key quality indicators are cecal intubation rate (minimum standard: ≥90%), rate of adequate bowel preparation (minimum standard: ≥90%), complication rate (minimum standard: ≤0.5% for 7-day readmission rate) and withdrawal time (minimum standard: mean 6 min) (4,5). Sedation administration rate (SAR) is also used as a quality indicator since there is evidence that it correlates with higher patient satisfaction and procedural quality (7,8).

Measuring and improving lower gastrointestinal (LGI) endoscopy performance gives the opportunity for self-improvement for each endoscopist individually and for applying plans to optimize facility's service (9).

The aim of this audit was the measurement of four quality indicators—SAR, colonoscopy completion rate (CCR), ADR and early complications rate (CR)—in all colonoscopies performed in an academic endoscopy facility in Athens, Greece during 2013 and 2015.

Methods

Design and definitions

Retrospective analyses of four quality indicators—SAR, CCR, ADR and CR—in colonoscopies performed during 2013 and 2015, respectively. Data were retrieved from our facility's records.

We define SAR as the proportion of colonoscopies with intravenous sedation-analgesia administration, CCR as the proportion of colonoscopies where cecum or terminal ileum was intubated or the anastomosis after resection was reached, ADR as the proportion of colonoscopies with at least one histologically confirmed adenoma and early CR as the proportion of colonoscopies associated with complications occurring during colonoscopy or until discharge.

We used three patients' cohorts (A, B and C) in order to run separate investigations for each quality indicator in different populations. Cases with intention for total colonoscopy constituted cohort A, whereas cohort A excluding cases with bowel obstruction comprised cohort B. Cohort C included CRC screening cases (asymptomatic subjects aged 50 years or older without personal or family history of colorectal neoplasia (in case of family history of colorectal neoplasia, the age limit was lowered, accordingly) within cohort B.

Different quality indicators measurements were applied in each cohort: we assessed reasons for incomplete colonoscopy and measured SAR and CR in cohort A, we measured SAR, CR and CCR in cohort B and finally, we measured all four indicators in cohort C.

Participating endoscopists were aware of the upcoming internal evaluation. The head of the facility disclosed the results of endoscopists performance, individually. In addition, a special meeting of the staff was held to present and discuss the overall performance of the facility.

Population and procedures

The selected quality indicators are measured and recorded in all procedures that intend to visualize the whole colon at the endoscopy facility of the Hepatogastroenterology Unit of Attikon University General Hospital in Athens, Greece.

Colonoscopies were performed daily, by or under the supervision of experienced gastroenterologists. Trainee participation occurred routinely, but not always; trainees started the examination and proceeded until no further progression. A consultant took over in these cases.

Procedures were performed using Olympus CF-Q145L or CF-Q165L standard-definition white-light colonoscopes (Olympus Corporation, Tokyo, Japan) after bowel preparation with 4 L of polyethylene glycol. Bowel preparation quality was characterized as adequate (excellent/good) or inadequate (fair/poor) for the right (caecum, ascending, and transverse) and the left (descending, sigmoid, and rectum) colon, separately, using a modified Boston bowel preparation scale (BBPS) (10).

Vital signs, such as heart rate, arterial blood pressure and oxygen saturation, and level of consciousness were monitored during the examination. Supplemental oxygen was routinely delivered via nasal catheters. Intravenous conscious sedation (midazolam) and analgesia (pethidine) was administered on demand. Flumazenil and/or naloxone were used to reverse sedation/analgesia, if needed.

Endpoints

The primary endpoint of the study was the overall measurement of the four quality indicators during the studied periods.

Secondary endpoint was the measurement of individual endoscopist performance during the audited periods.

Ethical considerations

This audit being part of continuous quality improvement program required neither Institutional Review Board approval nor specific informed consent (data retrieved from patients' records were de-identified). However, patients provided standard informed consent before colonoscopy.

Statistical analysis

Continuous variables are presented as means (standard deviations) or medians (interquartile range). Binary variables are reported as percentages with corresponding 95% confidence intervals (CI) using normal approximation (Wald) test. For percentages ranging between 0–1, the Clopper-Pearson exact test was used to calculate their 95% CI. Non-parametric tests were used to detect differences, as appropriate. A P value less than 0.05 indicated a statistical significance.

Results

During the audited periods, 3,707 colonoscopies were performed in our facility. After excluding referrals for polypectomy and cases in which there was no intention for whole colon examination, 1,016 and 1,213 exams were included in the analysis for the years 2013 and 2015, respectively. These cases comprised cohort A. and their baseline characteristics are listed in *Table 1*. Trainees either initiated or performed the colonoscopy under the supervision of a senior endoscopist in 70.8% and 70.3% of the cases for the audited periods. The main indication for the procedures was symptoms evaluation for both periods; however a significant increase in the number of CRC screening cases was apparent in 2015. According to the ASA classification (11), there were significantly less cases with severe comorbidities in 2015 and according to the modified BBPS scale used in our facility, there were significantly more cases with adequate bowel preparation in 2015 as compared to 2013. The distribution of incomplete colonoscopy etiologies was similar among the two periods; however, there were significantly more complete colonoscopy cases in 2015. After excluding the cases with bowel obstruction due to tumor or severe inflammation, there remained 999 and 1,207 cases for the years 2013 and 2015 comprising cohort B. Among them there were 262 and 415 CRC screening cases (cohort C) for the same years.

Primary endpoint outcomes

Table 2 tabulates the primary endpoints outcomes according to the period of evaluation. In 2015, SAR surpassed the level of 90 in cohort A. and this rate remained over 90% in cohorts B and C, as well.

CCRs in cohorts B and C were higher than the recommended levels (90% and 95%, respectively) in both studied periods, although the lower CI of CCR in 2013 was just below 95% in cohort C. A significant increase of CCR was detected in 2015 (98.1% *vs.* 94.8%, P<0.0001) compared to 2013 only in cohort B.

ADR was similar [27.1% (21.7–32.5%) and 27% (22.7–31.3%)] in the two audited periods. When splitting ADR results according to patients gender, ADR was higher than 30% in males only in 2015 [39.4% (32.1–46.8%)], while the lower CI of the indicator did not reach this margin [33.8% (25.8–41.9%)] in 2013. For females, ADR was not constantly over 20% [20.2% (13.2–27.1%) and 18.4% (13.6–23.3%) for years 2013 and 2015, respectively].

CR was 0.1% in the two periods. There was one cardiopulmonary event reversed with ventilation and pharmacological interventions in 2013 and one surgically managed perforation in 2015. No complication occurred in cohort C. and no death occurred, as well.

Trainee involvement had no significant effect on the colonoscopy quality indicators during the two periods.

Secondary endpoint outcomes

One of the participating endoscopist was hired at the end of 2013; therefore his performance has been measured only

Table 1 Patients' characteristics

Characteristics	2013 (N=1,016)	2015 (N=1,213)	P
Male/female gender, n	511/505	581/632	ns
Mean age (SD), years	62.2 (12.9)	62.2 (12.8)	ns
ASA score category, n (%)			<0.0001
I	620 (61.0)	933 (76.9)	
II	371 (36.5)	265 (21.8)	
III	17 (1.7)	13 (1.1)	
IV	2 (0.2)	0	
Missing data	6 (0.6)	2 (0.2)	
Indication for colonoscopy, n (%)			<0.0001
Colorectal cancer screening	262 (25.8)	415 (34.2)	
Colorectal cancer surveillance	263 (25.9)	307 (25.3)	
Symptoms evaluation	491 (48.3)	491 (40.5)	
Distal colon bowel preparation, n (%)			<0.0001
Adequate	871 (85.7)	1,115 (91.9)	
Inadequate	101 (9.9)	63 (5.2)	
Missing data	44 (4.3)	35 (2.9)	
Proximal colon bowel preparation, n (%)			<0.0001
Adequate	732 (72.0)	987 (81.4)	
Inadequate	187 (18.4)	167 (13.8)	
Missing data	97 (9.5)	59 (4.9)	
Incomplete colonoscopies, n (%)	69 (6.8)	29 (2.4)	<0.0001
Etiology of incomplete colonoscopy, n (%)			ns
Inadequate bowel preparation	22 (31.9)	7 (24.1)	
Discomfort	19 (27.5)	9 (31)	
Acute colon angulations	10 (14.5)	6 (20.7)	
Bowel obstruction	17 (24.6)	6 (20.7)	
Colonoscopy associated adverse event	1* (1.4)	1** (3.4)	
Colonoscopies performed by each endoscopist, n (%)			<0.0001
1	99 (9.7)	131 (10.8)	
2	436 (42.9)	270 (22.3)	
3	359 (35.3)	266 (21.9)	
4	121 (11.9)	254 (20.9)	
5	1 (0.1)	292 (24.1)	

*, cardiorespiratory distress; **, perforation. SD, standard deviation; ns, not significant.

Table 2 Colonoscopy quality indicators during the two studied periods

Patients cohorts	SAR, % (95 % CI)		CCR, % (95% CI)		ADR, % (95% CI)		CR, % (95% CI)	
(N = patients per period)	2013	2015	2013	2015	2013	2015	2013	2015
A (N=1,016, 1,213)	89.7 (87.8–91.5)	93.0* (91.6–94.4)	–	–	–	–	0.1 (0.0–0.5)	0.1 (0.0–0.5)
B (N=999, 1,207)	90.2 (88.3–92.0)	93.1** (91.7–94.6)	94.8 (93.4–96.2)	98.1*** (97.3–98.9)	–	–	0.1 (0.0–0.6)	0.1 (0.0–0.5)
C (N=262, 415)	93.5 (90.5–96.5)	95.9 (94–97.8)	96.6 (94.4–98.8)	98.6 (97.4–99.7)	27.1 (21.7–32.5)	27 (22.7–31.3)	0 (0.0–1.4)	0 (0.0–0.9)

*, denotes significant difference (P=0.003) between the audited periods; **, denotes significant difference (P=0.008) between the audited periods; ***, denotes significant difference (P<0.0001) between the audited periods. N, number of colonoscopies; SAR, sedation administration rate; CI, confidence interval; CCR, colonoscopy completion rate; ADR, adenoma detection rate; CR, early complications rate.

for 2015. Another endoscopist performed colonoscopies only during the first half of 2013 and another one practiced colonoscopies during the last trimester of this year. All five endoscopists performed colonoscopies in 2015. Given these remarks, the number of procedure performed by endoscopist was quite variable during the first period, while it was more homogeneous in 2015 when four out of five endoscopists performed or supervised more than 200 colonoscopies each (cohort A). There was also significant (P<0.0001) variability regarding trainees' participation in senior endoscopists lists (cohort A) ranging from 53.3% to 85.8% in 2013 and from 54.9% to 85.9% in 2015.

Variability among endoscopists regarding the four quality indicators during the study periods was also evident, as shown in *Tables 3* and *4*. SAR exhibited significant variability in cohorts B (80–96%) and C (81–100%) in the two periods. This variability is attributed to one endoscopist who offers unsedated colonoscopy to almost 20% of the patients.

CCR was less variable among endoscopists in cohorts B and C. and the only endoscopist with low performance in 2013 significantly (P<0.04) improved in 2015.

ADR was highly variable among endoscopist in 2013 (ranging from 21.6% to 40%) and in 2015 (ranging from 21.1% to 37.2%). There was no difference between the endoscopists regarding ADR in males and females in 2013 (P>0.3) and in 2015 (P>0.18), respectively.

The two early complications were observed in procedures performed by two different endoscopist.

Discussion

Our audit demonstrates that overall, our Academic endoscopic facility offers high quality service regarding the endoscopic examination of the large bowel by reaching and maintaining the internationally defined standards of certain quality indicators. Nevertheless, there is some variability among individual endoscopists' performance indicating that there is still room for improvement.

ADR is considered the most important indicator, reflecting the quality level of LGI endoscopy (12,13). In our facility, the overall mean ADR remained above the proposed by ESGE and ASGE level of 25% in both audited periods.

Beyond ADR, colonoscopy completion is of paramount importance for high performers. In both audited periods, CCR in cohorts B and C was above the recommended performance targets (all examinations ≥90%, screening ≥95%) by ASGE (14). However, according to ESGE guidelines there should be no difference of the cecal

Table 3 Individual endoscopist performance in cohort B

Endoscopist (N = patients per period)	SAR, % (95% CI)		CCR, % (95% CI)		CR, % (95% CI)	
	2013	2015	2013	2015	2013	2015
1 (N=96, 130)	80.2 (72.2–88.2)	82.3 (75.7–88.9)	95.8 (91.8–99.8)	98.5 (96.3–100)	0.0 (0.0–3.8)	0.0 (0.0–2.8)
2 (N=429, 268)	92.8 (90.3–95.2)	95.1 (92.6–97.7)	96.3 (94.5–98.1)	97.4 (95.5–99.3)	0.0 (0.0–0.9)	0.4 (0.0–2.1)
3 (N=354, 265)	90.1 (87–93.2)	96.2* (93.9–98.5)	96.0 (94–98.1)	98.9 (97.6–100)	0.0 (0.0–1.0)	0.0 (0.0–1.4)
4 (N=119, 254)	89.1 (83.5–94.7)	93.7 (90.7–96.7)	85.7 (79.4–92)	98.4** (96.9–100)	0.8 (0.0–4.6)	0.0 (0.0–1.4)
5 (N=1, 290)	N/A	92.8 (89.8–95.7)	N/A	97.6 (95.8–99.4)	N/A	0.0 (0.0–1.3)

*, denotes significant difference (P=0.004) between the audited periods; **, denotes significant difference (P<0.0001) between the audited periods. SAR, sedation administration rate; CI, confidence interval; CCR, colonoscopy completion rate; ADR, adenoma detection rate; CR, early complications rate.

intubation rate among screening and routine examinations and the target standard for both should be at least 95% (4). On top of that, a recently published study from Norway that reported CCRs above 97% in all categories, concludes that CCRs were similar among screening and routine colonoscopies and suggested the use of one target standard for better adherence to the guidelines (15). Indeed, our audit showed that apart from 2013 cohort B cases our CCR exceeded 95%, overall.

Another significant audit finding was the very low early complication rate. Moreover, there was no complication in screening exams and there was need for surgical intervention in only one case.

Adequate sedation is a factor that determines patient satisfaction and may improve endoscopist's comfort during colonoscopy (16). While sedation carries low risks for cardiopulmonary events, it is a costly option and requires time, facilities and personnel to monitor patients until recovery (17). SAR in both periods and in all cohorts was constantly higher than 90%, a target proposed by the Hellenic Foundation of Gastroenterology and Nutrition (18). However, it's worthily to mention that one of the two recorded early complications was related to sedation administration.

When trying to informally compare this audit results with those previously reported for the year 2011 (9), as shown *Table 5*, overall SAR increased numerically in 2013 and significantly in 2015, as compared to that of 2011. At the same time CCR was similar in the three audited period in cohorts B and C, respectively. Although at a glance ADR is declining, when corrected to include CRC surveillance cases in order to match the definition of cohort C in 2011, it is obvious that the results are unchanged. Finally, although low in all audited periods, the rate of early complications is at least numerically lower in the current audit.

Quality indicators have advantages and disadvantages in their application in clinical practice. The major disadvantage of ADR calculation is that it requires histology. Thus, other pathology-independent indices are warranted. In this context British researchers proposed the Performance Indicator of Colonic Intubation (PICI) as an effective tool that combines CCR, patient's comfort and level of sedation (19) to better assess colonoscopy quality. While there is evidence that PICI correlates with polyp detection rate in screening colonoscopy cases, there is no evidence that it can replace ADR, yet.

Regarding the secondary study endpoint, our key finding as depicted in *Tables 3* and *4* is the endoscopists' variability, with the exception of CCRs where low (≤5%) inter endoscopists' differences were detected. Moreover, there the only low performer in 2013 significantly improved CCR in 2015. Our finding is in contrast to recent studies reporting variable CCRs among endoscopists (ranging from less than 80% to over 90%) and it seems that experience and annual procedure numbers are the most influential factors for high CCRs (20,21).

Both SAR and ADR were quite variable among participating endoscopists in our audit. A huge variability in SAR has been reported among colonoscopists: 0–63.0% of patients receiving no sedation (22) and 4.1–100% of patients undergoing sedated colonoscopy (23). Similarly, high variability among endoscopists of the same unit has also been reported regarding ADR per endoscopist ranging from 21.9% to 59.8% (22).

The major advantage of our study is the continuous measurement of our colonoscopy quality performance. Our

Table 4 Individual endoscopist performance in cohort C

Endoscopist (N = patients per period)	SAR, % (95% CI)		CCR, % (95% CI)		ADR, % (95% CI)		CR, % (95% CI)	
	2013	2015	2013	2015	2013	2015	2013	2015
1 (N=25, 43)	88 (75.3–100)	81.4 (69.8–93)	100	97.7 (93.3–100)	40 (20.8–59.2)	37.2 (22.8–51.7)	0.0 (0.0–13.7)	0.0 (0.0–8.2)
2 (N=136, 114)	95.2 (91.5–98.9)	98.2 (95.8–100)	99.2 (97.6–100)	99.1 (97.4–100)	21.6 (14.4–28.8)	25.4 (17.4–33.4)	0.0 (0.0–2.7)	0.0 (0.0–3.2)
3 (N=83, 96)	90.4 (84–96.7)	100	95.2 (90.6–99.8)	99 (96.9–100)	30.1 (20.3–40)	27.1 (18.2–36)	0.0 (0.0–4.3)	0.0 (0.0–3.8)
4 (N=29, 71)	100	94.4 (89–99.7)	86.2 (73.3–98.8)	97.2* (93.3–100)	31 (14.2–49.7)	21.1 (11.6–30.6)	0.0 (0.0–11.9)	0.0 (0.0–5.1)
5 (N=0, 91)	–	96.7 (93–100)	–	98.9 (96.8–100)	–	28.6 (19.3–37.9)	–	0.0 (0.0–4.0)

*, denotes significant difference between the audited periods (P=0.04). SAR, sedation administration rate; CI, confidence interval; CCR, colonoscopy completion rate; ADR, adenoma detection rate; CR, early complications rate.

Table 5 Comparisons to 2011

Patients cohorts (N = patients per period)	SAR, % (95% CI)			CCR, % (95% CI)			ADR, % (95% CI)			CR, % (95% CI)		
	2011	2013	2015	2011	2013	2015	2011	2013	2015	2011	2013	2015
A (N=617, 1,016, 1,213)	86.5 (83.8–89.2)	89.7 (87.8–91.5)	93.0 (91.6–94.4)	–	–	–	–	–	–	0.3 (0.0–1.2)	0.1 (0.0–0.5)	0.1 (0.0–0.5)
B (N=604, 999, 1,207)	87.6 (85–90.2)	90.2 (88.3–92.0)	93.1 (91.7–94.6)	96.4 (94.9–97.9)	94.8 (93.4–96.2)	98.1 (97.3–98.9)	–	–	–	0.3 (0.0–1.2)	0.1 (0.0–0.6)	0.1 (0.0–0.5)
C {N=234, 262 [525], 415 [722]}	88.5 (84.4–92.6)	93.5 (90.5–96.5)	95.9 (94–97.8)	98.3 (96.6–100)	96.6 [97.5] (94.4–98.8) [(96.2–98.9)]	98.6 [98.2] (97.4–99.7) [(97.2–99.2)]	35.0 (28.9–41.1)	27.1 [33.3] (21.7–32.5) [(29.3–37.4)]	27 [31] (22.7–31.3) [(27.7–34.4)]	0.9 (0.1–3.1)	0.0 (0.0–1.4)	0.0 (0.0–0.9)

Data in square brackets represent numbers including colorectal cancer (CRC) surveillance patients to match 2011 cohort C. N, number of colonoscopies; SAR, sedation administration rate; CI, confidence interval; CCR, colonoscopy completion rate; ADR, adenoma detection rate; CR, early complications rate.

study limitations are the lack of measurement of additional quality indicators, such as colonoscope withdrawal time, which is proposed as key indicator, the relatively small number of colonoscopies overall and more specifically of the CRC screening exams, the lack of adjusting the results according to the endoscopists experience and the annual number of cases per endoscopist and the single center setting.

In conclusion, our facility adheres to the international minimum standards of LGI endoscopy providing efficient screening and routine colonoscopy services. The results reveal potential targets for performance optimization, particularly in individual level.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: This audit being part of continuous quality improvement program required neither Institutional Review Board approval nor specific informed consent (data retrieved from patients' records were de-identified). However, patients provided standard informed consent before colonoscopy.

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