

Online patient endoscopy education platform improves outpatient bowel preparation quality: Retrospective observational study



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ABSTRACT

Background and study aims High-quality bowel preparation is integral to high-quality colonoscopy and adenoma detection. Studies evaluating the effect of pre-colonoscopy educational videos on bowel preparation quality have been variable. We investigated whether augmenting bowel preparation education using our professionally produced, patient-oriented, online educational video series would improve preparation quality, reduce need for repeat procedures, and improve adenoma detection rate (ADR).

Patients and methods We conducted a pilot, retrospective, single-center observational study using endoscopy data from a tertiary hospital. Colonoscopy outcomes were compared between two discrete 6-month study periods, before (control group) and after (video group) implementation of the online video intervention. All patients received standard-of-care written and verbal instructions. The video group received a link providing access to the video platform. Primary outcome was adequacy of bowel preparation (defined by the Aronchick Scale). Secondary outcomes included rate of repeat colonoscopy due to inadequate preparation, ADR, and sessile serrated lesion (SSL) detection rate.

Results The video intervention group had a lower rate of inadequate bowel preparation compared with the control group (6.3% vs 9.8%, $P=0.018$). There was no difference between groups in rate of repeat colonoscopies due to inadequate preparation ($P=0.62$), ADR ($P=0.11$), or SSL detection rate ($P=0.94$). Multivariable analysis did not reveal any independent predictors of bowel preparation quality.

Conclusions Our study supports the addition of a novel patient-oriented online educational video resource as an effective tool in enhancing bowel preparation adequacy while maintaining provision of high-quality colonoscopy.

Introduction

The COVID pandemic placed an enormous strain on health systems worldwide, and its impact on patient outcomes is only beginning to be recognized [1]. Healthcare services across Australia have adapted to hybrid physical and telemedical models of

care [2]. Prior to the adoption of vaccination programs, COVID posed challenges for endoscopy services, including suspension of non-urgent procedures and stringent infection control measures, which heavily limited patient attendance [3]. Serendipitously, restrictions imposed on healthcare settings alongside increasing patient and health provider acceptance of online

healthcare platforms created the ideal context in which our department introduced the Gastroenterology Online (GEO) platform. GEO is a patient-centered, professionally produced, online endoscopy and colonoscopy educational video resource. In 2019, GEO was officially introduced for patient use at our hospital.

Approximately 800,000 colonoscopies are performed in Australia annually, a significant portion for colorectal cancer screening and polyp surveillance [4]. Adequacy of bowel preparation is an important performance indicator of quality colonoscopy and forms one of the key colonoscopy clinical standards in Australia [4]. It is well recognized that inadequate preparation of colonic mucosa correlates with suboptimal colonoscopy efficacy, disproportionately affecting detection of early lesions compared with advanced adenoma [5]. Sessile serrated lesions (SSLs) precede a considerable portion of interval colorectal cancer and accurate detection requires high preparation quality [6,7]. Inadequate bowel preparation also lengthens procedure time and often necessitates repeat procedures, both of which place patients at additional risk and contribute to preventable healthcare costs. Endoscopy services should ideally ensure at least 85% of outpatient procedures have acceptable preparation [8].

There are many non-modifiable patient factors associated with inadequate preparation, some of which include age, medication use, and multimorbidity [9, 10]. Enhancing patient education, therefore, focuses on addressing a substantial modifiable predictor. In a recent network meta-analysis, augmenting conventional (written and verbal instructions) pre-colonoscopy instructions with phone calls, booklets, videos or social media tools can significantly improve preparation quality [11, 12, 13]. A more novel method of enhanced patient instruction involved the use of virtual reality technology [14]. Utilization of patient instructional videos has mostly positive effects on preparation quality [11, 15, 16]. Intriguingly, including interactive components in education videos did not improve preparation quality except in certain subpopulations [16]. Currently available videos in use at other centers utilize a semi-didactic approach in their description of the bowel preparation process to patients. To our knowledge, GEO is a first-of-its-kind online video platform that uses combined third-person patient perspective with health literacy-appropriate, documentary-style narration to coach patients through the peri-procedural experience. Given the significant variability in delivery, video content, and design, more studies are needed to elucidate the optimal video format.

Using a validated bowel preparation scoring system, we aimed to evaluate bowel preparation quality between patients who were provided standard-of-care instructions and patients who also had access to the online videos. We hypothesized that inadequate bowel preparation would be reduced in the video group and there would be a reduction in repeat procedures due to poor preparation.

Patients and methods

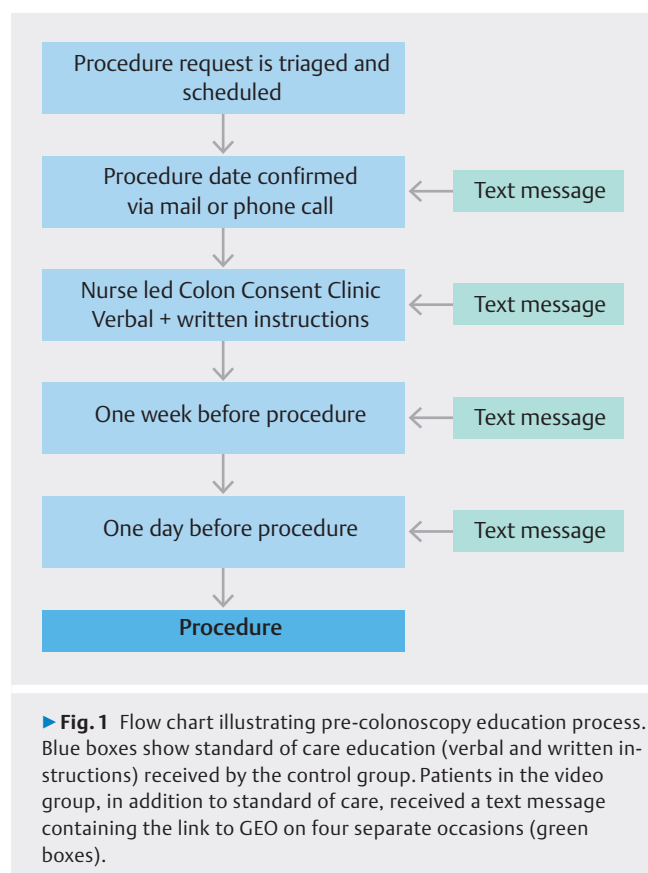
Patients

Our study was conducted in a high-volume metropolitan teaching hospital in Brisbane, which performs approximately 6,000 colonoscopies annually. Retrospective data from patients who underwent lower gastrointestinal endoscopies for all indications were obtained from an encrypted endoscopy database using the Provation MD software (Provation, Minneapolis, Minnesota, United States). Because the GEO platform was introduced for patient viewing toward the end of 2019, consecutive procedures performed from January to June 2019 and January to June 2021 were selected as the control and intervention groups, respectively. Procedures were excluded if they were performed for inpatients or acute indications, performed by trainees or fellows, were incomplete (failure of cecal intubation), lacked documentation of preparation quality, or were performed on patients with a history of bowel resection or diagnosis of inflammatory bowel disease. As a part of the standard pre-procedure patient questionnaire, patients presenting to our unit for procedures are consented for use of their de-identified health data for research purposes. An exemption for full ethical review was granted by the Human Research Ethics Committee of Metro North Health.

Pre-colonoscopy intervention

Patients belonging to the control group attended an outpatient nurse-led colonoscopy consent clinic in person or via telephone and were provided standard-of-care verbal bowel preparation instructions by a clinical nurse and an instructional pamphlet. In addition to standard-of-care education (delivered via phone and mail due to active COVID restrictions during the study period), patients in the video group were provided a link via text message to access a website containing the videos on four separate occasions prior to their scheduled date of colonoscopy (► **Fig. 1**). The link took patients to a website with six videos entitled “What is endoscopy,” “What is a colonoscopy,” “What might be found,” “Understanding consent,” “Colonoscopy preparation,” and “Welcome to Prince Charles Hospital” for First Nation patients [17]. Each video was approximately 10 minutes long and narrated in English. An account was not required to watch the videos and patients had on-demand access, allowing unlimited repeat viewings as required. Anonymized website traffic data were collected monthly by the hosting website, tallying the total number of website visits per month. The website traffic data did not reveal any details about whether individual patients watched every video, had multiple viewings, or duration of the videos they watched. Patients who did not have internet or smartphone access had the option of viewing the videos at a community library.

At our center, all patients undergoing colonoscopy are prescribed a standard bowel lavage solution. The standard preparation formulation is a packaged kit containing magnesium citrate, bisacodyl, and three polyethylene glycol sachets in lemon or orange flavor (Glycoprep Kit; Fresenius Kabi, Bad Homburg, Germany). Split dosing of three liters of preparation solution between the day before and the day of procedure is used for



all patients. As part of pre-colonoscopy education, patients who were unable to complete the bowel preparation solution for any reason, or did not achieve transparent stool clarity, were encouraged to contact our department to have their procedure rescheduled. Our unit's approach to bowel lavage, type of bowel lavage solution, as well as application of split dosing remained the same across the two observational periods between the control and intervention groups.

Videos

In 2017, our department collaborated with an international digital health media company with expertise in broadcast-standard documentary filmmaking to create a patient-centered informative video series. The focus was for patients and carers to better understand their procedures. Moreover, the clinical and creative team intended to establish a platform whereby patients and carers could have real-time "coaching" of bowel preparation by following videos of actual patients undergoing preparation. The clinical content was developed and edited by several of the authors (AV, RH, TR) with additional input from nursing, administrative and support staff within the department for script revision. Filming locations included our department's procedural areas and homes of actual patients. The format of the education delivery was direct-to-camera performance by clinical staff juxtaposed with graphic illustrations for ease of understanding, followed by footage of patients making their bowel preparation mixture and descriptions of their pre-procedure diet. Prior to February 2024, the video platform was

hosted on a website address only accessible to patients scheduled for endoscopic procedures at our hospital. Video traffic data from the observation period of the intervention group (2021) reflect website visits exclusively from patients attending our hospital. Since February 2024, the videos have been made publicly available on the digital health media website and uploaded to YouTube (Google, Mountain View, California, United States) [17].

Procedure

Patient demographic data were collected. History of previous colonoscopies and type of endoscopist (gastroenterologist or surgeon) were noted. Details surrounding technical aspects of each colonoscopy were determined by the endoscopist. The endoscopy reporting software prompts the proceduralist to document bowel preparation quality using the Aronchick scale when completing a colonoscopy report. For each colonoscopy, the Aronchick scale rating was scored based on real-time evaluation of colonic mucosal cleanliness by the respective endoscopist performing the procedure. Other procedural data including polyp detection, adenoma detection, and histopathology were obtained from an encrypted electronic medical record. Procedures performed by trainees under supervision were excluded to minimize any confounding of adenoma/SSL detection rate.

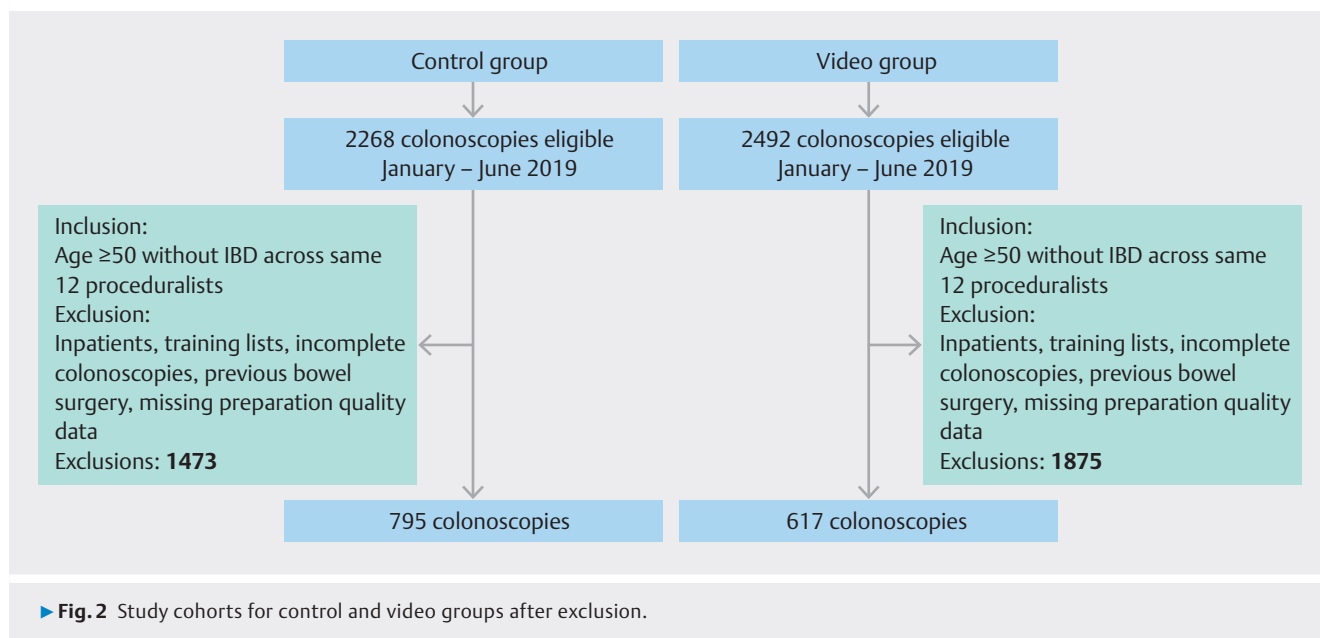
In our center, selection of insertion technique using either carbon dioxide insufflation or water-assisted colonoscopy (water immersion) was applied on a case-by-case basis. Procedures performed using either technique were included. The only distal colonoscope attachments available at our unit were transparent caps, which were applied as per endoscopist preference. To control for proceduralist variability, endoscopic examinations by the same 12 expert endoscopists were identified and included for both study periods. Finally, all colonoscopies were performed using the high-definition video colonoscope (Olympus CF-HQ190L/I, Olympus America, Center Valley, Pennsylvania). Procedures using the newest-generation Olympus CF-EZ1500 DL/I colonoscope were excluded.

Outcomes

The primary endpoint was comparison of bowel preparation quality, as assessed by the proceduralist using the Aronchick scale, between the control and video groups. Inadequate preparation was defined as a rating of "poor" or "fair" quality documented in the colonoscopy report. Secondary outcomes included the number of repeat colonoscopies due to inadequate preparation, adenoma detection rate (ADR), SSL detection rate, and colorectal cancer detection rate. Independent predictors of bowel preparation quality from the study cohorts were also evaluated.

Statistical analysis

Previous literature investigating the effect of online instructional videos on preparation quality have found a reduction in suboptimal bowel preparation (Aronchick scale) from 12.6% to 7.7% [18]. Based on this, a minimum sample size of 595 patients was required for each group after exclusion, assuming



an alpha of 0.05 and power of 80%. Fisher's exact test was used for analysis of categorical variables. To identify independent predictors associated with adequate bowel preparation, multiple logistical regression analysis was performed. $P < 0.05$ was considered statistically significant. GraphPad Prism was used for data analysis (GraphPad Software, Boston, Massachusetts, United States).

Results

In total, 4760 colonoscopies were identified across the two study periods. After exclusions, 795 patients were included in the control group and 617 patients in the video group (► **Fig. 2**). Baseline characteristics of the two study groups are shown in ► **Table 1**.

Patients in the video group had a significantly lower rate of inadequate bowel preparation ($P = 0.018$, ► **Table 2**). When stratified by age group, there was a significant reduction in inadequate preparation in patients aged between 50 to 74 in the video group ($P = 0.025$) but not in patients older than age 74 years ($P = 0.46$). However, no significant difference in rate of repeat colonoscopies was observed between groups ($P = 0.62$). Despite improvement in preparation quality, there was no significant difference observed in all measures of adenoma, conventional adenoma, SSL or cancer detection rates between groups (► **Table 3**).

Multiple logistic regression analysis of patients from the control and video groups examining variables including age, gender, history of previous colonoscopies, and proceduralist type did not reveal any to be independent predictors of adequate bowel preparation (► **Table 4**).

Discussion

To the best of our knowledge, GEO is a first-of-its-kind colonoscopy video coaching platform in clinical application in Australia. This study confirms that GEO is an effective intervention for improving bowel preparation quality in outpatient colonoscopies at our unit. These findings lend further support to the growing body of literature that has similarly observed the benefits of augmenting traditional bowel preparation methods with educational online video [19, 20]. Evaluation of "innovative" bowel preparation instructions can be challenging due to the considerable heterogeneity in the format, delivery, and content reported in published literature [21]. The largest systematic review to date on the utility of bowel preparation innovative technology instructions, which included web-based and video streaming platforms, examined 47 randomized controlled trials (RCT) and concluded that augmented education modestly enhanced bowel preparation quality [21]. The authors highlighted that the lack of well-designed RCTs led to small observed effects driven by low-certainty evidence.

One of the theoretical disadvantages of widespread adoption of augmented instructions is ostracization of patients with low technological literacy. However, an Australian survey in 2019 estimated that over 90% of Australian adults own a smartphone, thus, the digitalization of modern healthcare would likely be acceptable to most patients [22]. Moreover, a key aim of the National Digital Health Strategy announced by the Australian government in 2017 was to empower patients with evidence-based digital health technologies [23]. The enormous carbon footprint of endoscopy is also increasingly recognized globally, thus, the added advantage of transitioning to home-based education is prevention of carbon emission from patients traveling to a hospital [24]. In addition, reducing unnecessary procedures, including repeat procedures due to poor preparation, is a crucial aspect of "green endoscopy".

► **Table 1** Baseline characteristics.

Demographics	Control, n = 795, n (%)	Video, n = 617, n (%)
Gender		
▪ Female	389 (48.9)	314 (50.9)
▪ Male	406 (51.1)	303 (49.1)
Age (± SD)	65.4 (8.8)	64.9 (9)
Indications		
▪ Polyp surveillance	217 (27.3)	221 (35.8)
▪ Symptoms	185 (23.3)	183 (29.7)
▪ Positive FOBT	130 (16.4)	125 (20.3)
▪ Anemia	36 (4.5)	39 (6.3)
▪ Family history of CRC/FAP	24 (3.0)	13 (2.1)
▪ Abnormal imaging	10 (1.3)	17 (2.8)
▪ Polyposis syndrome	3 (0.4)	12 (1.9)
▪ Personal history of CRC	4 (0.5)	3 (0.5)
▪ Therapeutic	1 (0.1)	2 (0.3)
▪ Other/no documentation	185 (23.7)	2 (0.3)
Previous colonoscopies		
▪ Yes	381 (47.9)	355 (57.5)
▪ No	400 (50.3)	249 (40.4)
▪ Unknown	14 (1.8)	13 (2.1)
Proceduralist type		
▪ Gastroenterologist	588 (74)	411 (66.6)
▪ Surgeon	207 (26)	206 (33.4)

CRC, colorectal cancer; FAP, familial adenomatous polyposis, FOBT, fecal occult blood test; SD, standard deviation.

► **Table 2** demonstrated an improvement in preparation quality for patients between ages 50 and 74 years, whereas no significant improvement was seen in patients aged 75 years and older. Although older age previously has been identified as a predictor of poor preparation, it is generally accepted that polyp surveillance is only continued on a case-by-case basis for patients aged 75 years or older due to reduced benefit [10, 25, 26]. Therefore, older patients who continue to undergo polyp surveillance are likely to be in good health, have robust performance status, and be more experienced in colonoscopy preparation. The 50- to 74-year-old cohort contains a portion of patients who are still working, for whom colonoscopy likely represents a major time commitment. Patients who are time-poor may benefit more from repeated text message prompts, thereby improving adherence with preparation advice. The flexibility of repeat viewing on a mobile device also improves convenience, which likely increases compliance. The importance of designing user-friendly educational tools was highlighted in a RCT by Walker et al. in which interactive videos combined with

► **Table 2** Bowel preparation outcomes.

	Control, n = 795, n (%)	Video, n = 617, n (%)	P value
Preparation quality*			0.018
▪ Adequate ("Excellent", "Good")	717 (90.2)	578 (93.7)	
▪ Inadequate ("Fair", "Poor")	78 (9.8)	39 (6.3)	
Preparation quality, aged 50–74 years*	680 (85.5)	518 (84)	0.025
▪ Adequate	612 (90)	485 (93.6)	
▪ Inadequate	68 (10)	33 (6.4)	
Preparation quality, aged ≥ 75 years	115 (14.5)	99 (16)	0.46
▪ Adequate	105 (91.3)	93 (93.9)	
▪ Inadequate	10 (8.7)	6 (6.1)	
Repeat colonoscopy	31 (3.9)	21 (3.4)	0.62

*Denotes statistical significance at P < 0.05

► **Table 3** Detection rates for polyps, adenomas, sessile serrated lesions and colorectal cancers.

Detection rates	Control, N = 795, n (%)	Video, N = 617, n (%)	P value
Polyp	549 (69.1)	402 (65.2)	0.12
Adenoma	492 (61.9)	356 (57.7)	0.11
Conventional adenoma	434 (54.6)	317 (51.4)	0.24
Sessile serrated lesions	130 (16.4)	102 (16.5)	0.94
Colorectal cancer	11 (1.4)	8 (1.3)	0.99

a quiz to assess patient comprehension did not demonstrate improvement in Boston Bowel Preparation Score (BBPS) [16].

Despite a reduction in inadequate preparation quality, detection rates for adenomas, SSLs, and cancers did not differ between study groups. Interestingly, recent studies evaluating interventions similar to GEO also reported no significant improvement in ADR [16, 18]. ADR calculation is based on identification of one adenoma in the entire colon, and it has been established that optimal preparation increases diagnosis of multiple clinically relevant adenoma in discrete and adjacent colonic segments [27]. Nevertheless, the baseline ADR of proceduralists in the control group was 61.9%, well exceeding the 30% benchmark set by the American Gastroenterological Association and the 55% ADR benchmark proposed by Denis et al. for colonoscopies investigating positive fecal occult blood tests (FOBT) [28, 29]. Importantly, the current study was only pow-

► **Table 4** Multivariable analysis – independent predictors of preparation quality.

	Odds ratio (95% CI)	P value
Age	1.01 (0.97–1.05)	0.66
Gender	0.93 (0.48–1.80)	0.82
Previous colonoscopy	0.83 (0.40–1.65)	0.61
Proceduralist type	1.21 (0.59–2.64)	0.61

► **Table 5** Website traffic to GEO.

Month	Unique visits	Repeat visits	Total visits
June 2020	150	82	232
July 2020	96	94	190
August 2020	120	46	166
September 2020	363	245	608
October 2020	1227	972	2199
November 2020	1056	654	1710
December 2020	700	495	1195
January 2021	941	725	1666
February 2021	910	536	1446
March 2021	549	857	1406
April 2021	694	396	1090
May 2021	1116	621	1737
Total	7922	5723	13645

GEO, Gastroenterology Online.

ered to evaluate bowel preparation outcomes. Therefore, with an already high baseline ADR in the control group, it is possible that the sample size was inadequate to detect any effect of the intervention on ADR, resulting in underpowering.

Another crucial Australian perspective on GEO which warrants exploring in future studies is whether the “Welcome” video produced for Indigenous Australians had a positive impact on colonoscopy outcomes. It is recognized that Aboriginal and Torres Strait Islanders have lower uptake of the Australian National Bowel Cancer Screening Program (23.5% compared with 40% in Non-Indigenous populations) and poorer 5-year colorectal cancer survival [30,31]. The subpar health outcomes observed in First Nation populations are a consequence of a complex interplay among cultural, historic, socioeconomic and environmental determinants of health. There are very scarce data about the bowel preparation experience in this population. Therefore, it is paramount for bowel preparation education to be culturally sensitive and accessible to deliver high-quality screening colonoscopies to this vulnerable group.

There were several limitations of this study. First, the retrospective nature of analysis created the possibility of confounders in the absence of randomization. Second, the generalizability of this study is limited by its single-center nature with observations made in a high-volume center by experienced endoscopists. It would be valuable to examine the impact of GEO on bowel preparation and colonoscopy performance in community-based or low-resource settings. A retrospective analysis by Hayat et al. did not show significant improvement in ADR following video education in a subgroup analysis of low-performing endoscopists (ADR < 25%) [18]. Third, there was no means of validating whether every patient in the video group had watched entire videos, or had multiple viewings, which would result in the video group patients receiving varying “doses” of the intervention. During the observation period for the intervention group (January to June 2021), the video platform was only offered to patients attending procedures at our hospital. Thus, ► **Table 5** shows the website traffic data during the study period, which include unique clicks and revisits. Because our center performs approximately 500 colonoscopies a month, the number of unique visits would suggest that almost all patients had visited the website at least once. Lastly, it is important to acknowledge the degree of interobserver variability when judging bowel preparation quality. The Aronchick scale uses a global quality rating, as opposed to the BBPS, which has improved objectivity through segmental scoring [32]. In this study, the primary outcome of preparation adequacy, determined using the Aronchick scale, was evaluated by the operator performing the procedure. With the perspective of only one assessor and its potential impact on the granularity of the preparation quality data, our primary outcome, therefore, was limited to distinguishing between adequate or inadequate preparation. Our unit transitioned to using the BBPS after the implementation of GEO. To account for the limitations of the Aronchick scale, the threshold for adequate preparation included only “excellent” and “good” ratings. In addition, relatively stringent exclusion criteria were applied to minimize confounding variables. A greater threshold for inclusion was also necessary because most of the colonoscopies included in the study were for polyp surveillance or positive FOBT, indications which demand higher ADR. Given the observational nature of the study, residual confounding variables due to procedural factors include insertion technique (water immersion or gas insufflation) and use of distal attachments. It is well recognized that water-aided colonoscopy, particularly water exchange, when compared with gas insufflation is superior in ADR and bowel preparation quality [33]. The insertion technique used at our unit consists of gas insufflation and water immersion, with little experience in water exchange due to paucity of expertise. In a multicenter RCT, Cadoni et al. demonstrated no difference in ADR or colon cleanliness between gas insufflation and water immersion [33]. Furthermore, by controlling for the same proceduralists in both study arms, we aimed to minimize the impact of interoperator technique variations on study endpoints.

The rate of inadequate bowel preparation (“fair” and “poor” quality preparation) in the control group, which received conventional instructions, was 9.8%. This figure is within the American Society of Gastrointestinal Endoscopy’s recommendation of 15% and reflects a high baseline standard of instructions provided by our staff [34]. If the benefit of augmented preparation can be demonstrated in a tertiary referral center, then implementation of a similar augmented preparation process in other endoscopy units is justified. Certainly, a recent non-inferiority RCT suggested that the future of bowel preparation education could be a greater role for home-based online platforms. Patients who used a web-based platform with site-specific videos and animations achieved adequate bowel preparation quality that was non-inferior to standard nurse-led counselling [35]. In light of recent broadening of colorectal cancer screening in the United States to commence at age 45, in addition to polyp surveillance in an increasingly ageing population, the liberation of valuable human resources could have enormous benefits for healthcare systems.

Conclusions

Inadequate bowel preparation can lead to abandonment of procedures, waste of health resources, as well as risk and inconvenience for patients and carers. GEO demonstrated a significant improvement in bowel preparation quality in a high-performing center, while maintaining adenoma and SSL detection rates. The program has been positively received by patients and carers because of its convenience and effectiveness. Utilization of an online video education platform also reduces its carbon footprint, is COVID-safe, and allows provision of quality care irrespective of geography.

Conflict of Interest

Kimberley Littlemore is the creative director of eHealth Digital Media. The remaining authors have no conflicts of interest to declare.

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