

Quality of colonoscopy practice: a single-center experience in Egypt

Ahmed S. Gado^a, Basel A. Ebeid^d, Aida M. Abdelmohsen^b, Tarek S. Gado^c, Anthony T. Axon^e

^aDepartment of Medicine, Bolak Eldakror Hospital, ^bDepartment of Community Medicine, National Research Center, ^cDepartment of Medicine, Cairo University, Giza, ^dDepartment of Tropical Medicine and Infectious Diseases, Beny Suef University, Beny Suef, Egypt, ^eDepartment of Gastroenterology, The General Infirmary at Leeds, Leeds, UK

Correspondence to Ahmed S. Gado, MD, Department of Medicine, Bolak Eldakror Hospital, Bolak Eldakror, Giza 2019, Egypt; Tel: +20 235 837 644; fax: +20 235 702 164/357 212 25; e-mail: agado1954@yahoo.com

Received 6 November 2016

Accepted 4 December 2016

The Egyptian Journal of Internal Medicine 2016, 28:108–115

Background

Colonoscopy is a technically demanding procedure with the potential to cause harm if its performance is suboptimal. It is incumbent on endoscopists, therefore, to evaluate their practices and to make improvements wherever possible. Bolak Eldakror Hospital is a secondary-care governmental hospital in Egypt in which we set up an endoscopy quality-assurance program in 2003.

Aim

The aim of this study was specifically to evaluate the quality of colonoscopy practice in our endoscopy unit and by publishing our experience to encourage others to develop a quality-improvement program.

Patients and methods

Predetermined international quality indicators for colonoscopy were employed to monitor the standard of endoscopic procedures between 2010 and 2014. Recorded information included all medical and technical details.

Results

A total of 286 colonoscopies were assessed. The main indication of colonoscopy was hematochezia (58.7%). Polyps were the main endoscopic findings (34.6%). Conscious sedation was used in 56.6%. Cecal intubation was achieved in 77.6%. The adjusted cecal intubation was 94%. Image documentation of cecal intubation was achieved in 92.3% examinations reaching the cecum. Mean cecal intubation time was 17.4±10 min. Mean withdrawal time was 6.6±4 min. The main reasons for unsuccessful cecal intubation were impassable mass or stricture in 23 (8%) colonoscopies and poor bowel preparation in 23 (8%). Colon preparation was rated adequate in 66.4%. Diagnostic colorectal biopsies for those with persistent diarrhea were obtained in 97%. Polyp detection rate was 36.1% and adenoma detection rate was 5.3%. Polypectomy was carried out in 89 (93.6%) patients with detected polyp/s. Retrieval of all excised polyps was successful in 84.3%. Postpolypectomy perforation occurred in one (0.4%) patient.

Conclusion

A high standard of colonoscopy can be achieved by the rigorous application of quality-assurance measures.

Keywords:

colonoscopy, quality assurance, quality

Egypt J Intern Med 28:108–115

© 2017 The Egyptian Journal of Internal Medicine 1110-7782

Introduction

Colonoscopy has become an essential investigation for screening, diagnosing, and treating colorectal problems. However, it is a technically demanding procedure with the potential to cause harm if its performance is suboptimal. Because the procedure is highly operator dependent, standards vary greatly both between individuals and endoscopy units [1]. High-quality colonoscopy maximizes its benefit but poor quality is associated with increased interval cancer rates [2]. A high cecal intubation rate is commonly regarded as a surrogate marker for good quality [3]. The United States Multi-Society Task Force on Colorectal Cancer has recommended that clinicians should achieve a cecal intubation rate of at least 90% overall and 95% in screening colonoscopies. Reported

rates, however, range from 76 to 99% [2]. This wide variation suggests that the quality of colonoscopy provided in some centers is poor [4]. The skill and performance of the individual endoscopist is the most important determinant for successful cecal intubation [5]. Professional societies have recommended that a system of continuous quality improvement should be part of every colonoscopy service [6]. A study in the UK in 2004 showed that the crude colonoscopy completion rate (CCR) improved from 60 to 88% after the implementation of a quality-improvement program

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work noncommercially, as long as the author is credited and the new creations are licensed under the identical terms.

[7]. In a repeat nationwide audit in the UK in 2011, the average CCR had increased to 92.3% [8].

Colonoscopy is generally safe, accurate, and well tolerated. However, it is incumbent on endoscopists to evaluate their practice and continue to improve. This concept of 'quality improvement' is not possible unless a series of suitable quality indicators have been identified and are then monitored and evaluated by tracking outcomes. This article describes how to identify quality indicators, how to monitor and evaluate them, and also shows that even in a small unit the quality of colonoscopy can be greatly improved by applying the lessons learned.

Bolak Eldakror Hospital is a secondary-care governmental hospital in Giza, Egypt. The gastrointestinal endoscopy unit was set up in 1999. Diagnostic and therapeutic upper and lower endoscopies are performed. The endoscopy unit has a low colonoscopy volume (<100 colonoscopies per year). An endoscopy quality-assurance program was instituted in 2003 [9,10]. This initially involved setting standards of practice and designing an approved training program. The team was strengthened by high-level consultant input. Quality indicators recommended by the American Society of Gastrointestinal Endoscopy (ASGE) and British Society of Gastroenterology (BSG) were identified. Protocols were developed. Worksheets (medical and technical) were established. Benchmarking was used to detect shortcomings and deviations from the recommended standards. Outcome indicators were used to evaluate and monitor the quality of endoscopic procedures. Procedures were assessed with an emphasis on improving performance. Regular audits were conducted. We previously reported an improved colonoscopy adjusted completion rate (ACR) from 60% in 2004 to 100% in 2009 following the implementation of a quality-assurance/improvement program [10]. This improved rate of technical success encouraged us to evaluate a wider range of quality indicators that included 'appropriateness of indication', 'diagnostic yield', 'adequacy of colon preparation', 'withdrawal time', 'adenoma detection rate (ADR)', and others to define areas for continuous quality improvement based on new recommendations from professional societies. The aim of this study was to evaluate the quality of our colonoscopy practice between 2010 and 2014.

Patients and methods

The quality of colonoscopic procedures was assessed over a 4-year-period between January 2010 and January 2014. All patients who underwent colonoscopy in Bolak Eldakror Hospital, Egypt, were included in the study.

All patients were prescribed a standard bowel preparation consisting of a low residue diet for 48 h, with clear fluids only for the last 24 h, and a purgative (castor oil) to be taken for the last 12 h before the procedure. An enema was given twice at night and immediately before the procedure. Polyethylene glycol preparations and sodium phosphate were not available in the hospital. The quality of bowel preparation was graded as excellent (completely clear), good (clear liquid aspirable stool), fair (semisolid debris, adhering to the colonic mucosa and not allowing adequate vision of the whole mucosa), or poor (solid stool, not allowing adequate progression of the endoscope and leading to subsequent termination of the procedure) [11]. The quality of bowel preparation was graded as 'excellent' or 'good' for adequate bowel preparation, and 'fair' or 'poor' for inadequate bowel preparation [12]. Consent for colonoscopy was obtained from the patient by the endoscopist in the examination room. In children, consent was obtained from the parents or guardians. A sedation protocol was developed. For adults and elderly patients who had an American Society of Anesthesiology (ASA) score greater than or equal to 3 colonoscopy was performed using conscious sedation (midazolam 5 mg and pethidine 50 mg, intravenously, combination) with midazolam 2.5 mg and pethidine 25 mg, intravenously, combination. Pethidine was routinely administered before midazolam. Reversal agents (flumazenil and naloxone) were available. Colonoscopy in patients under 18 years of age was performed under general anesthesia (propofol or ketamine) with the assistance of an anesthetist who attended all procedures using deep sedation. In all patients, intravenous access was established with a standard cannula. Supplemental oxygen was administered to all patients during the procedure. Full and continuous monitoring was performed during the procedure. Colonoscopies were performed by a competent endoscopist and a trainee under the supervision of the senior endoscopist. The endoscopist had received supervised training for his first 200 diagnostic colonoscopies and 30 polypectomies before the onset of the study. Two adult colonoscopes (Olympus CF-230L/I, and CF-EL; Olympus, Tokyo, Japan) were used. Polypectomy was performed with a diathermy snare and electrosurgical unit (Olympus PSD-20; Olympus). Pure coagulation current was used for polypectomy. Removal, retrieval, and collection of polyps were performed with a snare, cold biopsy for diminutive polyps, polyp retriever and polyp trap.

The quality standards for colonoscopy (benchmarks) we aimed for were as follows: complete examination of the colon (cecal intubation rate $\geq 90\%$ overall), image documentation of cecal intubation 100%, cecal intubation time (CIT) less than 15 min, withdrawal

time during negative colonoscopy greater than or equal to 6 min, an adequate quality of bowel preparation of greater than or equal to 90%, diagnostic colorectal biopsies for persistent diarrhea 100%, and a 90% retrieval rate of all excised polyps for histological analysis [11–13]. ADR was recorded but this varies widely according to world geography. Data from Egypt are limited, and thus no specific ADR standard can be laid down at present.

A standardized data collection form (sheet) was completed for each patient. Recorded information included all medical and technical details. Recorded medical information included demographic data (age and sex), indication for the colonoscopy, presence of comorbidities, patients risk stratification (ASA score), endoscopic findings, and histology follow-up. Recorded quality parameters included cecal intubation, landmarks for cecal intubation, image documentation of claimed cecal intubation, CIT, reasons for failed and aborted colonoscopy, withdrawal time during negative colonoscopies, sedation practice, quality of bowel preparation, diagnostic colorectal biopsies for persistent diarrhea, procedures with polyps, polypectomy practice, procedures with adenoma, and complications.

Colonoscopy was defined as complete if the cecum was reached. The landmarks used for successful cecal intubation were a combination of signs – indentation or transillumination in the right iliac fossa and view of the appendix, the triradiate fold, the ileocecal valve, or the terminal ileal mucosa. Unadjusted cecal intubation was defined as CCR and adjusted cecal intubation as ACR. ACR was calculated by excluding the factors beyond the endoscopist's control (failure due to poor bowel preparation, equipment failure, impassable mass or stricture) and cecal intubation based on reliable landmarks only (visualization of ileocecal valve or intubation of terminal ileum). Polyp detection rate (PDR) and ADR were calculated after excluding the procedures abandoned due to poor preparation.

Data were collected, documented, and evaluated. A database was created for all procedures performed. Microsoft Excel [Microsoft Corporation, Redmond, WA 98052-6399, United States] was used for recording and analysis of the data. Annual audits were conducted to monitor performance. The results of the audits were presented to the team for their information and analysis. Observed deviations were identified and corrective measures were implemented. Between 2010 and 2014 annual quality-assurance reports were transmitted to an independent experienced endoscopist with

particular interest in quality assurance for comment and advice.

A total of 286 patients underwent colonoscopy over the period 2010–2014. Sixty-five colonoscopies were performed in 2010, 75 in 2011, 63 in 2012, and 83 in 2013.

Results

A total of 286 colonoscopies were assessed. The mean patient age was 25.1±22 years, and 53.5% were males. The patients' characteristics are shown in Table 1. In 276 (96.5%), the colonoscopy was performed because of symptoms, whereas in nine (3.2%) it was performed for follow-up (surveillance) of polyps or ulcerative colitis, and in one (0.4%) for screening. The indications for colonoscopy are detailed in Table 2. Of the 286 colonoscopies, 81 (28.3%) were normal. Abnormal findings are detailed in Table 3. A significant lesion was found in 144 (50.4%) cases if we considered only the presence of polyps, inflammatory bowel disease, arteriovenous malformations, and tumors. All procedures were performed according to the protocol stated above. Conscious sedation was used in 162 (56.6%) colonoscopies and general anesthesia in 124 (43.4%). The mean dose of midazolam was 4.2 mg (1–5) and of pethidine it was 38.5 mg (20–50). In elderly patients or those with an ASA score greater than or equal to 3, the mean dose of midazolam was 2.4 mg (1–3.5) and of pethidine it was 23.9 mg (20–25). The dose of propofol or ketamine depended upon the duration of the procedure and was determined by the attending anesthetist. CCR was achieved in 222 (77.6%). The landmarks used to determine successful cecal intubation were the ileocecal valve [117 (40.9%)], terminal ileal mucosa [102 (35.7%)], indentation in the right iliac fossa [two (0.7%)], and the triradiate fold [one (0.4%)]. The reasons for unsuccessful cecal

Table 1 Patients' characteristics

Number of patients	286
Mean age	25.1 years (6–76 years)
Sex ratio Male/Female	153/133
Diabetes and/or hypertension	34 (11.9%)
Ischemic heart disease	4 (1.4%)
Liver cirrhosis	3 (1.5%)
Pulmonary pathology	2 (0.7%)
Malignancy*	2 (0.7%)
Renal impairment	1 (0.4%)
ASA score**	I 240 (83.9%) II 34 (11.9%) III 10 (3.5%) IV 2 (0.7%)

*Cancer pancreas – liver metastasis. **American Society of Anesthesiology score.

Table 2 Indications of colonoscopy

Indications	Number of patients N (%)
Symptomatic	276 (96.5%)
Hematochezia	168 (58.7%)
Chronic diarrhea	33 (11.5%)
Anemia	14 (4.9%)
Abdominal pain*	12 (4.2%)
Change in bowel habits (constipation)	10 (3.5%)
Abdominal mass	3 (1.1%)
Melena	2 (0.7%)
Repeat	13 (4.6%)
Abnormal images on CT scan	11 (3.9%)
Rectal prolapse	10 (3.5%)
Follow up (polyp – ulcerative colitis)	9 (3.2%)
Screening**	1 (0.4%)

*Intestinal obstruction – unexplained nonspecific abdominal pain.

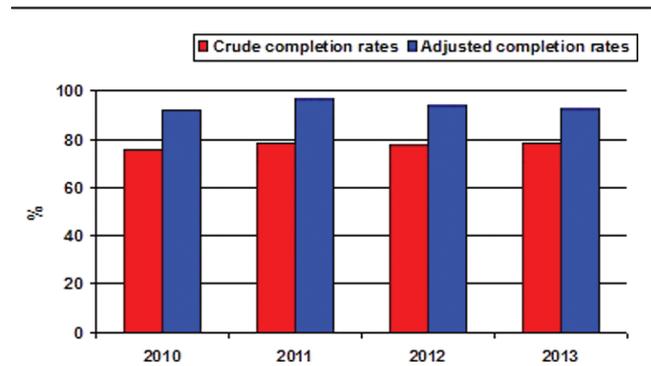
**Hereditary nonpolyposis colorectal cancer.

Table 3 Endoscopic findings of the colonoscopies

Endoscopic findings*	Number of patients N (%)
Normal	81 (28.3%)
Polyps	99 (34.6%)
Neoplasia	27 (9.4%)
Inflammatory bowel disease	15 (5.3%)
Mild colitis (erythema)	14 (4.9%)
Solitary rectal ulcer	8 (2.8%)
Diverticulosis	5 (1.8%)
Arteriovenous malformations	3 (1.1%)
Site of auto amputated polyp	3 (1.1%)
Stenosis	2 (0.7%)
Fecal impaction	1 (0.4%)
Procedure was aborted**	11 (3.9%)
Enterobius Vermicularis identified macroscopically	25 (8.7%)

*More than one finding. **Procedure was aborted immediately after insertion due to bad preparation.

intubation were impassable mass or stricture in 23 (8%), poor bowel preparation in 23 (8%), looping in seven (2.5%), angulation in three (1.1%), equipment failure in three (1.1%), repeat examination to remove a polyp in three (1.1%), fixed colon in one (0.4%), and inadequate sedation in one (0.4%). ACR was achieved in 219 (94%) colonoscopies. Ileal intubation was systematically attempted in patients with chronic diarrhea and was achieved in 72.7%. Image documentation was achieved in 205 (92.3%) of those in whom cecal intubation was claimed. Mean CIT was 17.4±10 min. Mean withdrawal time during negative colonoscopies was 6.6±4 min. The quality of colon preparation was graded as excellent in 129 (45.1%), good in 61 (21.3%), fair in 73 (25.5%), and poor in 23 (8%). Thirty-three (11.5%) patients presented with persistent diarrhea. Biopsies were obtained in 32 (97%) of these. Biopsies were not obtained in one (3%) because of poor bowel preparation. Microscopic colitis was diagnosed

Figure 1

Crude completion rates and adjusted completion rates in the studied years.

in five (20%) of 20 patients with watery diarrhea and normal-appearing mucosa.

Ninety-five (36.1%) patients had polyps. Mean age was 18 years (range: 6–73 years). Polypectomy was performed in 89 (93.6%) of the patients in whom polyps were detected – in 79 using snare polypectomy and in 10 using cold forceps excision. A total of 243 polyps were resected altogether, of which 236 (97.2%) were retrieved. All polyps were judged to have been completely removed in 76 (85.4%) colonoscopies. Retrieval of all excised polyps was successful in 75 (84.3%). Polypectomy was not performed in six colonic examinations with solitary polyps. Three of these were in close proximity to a colorectal cancer and they were referred for surgery. Two polyps were missed during withdrawal and in a third case malfunction of the electrosurgical unit prevented removal. Juvenile polyps were found in 51 (19.4%) patients, hyperplastic in nine (3.4%), inflammatory in six (2.3%), and adenomas in 15 (5.9%). Ten of these were tubular adenomas, three were tubulovillous, one was a flat adenoma, and one a villous adenoma. Histology was not available in 14 (5.3%) patients. PDR was 36.1%. Excluding those patients in whom histology was not available the ADR was 5.3%. Nine (3.2%) adverse clinical incidents were recorded. Vomiting was seen in seven patients; these were resolved spontaneously without need for treatment. In one patient there was slight postpolypectomy bleeding that resolved spontaneously and in another patient there was thermal injury. Postpolypectomy perforation occurred in one (0.4%) patient, who was then managed surgically.

The CCR, ACR, CIT, image documentation of claimed cecal intubation, withdrawal time, quality of bowel preparation, diagnostic colorectal biopsies for persistent diarrhea, PDR, and ADR among years studied are shown in Figs 1–7.

Figure 2

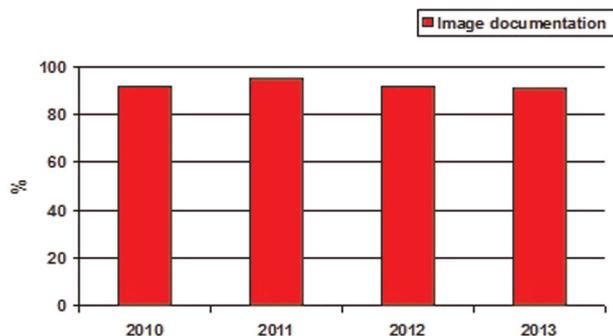
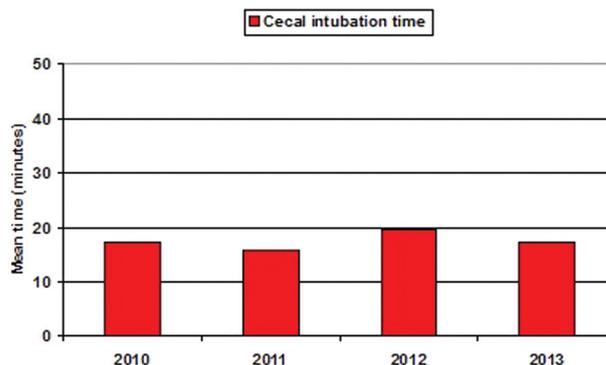


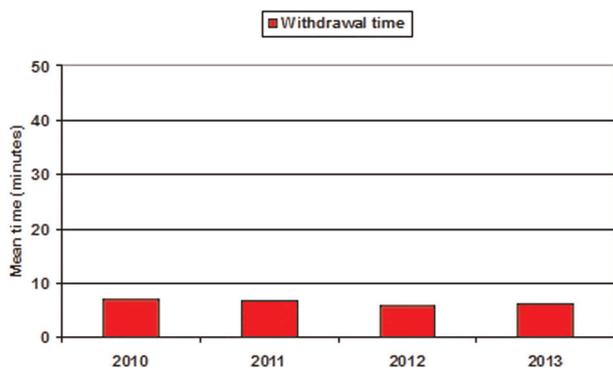
Image documentation of claimed cecal intubation in the studied years.

Figure 3



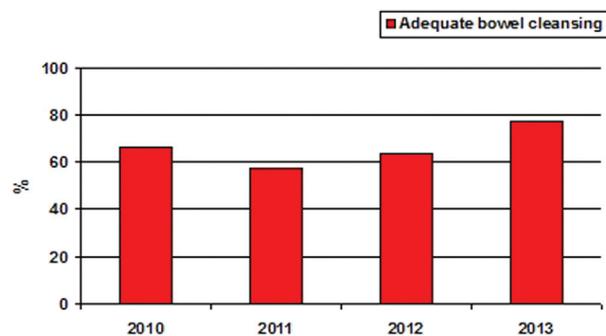
Cecal intubation time in the studied years.

Figure 4



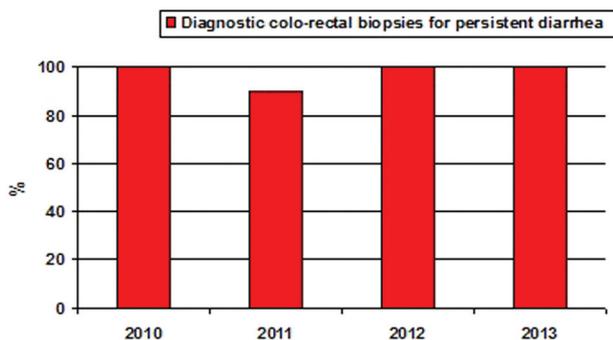
Withdrawal time during negative colonoscopy in the studied years.

Figure 5



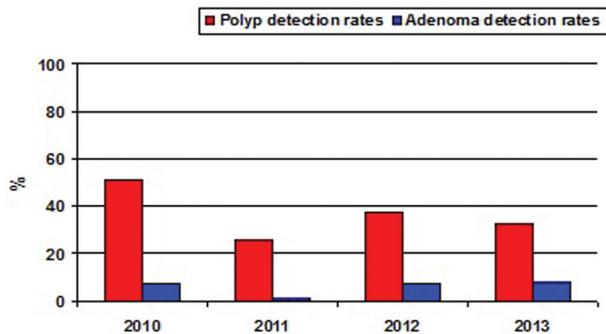
The quality of bowel preparation in the studied years.

Figure 6



Diagnostic colorectal biopsies for persistent diarrhea in the studied years.

Figure 7



Polyp detection rates and adenoma detection rates in the studied years.

Discussion

The effectiveness of colonoscopy is dependent upon its quality [14]. Population studies show that patients are at a lower risk for developing interval cancer if the endoscopist's cecal intubation and ADR are high [15]. Therefore, the quality of the examination has an important impact on patient outcome. This has led

to a demand for routine assessment of quality indicators in colonoscopy services, particularly in screening cases [16].

Bolak Eldakror Hospital is a secondary-care governmental hospital in Giza, Egypt. Our unit has a relatively low colonoscopy volume, but despite this we intended to provide our patients with a high-quality service in line with recognized international standards. To achieve this we instituted a quality-assurance program

in 2003 and following this we showed that our colonoscopy ACR had risen from 60% in 2004 to 100% in 2009 [10]. This technical success encouraged us to evaluate a wider range of quality indicators including 'appropriateness of indication', 'diagnostic yield', and others relating to the procedure itself: 'adequacy of colon preparation', 'sedation practice', 'image documentation of cecal intubation', 'CIT', 'withdrawal time during negative colonoscopy', 'diagnostic colorectal biopsies for persistent diarrhea', 'PDR', 'ADR', 'polyp recovery', and 'complication rate'. Benchmarking was used to detect shortcomings in our practice; where there were deviations from recommended standards we adjusted practices aiming for maximum efficiency within our available resources. By monitoring these new quality indicators, we were able to define an area for continuous quality improvement (poor bowel cleansing). According to international guidelines it should be possible in routine practice to achieve a CCR of 90%, ACR of 94%, CIT less than 20 min, an adequate quality of bowel preparation in greater than or equal to 85%, and photo documentation of cecal intubation in 95% [7,11,15,17–19]. ASGE and BSG guidelines also recommend a withdrawal time greater than or equal to 6 min, all patients with persistent diarrhea should have diagnostic colorectal biopsies, and there should be a 90% retrieval rate of all excised polyps [11,20]. Our aim was to determine whether a small unit such as ours could achieve these quality benchmarks and in the light of our results to re-evaluate our protocols.

Eighty-nine percent of our patients underwent colonoscopy for an indication considered appropriate or 'generally indicated', according to the ASGE guidelines. Reports from the USA, Italy, and Switzerland have shown the number 'appropriate' of examinations to range between 61 and 66% in open-access colonoscopy settings [21–23]. Eleven percent of our patients underwent colonoscopy for reasons considered inappropriate by the ASGE guidelines (unexplained abdominal pain, change in bowel habit, and rectal prolapse); however, 25% of these did, in the event, turn out to have significant lesions. The Italian Society of Digestive Endoscopy accepts 'persistent and significant alteration of bowel habit and chronic abdominal pain' as an appropriate indication for colonoscopy to rule out the disease [24]. The Standards Practice Task Force of the American Society of Colon and Rectal Surgeons has also recommended that colonoscopy can be used selectively in patients with rectal prolapse to define the diagnosis and identify other important pathology [25]. Overall, 50% of our patients had significant lesions. This result is higher than the anticipated diagnostic yield of colonoscopy as stated in the literature (15–45%) [26]. Fifty-six percent of our patients were under the age of 20 years and 45% of

them had polyps. This may explain the higher rate of significant lesions in this study. Conscious sedation was used in 56.6% of our colonoscopies, which is in line with ASGE and BSG guidelines. Sedation overdose (midazolam 3.5 mg) was given in one (0.4%) patient: he was 62 years old with coronary heart disease and underwent therapeutic colonoscopy. We experienced no sedation-related complications.

Annual assessment showed that quality was maintained over the years studied (Figs 1–7). CCR was 75.4–78.7% and ACR 92.3–96.7%. Apart from CCR, our colonoscopy practice met the accepted standards. Improved CCR could be achieved if we can correct reversible reasons for incomplete colonoscopy (mainly poor bowel cleansing). Colon preparation was rated adequate in only 66.2% of the colonoscopies and poor bowel cleansing was responsible for failure of cecal intubation in 23 of the 64 (36%) CCR failures. Poor preparation was due to the type of preparation used, lack of compliance with instructions, and noncooperation. We tried to improve the quality of bowel preparation by adding magnesium citrate (12 sachets twice daily on the previous day of the procedure), more time was spent with the patient to explain the importance of taking the preparation and following instructions to improve bowel preparation, and frail patients were admitted to the ward for bowel preparation. These measures were also unsuccessful. The quality of preparation in our patients would be improved by the use of modern proprietary formulations using polyethylene glycol with split dosing. Polyethylene glycol preparations became available in the hospital in 2015 and we plan to report its effect in the future.

A total of 243 polyps were resected, of which 2.8% were not recovered for pathological examination. In two studies from the UK and France, 7.7 and 12% of resected polyps were not recovered; the accepted standard in the USA is less than 5% and less than 10% in the UK [4,8,27,28]. Our ADR, in all patients, was 5.3% (1.5–8%). Our ADR findings are similar to those reported from other countries in our area. During routine colonoscopy practice, a study from Kuwait showed a PDR of 12.5% and ADR of 10% [29]. Another study from Nigeria showed the overall PDR to be 16.1% and ADR 6.8% [30]. A study from Egypt reported a PDR of 18.9% and ADR 3.7% [31]. Another study from Egypt showed the PDR to be 16% and ADR 6% [32]. In patients undergoing screening colonoscopy, the ASGE expects an ADR of at least 25% in men and 15% in women aged greater than or equal to 50 years [11]. The incidence of both adenomas and colorectal cancer,

however, is much lower in Egypt than in the USA. Furthermore, the age profile of our colonoscopy patients (mean: 25.1 years) was considerably lower than that in the West. Postpolypectomy perforation occurred in one patient (0.4%) and was managed surgically. The rate of perforation stated in the literature is 0.03–0.8% for diagnostic colonoscopy and 0.073–3% for therapeutic colonoscopies [26].

To our knowledge this is the first study to assess colonoscopy practice in Egypt using robust and externally adjudicated outcome measures. It demonstrated that a small endoscopy unit in a government hospital can achieve high-quality colonoscopy comparable with published international standards and performance benchmarks. We hope that our results will encourage other endoscopists in other government hospitals. Our work should give confidence to those who have not yet started on the quality road but who wish to provide a high-quality service to their patients. The detailed long-term experience we have recorded here should enable those intending to start a process of quality improvement to tackle it in a gradual, incremental, and logical way. In our experience it is difficult to try to do everything at once; it is better to build up the range of quality parameters to be monitored and improved gradually over a longer period.

Our data will be useful for local benchmarking, which is an essential element in quality improvement. Practices should implement internal benchmarking (through data collection) and external benchmarking (through comparing data with the GI Quality Improvement Consortium in the USA and Global Rating Scale in UK) [33,34]. Benchmarking is followed by implementing a continuous quality-improvement process with prospective monitoring that is continuously assessed. Our study had a few limitations: patients' and endoscopists' satisfaction was not evaluated and this being a single-center study, it does not necessarily reflect what is really happening on a national level.

In conclusion, a high standard of colonoscopy can be achieved by the rigorous application of quality-assurance measures.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

- Balfour TW. Training for colonoscopy. *J R Soc Med* 1999; 94:160–161.
- Kaminski M, Regula J, Kraszewska E, Polkowski M, Wojciechowska U, Didkowska J, *et al*. Quality indicators for colonoscopy and the risk of interval cancer. *N Engl J Med* 2010; 362:1795–1803.
- Romagnuolo J, Enns R, Ponich T, Springer J, Armstrong D, Barkun A, *et al*. Canadian credentialing guidelines for colonoscopy. *Can J Gastroenterol* 2008; 22:17–22.
- Rex D, Bond J, Winawer S, Levin T, Burt R, Johnson D, *et al*. Quality in the technical performance of colonoscopy, the continuous quality improvement process for colonoscopy: recommendations of the US Multi-Society Task Force on Colorectal Cancer. *Am J Gastroenterol* 2002; 97:1296–1308.
- Garborg K, Bretthauer M. Cecal intubation failure: refer or change technique? *Gastrointest Endosc* 2016; 82:1245–1247.
- Imperiali G, Minoli G, Meucci GM, Spinzi G, Stocchi E, Terruzzi V, *et al*. Effectiveness of a continuous quality improvement program on colonoscopy practice. *Endoscopy* 2007; 39:314–318.
- Ball J, Osbourne J, Jowett S, Pellen M, Welfar M. Quality improvement programme to achieve acceptable colonoscopy completion rates: prospective before and after study. *BMJ* 2004; 329:665–667.
- Gavin DR, Valori RM, Anderson JT, Donnelly MT, Williams JG, Swarbrick ET. The national colonoscopy audit: a nationwide wide assessment of the quality and safety of colonoscopy in the UK. *Gut* 2013; 62:242–249.
- Gado A, Ebeid B, Abdelmohsen A, Axon A. Improving the quality of endoscopic polypectomy by introducing a Colonoscopy Quality Assurance Programme. *Alex J Med* 2013; 49:317–322.
- Gado A, Ebeid B, Axon A. High quality colonoscopy in a low volume unit; is it achievable? *Arab J Gastroenterol* 2010; 11:161–164.
- Bjorkman DJ, Popp JW. Measuring the quality of endoscopy. *Gastrointest Endosc* 2006; 63:S1–S2.
- Morán Sánchez S, Torrella E, Esteban Delgado P, Baños Madrid R, García A, Ono A, *et al*. Colonoscopy quality assessment. *Rev Esp Enferm Dig* 2009; 101:107–112.
- Sedlack RE, Coyle WJ; ACE Research Group. Assessment of competency in endoscopy: establishing and validating generalizable competency benchmarks for colonoscopy. *Gastrointest Endosc* 2016; 83:516–523.e1.
- Raymond J, Tissot B, Dartigues J, Saint-Martin E, Vergier J, Michel P, *et al*. Quality assessment of colonoscopy in usual practice in a French area: aquitaine. *Abstr Int Soc Technol Assess Health Care Meet* 1993; 9:142.
- Lee SH, Chung IK, Kim SJ, Han DS. An adequate level of training for technical competence in screening and diagnostic colonoscopy: a prospective multicenter evaluation of the learning curve. *Gastrointest Endosc* 2008; 67:683–689.
- Baxter NN, Sutraduhar R, Forbes SS, Paszat LF, Saskin R, Rabeneck L. Analysis of administrative data finds endoscopist quality measures associated with post colonoscopy colorectal cancer. *Gastroenterology* 2011; 140:65–72.
- Rizk MK, Sawhney MS, Cohen J, Pike IM, Adler DG, Dominitz LA, *et al*. Quality indicators for all GI endoscopic procedures. *Gastrointest Endosc* 2015; 81:3–16.
- Rees CJ, Gibson ST, Rutter MD, Baragwanath P, Pullan R, Feeney M, *et al*. UK key performance indicators and quality assurance standards for colonoscopy. 2013. Available at: http://www.bsg.org.uk/images/stories/docs/clinical/guidance/uk_kpi_qa_standards_for_colonoscopy.pdf. [Last accessed 2016 Oct].
- Hewett DG, Rex DK. Improving colonoscopy quality through health-care payment reform. *Am J Gastroenterol* 2010; 105:1925–1933.
- BSG Endoscopy Committee. Quality and safety indicators for endoscopy. 2007. Available at: http://www.bsg.org.uk/attachments/170_bsg_grs_indic07.pdf. [Last accessed 2016 Oct].
- Morini S, Hassan C, Meucci G, Toldi A, Zullo A, Minoli G. Diagnostic yield of open access colonoscopy according to appropriateness. *Gastrointest Endosc* 2001; 54:175–179.
- American Society for Gastrointestinal Endoscopy. Appropriate use of gastrointestinal endoscopy. *Gastrointest Endosc* 2000; 52:831–837.
- Froehlich F, Pache I, Burnand B, Vader JP, Fried M, Beglinger Kolodny M, *et al*. Performance of panel-based criteria to evaluate the appropriateness of colonoscopy of colonoscopy: a prospective study. *Gastrointest Endosc* 1998; 48:128–136.
- Grassini M, Verna C, Niola P, Navino M, Battaglia E, Bassotti G. Appropriateness of colonoscopy: diagnostic yield and safety in guidelines. *World J Gastroenterol* 2007; 13:1816–1819.

- 25 Varma M, Rafferty J, Buie W. Standards Practice Task Force, American Society of Colon and Rectal Surgeons. Practice parameters for the management of rectal prolapse. *Dis Colon Rectum* 2011; 54:1339–1346.
- 26 Slim R, Khairallah L, Yaghi C, Honein K, Chemaly M, Kheir B, *et al.* Prospective audit of colonoscopy practice in a Lebanese University Hospital. *Clin Med Insights Gastroenterol* 2008; 1:5–10.
- 27 Gavin D, Valori R, Anderson J, Donnelly M, Williams J, Swarbrick E. The national colonoscopy audit: a nationwide assessment of the quality and safety of colonoscopy in the UK. *Gut* 2012; 61(Suppl 2):242–249.
- 28 Denis B, Weiss AM, Peter A, Bottlaender J, Chiappa P. Quality assurance and gastrointestinal endoscopy: an audit of 500 colonoscopic procedures. *Gastroenterol Clin Biol* 2004; 28:1245–1255.
- 29 Al-Enezi SA, Alsurayei SA, Ismail AE, Aly NY, Ismail WA, Abu-Bakr AA. Adenomatous colorectal polyps in patients referred for colonoscopy in a regional hospital in Kuwait. *Saudi J Gastroenterol* 2010; 16:188–193.
- 30 Alatise OI, Arigbabu AO, Agbakwuru AE, Lawal OO, Sowande OA, Odujoko OO, *et al.* Polyp prevalence at colonoscopy among Nigerians: A prospective observational study. *Niger J Clin Pract* 2014; 17: 756–762.
- 31 Zaher T, Bahgat M, Ibrahim A, Ahmady M, Esmat S, Gouda H, *et al.* Colorectal polyps in Sharkia, Egypt: clinico-pathological study of our experience with endoscopy. *J Med Sci* 2008; 8:196–200.
- 32 Younis H, Moustafa H, Alaam M. Value of colonoscopy in the diagnosis of lower gastrointestinal disorders. *Al-Azhar Med J* 2003; 1:1–14.
- 33 Gurudu SR, Ramirez FC. Quality metrics in endoscopy. *Gastroenterol Hepatol* 2013; 9:228–232.
- 34 MacIntosh D, Dubé C, Hollingworth R, Veldhuyzen van Zanten S, Daniels S, Ghattas G. The endoscopy global rating scale – Canada: development and implementation of a quality improvement tool. *Can J Gastroenterol* 2013; 27:74–82.