

## Retrospective Study

**Use of automated irrigation pumps improves quality of bowel preparation for colonoscopy**

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**Abstract**

**AIM:** To evaluate the effectiveness of automated irrigation pumps (AIPs) in improving the quality of the bowel preparation and the yield of colonoscopy.

**METHODS:** A retrospective observational study was conducted at a single medical center. Outpatient colonoscopies performed during a 4-mo time period when AIPs were not in use, were compared to colonoscopies performed during control period. The main outcomes measured were quality of bowel preparation, procedures aborted due to poor preparation, recommendations to repeat at short interval due to sub-optimal bowel preparation and adenoma detection rates.

**RESULTS:** One thousand and thirty-seven colonoscopies were included. A higher proportion of cases did not achieve a satisfactory bowel preparation when AIPs were not used (24.4% *vs* 10.3%,  $P < 0.01$ ). The number of procedures aborted due to inadequate preparation was not significantly different, however a repeat procedure at a short interval was recommended in a higher proportion of cases when AIPs were not used (21.3% *vs* 6.9%,  $P < 0.01$ ). Good or excellent preparation was 2.91 (95%CI: 2.04-4.15) times more likely when AIPs were used. Detection of polyps and adenomas was not significantly different.

**CONCLUSION:** AIP use during colonoscopy results in a higher proportion of colonic preparation rated as satisfactory, although polyp detection rate is not significantly affected. Recommendations for repeat colonoscopy at shorter interval significantly decrease with the use of AIPs. This study supports the use of the irrigation pumps in endoscopy units to improve the quality of colonoscopy.

**Key words:** Automated irrigation pumps; Adenoma; Quality; Polyps; Bowel preparation; Surveillance interval; Colonoscopy

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**Core tip:** The use of automated irrigation pumps during colonoscopy results in higher quality of preparation and decreases recommendations for repeating colonoscopy at short interval.

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## INTRODUCTION

Colorectal cancer (CRC) is the third most common cancer and the second leading cause of cancer deaths in the United States<sup>[1,2]</sup>. Colonoscopy is used for screening to detect early cancer, and may also prevent CRC by detection and removal of the CRC neoplastic precursor, the adenomatous polyp<sup>[3-5]</sup>. Improving the yield of colonoscopy has attracted much attention in recent years<sup>[6]</sup>. In the past, manual irrigation using water-filled syringes, was used to clean any retained fecal matter or colonic contents, in order to allow for a detailed examination of the colonic mucosa and therefore to improve the yield of colonoscopy<sup>[7,8]</sup>. Automated irrigation pumps (AIPs), which are operated by a foot pedal and connect to the auxiliary channel of newer generation endoscopes have largely replaced the manual irrigation method, as they are much more efficient and

convenient. It is, however, not known whether the AIPs increase the detection of polyps during colonoscopy when compared to the manual method. Moreover, the efficacy of these AIPs in decreasing the rate of procedures prematurely repeated due to inadequate bowel preparation has also never been studied. The aim of this study is to evaluate the effectiveness of AIPs in improving the quality of the bowel preparation, improving the yield of colonoscopy and decreasing the rate of repeat colonoscopy for inadequate bowel preparation.

## MATERIALS AND METHODS

### Study design

The study was conducted at the John D. Dingell Veterans Affairs Medical Center (JDDVAMC) in Detroit, Michigan. It was approved by the Wayne State University Institutional Review Board and the JDDVAMC Research Committee.

A retrospective chart review was performed for colonoscopies completed during the study periods. The use of AIPs was suspended at the endoscopy unit of the JDDVAMC for a period of 4 mo in 2009 for administrative reasons; therefore patients who underwent colonoscopy during this period constituted the main study group. For these procedures, manual irrigation was performed at the request of endoscopist, when retained fecal or bilious material was encountered. It was done by a technician using syringes filled with 60 mL of sterile water through the suction channel of the endoscope. Patients who underwent colonoscopy in an eight-month period in 2008 and 2009 constituted the control groups. They were selected to match the level of training of the gastroenterology fellows involved and the calendar year of the study group. Standard bowel preparation for both groups consisted of conventional dosing of a 4-L polyethylene glycol solution and 15 mg of Bisacodyl the evening prior to endoscopy. Colonoscopies that were aborted due to reasons other than poor colonic preparations, procedures repeated at a short interval (such as for follow-up after piecemeal polypectomy), colonoscopies performed on hospitalized patients, and those performed by non-gastroenterologists were excluded from the study.

Information was collected by review of the medical records about each patient's demographics, indication for the procedure, history of prior adenomatous polyps or cancer, involvement of a gastroenterology fellow, use of the AIPs, quality of the colonic preparation, detection of polyps and adenomas, with all associated details, and if the procedure was aborted due to sub-optimal preparation or if it was advised to repeat the procedure sooner than recommended by guidelines due to the quality of the preparation.

Colonoscopy was performed using Olympus Q160 and Q180 endoscopes (Olympus America Inc., Center Valley, PA). Some procedures were performed by an

**Table 1** Baseline characters of the study population

	Manual flushes	Automated irrigation pumps	P value
<i>n</i>	328	709	
Age, yr (mean, 95%CI)	60.0 (59.0-61.1)	60.3 (59.6-61.1)	0.70
Gender, <i>n</i> (%)			0.34
Female	18 (5.5)	49 (6.9)	
Male	310 (94.5)	660 (93.1)	
Race, <i>n</i> (%)			0.47
African-American	176 (53.7)	359 (50.6)	
Caucasian	146 (44.5)	341 (48.1)	
Others	6 (1.8)	9 (1.3)	
Performed by: <i>n</i> (%)			0.42
Attending physician alone	65 (19.8)	156 (22.0)	
GI fellow with attending physician	263 (80.2)	553 (78.0)	
Indications, <i>n</i> (%)			0.09
Screening	191 (58.2)	373 (52.6)	
Diagnostic	137 (41.8)	336 (47.4)	
History of CRC/polyps, <i>n</i> (%)			0.55
No	238 (72.6)	527 (74.3)	
Yes	90 (27.4)	182 (25.7)	

GI: Gastroenterology; CRC: Colorectal cancer.

attending physician alone (board-certified in Gastroenterology), while, in other cases, the attending physician directly supervised a gastroenterology fellow. Attending physicians involved in the procedures were the same during the different study periods. AIPs (OPF, Olympus America Inc., Center Valley, PA) were available in every procedure room and routinely connected to the endoscope during the control period. Indications for colonoscopy were classified into either screening or diagnosis. The bowel preparation was determined by the attending physician for every case and reported in the endoscopy report using the Aronchick scale<sup>[9]</sup>, as excellent, good, fair or poor. For our study, we considered the bowel preparation to be satisfactory if the procedure report described it as either good or excellent, no retained fecal material was mentioned in the findings and no recommendation for repeat at short interval for sub-optimal bowel preparation was made.

The primary outcomes were quality of the bowel preparation and the number of procedures aborted or repeated early due to sub-optimal preparation. The secondary outcomes evaluated were detection rates for polyps and adenomas.

### Statistical analysis

SAS version 9.3 (SAS Institute, Cary, NC) was used for statistical analyses. For the preliminary descriptive analyses,  $\chi^2$  test was used for the description of categorical variables and a two-sided *t*-test was used for continuous variables for the comparison of means. Multivariable logistic regression model was used to compare the outcomes between the groups. Odds ratio was considered to be statistically significant if the *P* value was less than 0.05.

## RESULTS

Information was collected for a total of 1037 colono-

scopies. AIPs were used for 709 procedures. Mean age of the group was 60.23 years. Majority was male (93.5%). The study group included 535 (51.6%) African-Americans and 487 (47%) Caucasians. Five hundred and sixty-four colonoscopies were performed for screening or surveillance (54.4%), while 473 (45.6%) were performed for diagnostic purposes. Two hundred and seventy-two (26.2%) of the patients had a prior history of polyps/CRC. The two groups were not significantly different in the demographic factors, endoscopist, indication for the procedure or history of polyps or CRC (Table 1).

A significantly higher proportion of cases did not achieve a satisfactory bowel preparation when manual flushes were used as compared to when AIPs were used (24.4% vs 10.3%, *P* < 0.01) (Table 2). Although the number of procedures aborted due to poor preparation was slightly higher in the group with manual flushes, this was not statistically different (*P* = 0.10). However a repeat procedure at a short interval was recommended in a significantly higher proportion of cases when manual flushes were used (21.3% vs 6.9%, *P* < 0.01). On multivariate logistic regression analysis, after adjusting for indication, history of polyps or CRC, sex, age and race, odds of calling bowel preparation satisfactory was 2.91 (95%CI: 2.04-4.15) times more likely when AIPs were used in comparison to manual flushes. When adjusted for the same variables, the detection of polyps and adenomas was not significantly different between the two groups.

## DISCUSSION

Colonoscopy is a cost-effective (USD 11900 per year of life gained)<sup>[10]</sup> tool for screening and prevention of CRC through the detection and removal of pre-cancerous, adenomatous polyps. However sub-optimal bowel preparation limits the effectiveness of colonoscopy as it

**Table 2** Colonoscopy results stratified by the use of the automated irrigation pumps

	Manual flushes	Automated irrigation pumps	Odds ratio (95%CI) P value
<i>n</i>	328	709	
Prep quality, <i>n</i> (%)			2.91 (2.04-4.15) <i>P</i> < 0.01
Sub-optimal prep	80 (24.4)	73 (10.3)	
Satisfactory prep	248 (75.6)	636 (89.7)	
Procedure aborted due to poor prep, <i>n</i> (%)			2.45 (0.92-6.50) <i>P</i> = 0.10
No	323 (98.5)	684 (96.5)	
Yes	5 (1.5)	25 (3.5)	
Recommendation to repeat early due to prep quality, <i>n</i> (%)			0.27 (0.18-0.40) <i>P</i> < 0.01
No	258 (78.7)	660 (93.1)	
Yes	70 (21.3)	49 (6.9)	
Polyp detection, <i>n</i> (%)			0.85 (0.64-1.12) <i>P</i> = 0.60
Yes	194 (59.2)	407 (57.4)	
No	134 (40.8)	302 (42.6)	
Adenoma detection, <i>n</i> (%)			0.99 (0.75-1.31) <i>P</i> = 0.65
Yes	133 (40.6)	298 (42.0)	
No	195 (59.4)	411 (58.0)	

can result in a higher than usual rate of missed polyps, which can lead to interval cancers<sup>[11]</sup>. Studies have shown that endoscopists do not always follow guidelines and frequently recommend repeat colonoscopy at a shorter interval than suggested by those guidelines<sup>[12,13]</sup>. This makes colonoscopy less cost-effective as a CRC screening modality. The reasons for such recommendations are not well known<sup>[12]</sup>, however the fear of missed lesions when bowel preparation is sub-optimal is probably a major factor<sup>[14]</sup>.

For all these reasons, a lot of attention has been paid in recent years towards improving the quality of bowel preparation, such as multiple studies comparing different types and brands of laxatives used for bowel preparation, as well as the recommended changes in the timing of those laxatives to "split dose"<sup>[15]</sup>.

However, there has not been much research to evaluate the effectiveness of AIPs in enhancing the adenoma detection rate, improving the quality of bowel preparation or decreasing the rate of procedures prematurely aborted and repeated due to inadequate bowel preparation. Our study supports the hypothesis that the use of AIPs during colonoscopy results in a significantly higher proportion of colonic preparation being rated as satisfactory with a corresponding decline in the odds of recommending a repeat procedure at a shorter than usual interval.

Our study results are in concurrence with other studies evaluating the relationship between quality of the bowel prep and the recommendation from the endoscopist about the timing of the repeat procedure<sup>[16-18]</sup>. As colonoscopy is usually aborted when the bowel preparation is very poor and unlikely to be improved with any type of irrigation, manual or automated, there was no difference in the rate of procedures aborted for poor

preparation in our study.

Although studies have shown an increase in adenoma and polyp detection rate with improvement in the quality of bowel prep<sup>[16,19-21]</sup>, we did not find an increased rate of adenoma or polyp detection with the use of AIPs, despite the improvement in the quality of the bowel preparation. We believe this could possibly be from the heightened vigilance of the endoscopist when the use of AIPs was suspended for a limited period of time in our unit, and the results might have been different if the AIPs were introduced for the first time during the study.

The study has a few limitations. The retrospective design has some inherent limitations. The determination of the quality of preparation was based on each individual endoscopist's interpretation on the Aronchick scale. Withdrawal time was not routinely recorded in our endoscopy unit at the time of the study. The influence of cleaning using manual flushes or AIPs on total procedure as well as on withdrawal times, which might be different depending on the quality of the bowel preparation, could not be determined. The total volume of water used in either group was not recorded. Although the devices were routinely connected to the endoscope for every single case in the AIPs group, while they were not available in the other group, we could not determine if irrigation by either method was indeed used in every case. Some of the information that could influence adenoma detection rate such as lifestyle and dietary habits could not be evaluated. The sample in itself included both diagnostic and screening colonoscopies. We attempted to alleviate the bias by adjusting for indication of colonoscopy. In addition, our study population was from a Veterans Affairs medical center with a majority of African-American males. This

might limit the generalizability of the results of the study. The suspension of the use of AIPs for a period of time might by itself have led to results that could be different if AIPs were being introduced to an endoscopy unit for the first time. As we used the conventional bowel preparation regimen in our endoscopy unit at the time of the study, we could not evaluate the usefulness of AIPs with split dose bowel regimen.

In conclusion, our study provides evidence that AIPs improve the endoscopist assessment of the quality of the bowel preparation and reduce the number of repeat procedures due to sub-optimal preparation. This supports the widespread use of these devices in endoscopy units to improve the quality of colonoscopy.

## COMMENTS

### Background

Colonoscopy is used for screening to detect early cancer, and may also prevent colorectal cancer (CRC) by detection and removal of the CRC neoplastic precursor, the adenomatous polyp. Automated irrigation pumps (AIPs), which are operated by a foot pedal and connect to the auxiliary channel of newer generation endoscopes have largely replaced the manual irrigation method, as they are much more efficient and convenient. It is, however, not known whether the AIPs increase the detection of polyps during colonoscopy when compared to the manual method. Moreover, the efficacy of these AIPs in decreasing the rate of procedures prematurely repeated due to inadequate bowel preparation has also never been studied.

### Research frontiers

AIPs, which are operated by a foot pedal and connect to the auxiliary channel of newer generation endoscopes have largely replaced the manual irrigation method, as they are much more efficient and convenient.

### Innovations and breakthroughs

The aim of this study is to evaluate the effectiveness of AIPs in improving the quality of the bowel preparation, improving the yield of colonoscopy and decreasing the rate of repeat colonoscopy for inadequate bowel preparation.

### Applications

This study provides evidence that AIPs improve the endoscopist assessment of the quality of the bowel preparation and reduce the number of repeat procedures due to sub-optimal preparation. This supports the widespread use of these devices in endoscopy units to improve the quality of colonoscopy.

### Peer-review

This manuscript by Ravi *et al* describes a retrospective evaluation of patients receiving colonoscopy performed with manual irrigation or an automatic irrigation device. The manuscript is certainly relevant to modern endoscopic practices.

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