



Use of a Second-Generation Irrigation Device May Shorten Time to Successful Inpatient Colonoscopy: A Case Series

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ABSTRACT

Inpatient bowel preparations are often inadequate, lengthening hospital stay and increasing costs. In this case series, we assessed whether a new irrigation device could shorten times to successful colonoscopy and hospital discharge. The device includes a disposable sleeve fitted over the colonoscope, delivering 4 streams of a pulsed air–water mixture to liquify stool, and contains 2 large-bore suction channels to evacuate fecal material. We present 6 inpatient colonoscopies where the device was used, demonstrating its utility in facilitating timely procedures and efficient patient care. Further study is required to determine whether the consistent use of the device can shorten time to successful inpatient colonoscopy.

INTRODUCTION

Inadequate bowel preparation during colonoscopy results in missed lesions, prolonged procedure times, decreased cecal intubation rates, increased electrocautery risk, and shorter intervals between examinations.¹ When performing colonoscopy on a hospitalized patient, inadequate bowel preparation can also result in significantly increased hospital length of stay and hospital cost.² Unfortunately, inpatient bowel preparation is deemed inadequate in up to one-third of cases, with various systematic interventions yielding only modest improvements in adequacy rates.^{3,4} The European Society of Gastrointestinal Endoscopy, for example, has recommended that verbal or written instructions should be provided to inpatients and hospital staff to improve bowel preparation adequacy.⁵ However, when one considers how common several of the variables associated with inadequate bowel preparation are among hospitalized patients, including polypharmacy; use of constipating medications such as opiates; obesity; advanced age; and comorbidities such as diabetes mellitus, stroke, and dementia,⁶ it becomes clear that additional approaches are likely required if we are to significantly improve inpatient bowel preparation adequacy rates and shorten length of stay.

One such approach would be to use irrigation pumps to salvage inadequate preparations through more effective cleaning during colonoscopy.⁵ The Pure-Vu System (Motus GI Holdings, Inc., Fort Lauderdale, FL) is a new, 510(k) US Food and Drug Administration-cleared irrigation device indicated to facilitate cleaning in poorly prepared colons during colonoscopy. Pure-Vu has also received Conformité Européenne (CE) mark approval in Europe. The device includes a portable pump/vacuum workstation connected to a disposable oversleeve that fits over standard or slim colonoscopes (Figure 1). Incorporated into the oversleeve are 4 water jets that enable a pulsed irrigation mixture of air and water to break up fecal material. The oversleeve also includes 2 large-bore suction channels for evacuation of fluid and debris, which have a unique autopurge system designed to avoid clogging. Details of the device are published elsewhere.^{7,8}

Pure-Vu has proven to be highly effective in cleaning the colon in both the ambulatory and inpatient settings.^{8,9} Because the ability of Pure-Vu to effectively clean the colon has previously been proven in clinical studies, our aim was to provide further support for the

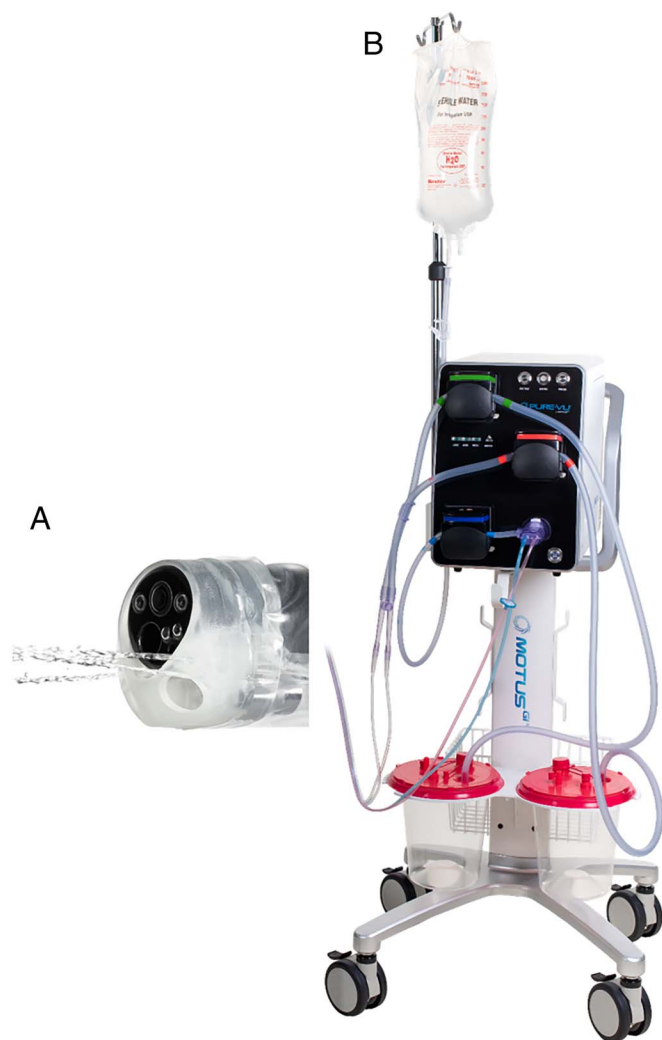


Figure 1. The Pure-Vu System consists of a portable workstation (A) and an oversleeve, here demonstrating 4 streams of pulsed irrigation (B).

use of the device for nontrial inpatient colonoscopy and to explore the possibility that the device might be associated with shortened time to a complete inpatient colonoscopy and time to hospital discharge.

CASE REPORT

Six inpatient colonoscopies performed between October 2019 and February 2020 used the Pure-Vu system. Details of all 6 cases are summarized in Table 1. The device was used successfully in both the endoscopy unit ($n = 4$) and the intensive care unit ($n = 2$). In all cases, the endoscopist felt that the preparation was adequate for the indication. Bowel preparation was scored using the Boston Bowel Preparation Scale (BBPS). The following cases are included to share the clinical reasoning that led to the use of the Pure-Vu device.

Case 1: A 54-year-old man presented with hematochezia and a hemoglobin of 7.6 g/dL 8 days after screening colonoscopy that included resection of a 1.5 cm sessile polyp in the cecum. The

patient was admitted to the intensive care unit (ICU) where he was volume-resuscitated with normal saline. To expedite his care and potentially shorten his use of a bed in an already-full ICU, 2 tap water enemas were administered and a Pure-Vu colonoscopy to the cecum was performed under moderate sedation. Although bowel preparation was poor (BBPS 3) on insertion, the device allowed for sufficient cleaning (final BBPS 8) to visualize the colon and confirm that the cecal polypectomy site was the sole source of bleeding. A pigmented spot in the base of a postpolypectomy ulcer was clipped, and there was no further blood loss.

Case 2: A 72-year-old woman with advanced dementia was admitted with a diagnosis of failure-to-thrive. Repeated episodes of fecal incontinence led to concern for rectovaginal fistula, a diagnosis further suggested by a computed tomography (CT) finding of a small focus of vaginal air. Given the perceived difficulty with an oral bowel preparation and the patient's inability to maintain administered enemas, as well as the limited extent of bowel visualization required, a Pure-Vu colonoscopy was deemed the best option. The distal bowel was unprepared (BBPS segment score 0) on insertion of the colonoscope but cleaned completely with the Pure-Vu device (BBPS segment score 3; Figure 2). No fistula was visualized. Moreover, vaginal padding remained dry throughout the procedure despite copious irrigation with the Pure-Vu device, further supporting a lack of fistula.

Case 3: A 71-year-old man with iron deficiency anemia (Hgb 4 g/dL before transfusion) had consumed 4 L of a polyethylene glycol bowel purgative with a bowel effluent that was still thick brown fluid and deemed inadequate for standard colonoscopy. To avoid another hospital day spent consuming more bowel purgative, decision was made to perform a Pure-Vu colonoscopy after an esophagogastroduodenoscopy (EGD). The upper endoscopy revealed gastric cancer, but the colonoscopy was performed to exclude any synchronous colonic lesions. Bowel preparation during colonoscopy insertion was deemed BBPS 5, improving to 8 with the use of the Pure-Vu device. The colonoscopy was normal.

Case 4: A 52-year-old woman was admitted to the ICU with hematochezia 6 days after polypectomy with a Hgb of 10 g/dL and a heart rate of 130 beats per minute. She was unable to drink a bowel purgative and refused placement of a nasogastric tube for rapid purge. The ICU team deemed her clinical status tenuous with ongoing hematochezia and was concerned about sending her to radiology for a CT enterography. Decision was, therefore, made to perform a Pure-Vu colonoscopy in the ICU without any bowel preparation. On insertion of the colonoscopy, the BBPS score was 0 with fresh and old blood throughout the colon. The use of Pure-Vu allowed for safe advancement of the colonoscope to the cecum with a final BBPS score of 6. A large adherent clot was identified in the cecum, and a thick visible vessel was successfully clipped with 2 hemoclips. There was no further blood loss.

Case 5: A 62-year-old man with quadriplegia had presented with melena and a 4-point drop in baseline Hgb. An EGD was normal, and the patient's limited mobility led the team caring for him to ask

Table 1. Details regarding patients' whose colonoscopy was performed with Pure-Vu

Patient number	Age/sex	Presentation	Colonoscopy details	Outcome	Time from GI consult request to colonoscopy	Time from GI consult request to hospital discharge
1	54/Male	Hematochezia; Hgb 7.6 g/dL 8 days after polypectomy; only bowel preparation: 2 tap water enemas	Performed in ICU with midazolam/fentanyl for sedation; BBPS score 3 on insertion, 8 at completion; colonoscope passed to cecum; cecal polypectomy site without active bleeding found after washing; hemoclip placed; procedure time 59 minutes	No further hematochezia; stable Hgb	5 hours	29 hours
2	72/Female	Suspected rectovaginal fistula based on CT findings; patient unable to tolerate bowel preparation	Performed in endoscopy unit with propofol sedation administered by anesthesia providers; colonoscope passed to descending colon only based on clinical presentation; BBPS segment score 0 on insertion, 3 (excellent) at completion; procedure time 19 minutes	No fistula noted, no fluid per vagina during copious washing of colon with Pure-Vu	29 hours	55 hours
3	71/Male	Iron deficiency anemia with Hgb 4 g/dL; patient completed 4L bowel preparation, but bowel effluent not clear	Performed in endoscopy unit with propofol sedation administered by anesthesia providers; colonoscope passed to cecum; BBPS score on insertion 5, 8 at completion; procedure time 68 minutes (including EGD; split time not captured)	Two adenomas (4 mm and 5 mm) found; EGD revealed gastric cancer	58 hours	102 hours
4	52/Female	Hematochezia 6 days after polypectomy; Hgb 10 g/dL but heart rate 130; unable to tolerate bowel preparation	Performed in ICU with midazolam/fentanyl for sedation; colonoscope passed to cecum; BBPS score 0 on insertion (fresh blood), 6 at completion; procedure time 41 minutes	Large adherent cecal clot with actively bleeding visible vessel; two hemoclips placed with no further bleeding	7 hours	80 hours
5	62/Male	Melena and 4-point drop in Hgb with normal EGD in patient with quadriplegia; unable to tolerate bowel preparation	Performed in endoscopy unit with propofol sedation administered by anesthesia providers; colonoscope passed to transverse colon only because of looping; BBPS score 0 on insertion and 2 at completion; procedure time 55 minutes	Pure-Vu allowed for spot washing to exclude stercoral ulcer, hemorrhoids, ischemia, and diverticulosis as potential causes; CT enterography completed workup with no findings and normalization of Hgb over ensuing months	26 hours	56 hours

Table 1. (continued)

Patient number	Age/sex	Presentation	Colonoscopy details	Outcome	Time from GI consult request to colonoscopy	Time from GI consult request to hospital discharge
6	71/Female	Hematochezia 2 days after polypectomy with a 2-point drop in Hgb; no preparation given because of planned use of Pure-Vu	Performed in endoscopy unit with propofol sedation administered by anesthesia provider; colonoscope passed to cecum; BBPS score 0 on insertion (old blood and stool) and 6 at completion; procedure time 62 minutes	Four postpolypectomy ulcers found, 3 with pigmented spots; hemoclips placed and no further bleeding	6 hours	8 hours

BBPS, Boston Bowel Preparation Scale; CT, computed tomography; EGD, esophagogastrroduodenoscopy; ICU, intensive care unit.

for an unprepared Pure-Vu colonoscopy. The colonoscope could only pass to the transverse colon because of significant looping, but Pure-Vu spot washing was able to exclude several potential sources

of bleeding (stercoral ulcer, hemorrhoids, diverticula, ischemia). A CT enterography was also normal, and the patient had no further GI bleeding over the ensuing year.

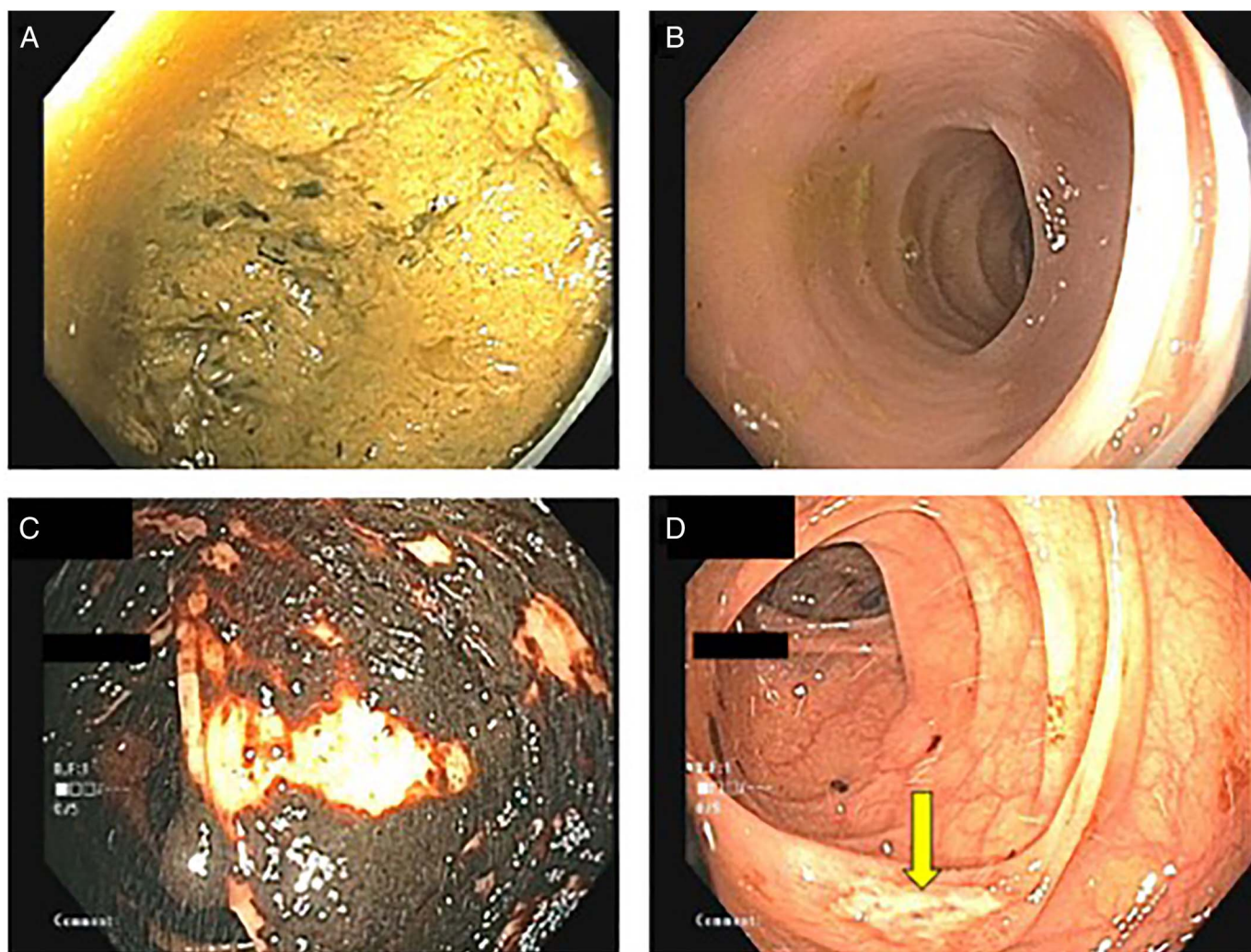


Figure 2. Images captured from Pure-Vu cases as described in Table 3. Patient #2 before cleaning with Pure-Vu (A). Patient #2 after cleaning (B). Patient #6 before cleaning with Pure-Vu (C). Patient #6 after cleaning; arrow indicates ulcer at the postpolypectomy site before clipping (D).

Case 6: A 71-year-old woman presented with self-limited hematochezia and a 2-point decline in Hgb 2 days after a colonoscopy with resection of 4 sessile polyps. She was admitted to the hospital observation unit on a Friday afternoon, and because our endoscopy unit does not perform procedures over the weekend, she would have to wait the weekend with a bowel preparation Sunday for a Monday colonoscopy. To expedite care, decision was made to perform a Pure-Vu colonoscopy without a bowel preparation on Friday afternoon. The BBPS score was 0 on insertion but converted to 6 with the Pure-Vu device (Figure 2). Four postpolypectomy ulcers were seen, 3 of which contained pigmented spots. Those 3 ulcers were clipped, and the patient was deemed stable for discharge that same evening. She had no further gastrointestinal bleeding.

Representative images from 2 cases (Figure 2), before and after the use of Pure-Vu, demonstrate the cleaning efficacy of the device. There were no complications associated with the Pure-Vu colonoscopies, although 1 patient was readmitted within 30 days for self-limited fever of unknown origin in the setting of myelofibrosis. His blood, respiratory, and stool cultures were all negative, and he recovered uneventfully.

As a hypothesis-generating endeavor to potentially justify a future comparative (ideally randomized) trial, we compared the median time between GI consult order placement and completed colonoscopy and hospital discharge with and without Pure-Vu use among all inpatient colonoscopies performed during this time frame ($n = 58$). The Boston Medical Center Institutional Review Board approved the chart reviews for comparisons of timing. In the 6 Pure-Vu cases, the median time between consult order and completed colonoscopy was 16 hours (IQR 6–28) and the median time from the consult order to hospital discharge was 56 hours (IQR 36–74) as determined from time stamps in our electronic health record. During the same calendar dates, the corresponding times for non-Pure-Vu inpatient colonoscopies ($n = 52$) were significantly greater when assessed by the Wilcoxon rank sum test: 53 hours (IQR 30–102; $P = 0.004$) and 117 hours (IQR 75–267; $P = 0.01$), respectively. Of note, the median procedure time of non-Pure-Vu colonoscopies was 39 minutes (IQR 30–50), compared with 57 minutes (IQR 45–61) when Pure-Vu was used ($P = 0.15$), although in 1 case, this time also included an esophagogastroduodenoscopy performed in the same setting and for which the scope-in time for the colonoscopy portion was unavailable.

DISCUSSION

This case series demonstrates that the Pure-Vu device was associated with shortened times between requests for gastroenterology service consultation and both completion of inpatient colonoscopy and hospital discharge. However, during the selected study period, provider uptake of the Pure-Vu device was low (6 cases of 58), and simply having it available for use, for example, in the case it was required to salvage an inadequate

bowel preparation, did not seem to encourage expedited colonoscopies in general. Yet, the device proved useful in both the endoscopy unit and intensive care unit settings for the management of lower gastrointestinal hemorrhage.

In previous studies, endoscopists using the first-generation Pure-Vu device reported satisfaction with its general ease of use.^{7,8} Nonetheless, the oversleeve does increase device stiffness and required holding forces,⁸ which may have created reluctance to use it by our endoscopists. As more data emerge about the efficacy and clinical impact of Pure-Vu, more endoscopists may opt for its use. A previous study reported improved bowel preparation adequacy from 38% on colonoscope insertion to 96% in the evaluated colonic segments by the procedure's end.⁹ We too found that the use of Pure-Vu resulted in a high rate of adequate bowel preparation but have uncovered the need to develop a better approach to facilitate its adoption, potentially ranging from improved provider education to modifications of the technology itself.

Furthermore, this case series highlights the portability of the Pure-Vu System and its utility in the ICU setting. This adds to growing evidence proving the clinical value of the device. In addition, Pure-Vu proved useful not only for improving inadequate bowel preparations due to excess stool but also for limited mucosal visibility due to fresh and old blood in the colon. In this series, there was utility of the device in the management of patients with lower gastrointestinal hemorrhage, including to achieve cessation of active bleeding and for secondary prophylactic hemoclipping.

There are a few limitations to highlight. First, this is a retrospective case series and not a prospective cohort study. Because of this, we are not able to control for the use of constipating medications and comorbidities, such as diabetes, stroke, and dementia, among the entire population of patients who underwent colonoscopy during this time frame. Future studies should prospectively capture accurate data to determine whether these variables affect “time-to” end points.

In conclusion, this case series provides proof of concept that Pure-Vu use in the inpatient setting can help decrease times to a successful colonoscopy and to hospital discharge. These findings have important implications for hospital leaders looking for ways to shorten hospital stays and/or make more efficient use of limited hospital beds. Finally, the portability of the Pure-Vu System makes it a promising new option for endoscopists managing acute lower gastrointestinal hemorrhage in the intensive care unit setting.

DISCLOSURES

Author contributions: Planning or conducting the study: A. Canakis, L. Guo, D. Parsons, H. Shah, BC Jacobson; Collecting and interpreting data: L. Guo, D. Parsons, H. Shah, BC

Jacobson; Drafting the manuscript: A. Canakis and BC Jacobson; All authors read and approved the final version of the manuscript.

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