

Patient-centered approaches to targeting incomplete bowel preparations for inpatient colonoscopies

Lindsey Russell^{a,b}, Pamela Mathura^{a,c}, Amanda Lee^a, Raveena Dhaliwal^a, Narmin Kassam^{a,c}, Ali Kohansal^{a,d}

University of Alberta, Edmonton AB Canada; McMaster University, Hamilton ON Canada; Alberta Health Services, Edmonton AB Canada; Dalhousie University, Halifax NS, Canada

Abstract

Background A high-quality colonoscopy bowel prep is vital to completing the procedure. Adequate inpatient bowel preparation has been consistently difficult to achieve because of multiple factors. Incomplete bowel prep can lead to repeated colonoscopies, poor patient experience, increased costs, and prolonged hospitalization. This study aimed to develop patient-centered interventions to optimize bowel prep for inpatients undergoing colonoscopy.

Methods The Model for Improvement and Donabedian frameworks guided this project. An interdisciplinary team compiled quality improvement tools that identified areas for improvement. Interventions development included a nursing tip sheet for troubleshooting symptoms, a standardized order label and a patient educational placemat. Plan-Do-Study-Act (PDSA) cycles were carried out to test and analyze the effects of the interventions. The project aim was a 30% reduction in incomplete inpatient colonoscopies from poor bowel prep. Process measures included the number of colonoscopy split prep order labels, and placemats used. The balancing measure was the number of repeat colonoscopies.

Results Prior to the intervention, 44% (44/99) of inpatient colonoscopies had poor bowel prep resulting in 10 repeat procedures (10%). Post intervention, 60% (28/47) of the colonoscopies used the standardized label, 66% of physician orders used 2-L split prep, and 80% of patients were provided with the educational placemat. Of the 47 colonoscopies audited post intervention, there was a significant decrease in poor prep (27.7% [13/47], $P=0.038$) for colonoscopies. The percentage of repeated colonoscopies decreased to 4% (2/47).

Conclusion Developing simple and easy-to-use patient-centered interventions can effectively improve colonoscopy preparation for hospitalized patients.

Keywords Healthcare quality improvement, patient-centered care, colonoscopy, bowel preparation

Ann Gastroenterol 2021; 34 (4): 547-551

Introduction

Poor-quality inpatient bowel preparation for colonoscopy has been well described and affects up to 50% of procedures [1].

^aDepartment of Medicine, University of Alberta, Edmonton AB (Lindsey Russell, Pamela Mathura, Amanda Lee, Raveena Dhaliwal, Narmin Kassam, Ali Kohansal); ^bMcMaster University, Hamilton ON (Lindsey Russell); ^cAlberta Health Services, Edmonton AB (Pamela Mathura, Narmin Kassam); ^dDivision of Digestive Care and Endoscopy, Department of Medicine, Dalhousie University, Halifax NS (Ali Kohansal), Canada

Conflict of Interest: None

Correspondence to: Pamela Mathura, 8440 112 St NW, Edmonton, AB T6G 2B7, Canada, e-mail: pam.mathura@albertahealthservices.ca

Received 9 November 2020; accepted 3 February 2021; published online 2 April 2021

DOI: <https://doi.org/10.20524/aog.2021.0623>

© 2021 Hellenic Society of Gastroenterology

Incomplete bowel preparation may delay treatment decisions, decrease gastrointestinal (GI) pathology detection, and increase repeat procedures and cost [2,3]. Standardized orders for bowel preparation can help reduce poor preparation, as demonstrated in previous studies [1]. Patient education is a vital aspect of successful bowel preparation [4], as a recent study demonstrated improved bowel preparation scores after the implementation of an educational booklet [5]. Patients' experience is affected by the instructions and education around colonoscopies [4,6].

The University of Alberta Hospital (UAH) has 2 GI inpatient units and the institutional standard colonoscopy preparation was 4 L of Golytely[®]. However, recent data suggest that a 2-L split prep is superior to a 4-L one [7]. When we surveyed 20 GI staff physicians, we found that only 45% of physicians ordered the 2-L split prep. In a randomized chart audit conducted from November 2018 to March 2019, we found that 34% (44/128) of all inpatient bowel preparations were rated as poor and 14

www.annalsgastro.gr

colonoscopies were repeated (11%; 14/128). The aim of this quality improvement (QI) project was to decrease the number of incomplete inpatient colonoscopies as a result of poor bowel preparations, and to improve patient preparation experience through simple and easy-to-use interventions.

Materials and methods

The Model for Improvement [8] and Donabedian [9] conceptual evaluation framework guided this project (Supplementary Fig. 1). We developed an interdisciplinary QI team that included GI/endoscopy unit managers, physicians, medical students, and a quality consultant. To identify improvement opportunities we completed QI tools, including direct observation, force-field and fishbone analysis (Supplementary Fig. 1), reviewed colonoscopy data, surveyed physicians and nurses, and completed a randomized chart audit on 129 charts from 2 GI units. This study was conducted in accordance with local organizational policies and formal Ethical Committee approval was not required [10].

Three improvement opportunities were identified: bowel preparation ordering, nursing education, and patient education (Supplementary Fig. 2). A bowel preparation order label for a 2-L split prep of Golytely® was created to promote order consistency to international standards [7]. A patient educational paper “placemat” was developed to facilitate standardized education about colonoscopy preparation, including a self-tracking section with the paper placemat placed on the patient’s bedside table during bowel preparation (Fig. 1). This tool was initially pilot tested with 6 patients and the feedback obtained was incorporated, resulting in a revised placemat. To support

nursing education a “Nursing Tip” sheet was created to provide strategies for patients who were having difficulty consuming the preparation fluid (Fig. 2). The nursing tip sheet was designed with the help of 2 unit managers based on commonly reported issues. Plan-Do-Study-Act (PDSA) cycles were carried out to test and analyze the effect of the interventions. The outcome measure was a 30% reduction in incomplete inpatient colonoscopies. The process measures included the monthly number of colonoscopy order labels and placemats used. The balancing measure was the number of repeat colonoscopies. The SQUIRE 2.0 guideline framework was used to report findings for this project (Supplementary Table 1).

Data was collected for analysis through retrospective chart audits, nursing notes, and colonoscopy reports. In addition, surveys were developed on a 5-point Likert scale (Supplementary Fig. 3) and completed by patients, physicians and nurses to determine the feasibility and satisfaction of each intervention. Bowel preparation was determined by keywords in the procedure note and noted to be the overall bowel preparation quality as deemed by the endoscopist. Only procedures with clearly good or bad prep noted in the procedure note were included in the analysis.

Statistical analysis

Continuous variables were reported as median with interquartile ranges (IQR). Differences between pre- and post-intervention in the preparation quality for colonoscopies and the sex of inpatients were evaluated using Fischer’s exact test. Age, Carlson comorbidity index score [11], and Schmid Fall Risk score [12] (Supplementary Table 2) were






<p>Getting ready for your colonoscopy</p> <p>You will have a colonoscopy (a test to examine your large intestine or colon).</p>  <p>We need your help to see inside your intestine.</p> <p>This guide helps healthcare providers explain to their patients the value and process of preparing for a colonoscopy. Please tape it to the patient’s bed table and use it as a placemat.</p> 	<p>1</p> <p>What is a colonoscopy?</p> <p>Colonoscopy is an exam to identify changes in the intestine, such as polyps or other abnormal tissue growths. If necessary, and possible, this tissue can be removed during the colonoscopy.</p> <p>A colonoscopy helps your doctor detect possible causes of intestinal problems you might be experiencing, such as abdominal pain and rectal bleeding.</p> <p>To look inside your intestine, the doctor uses a thin and flexible tube with a tiny camera.</p> <p>The colonoscopy usually takes between 1 and 2 hours, because of the sedation and the other necessary steps.</p>	<p>2</p> <p>What is a bowel prep?</p> <p>A bowel prep is a process to clean your intestine before the colonoscopy. To achieve this goal, you will start: a) a clear fluid diet, and b) drink a laxative called Colyte.</p> <p>If your intestine is not clean, the colonoscopy cannot be performed, and the bowel prep process needs to be repeated.</p> <p>A good bowel prep is key for the success of your colonoscopy.</p>	<p>3</p> <p>Drinking clear fluids</p>  <p>Start a 24 hour clear fluid diet. Do not eat solid food. Please drink lots of clear fluids before your colonoscopy.</p> <p>Clear fluids include:</p> <ul style="list-style-type: none"> • Water • Iced tea • Tea or coffee (no milk) • Fruit juices (pulp-free): apple, white grape, lemonade • Kool-Aid • Ginger ale • Sprite or 7-Up • Coconut water • Gatorade or Powerade • Clear broth <p>You can also have Jeli-O and juice popsicles.</p> <p>If some of these fluids are not available at the unit, you can ask your family members or friends to bring them to you.</p> <p>Please do not drink red, purple, or blue fluids; milk products or substitutes (soy, almond); or alcohol.</p> <p>Keep drinking. It is important to avoid dehydration.</p>	<p>4</p> <p>Taking the bowel prep solution: Colyte</p> <p>Before the colonoscopy drink 4 L of Colyte. Take 8 glasses of about 500 mL (16.9 ounces) as frequently as possible. Your nurse will tell you when to start drinking.</p> <p>The Colyte may taste unpleasant. It might help to cool it before you drink, or to drink it quickly. Suck on a light colour hard candy (not red, purple or blue) after you drink the bowel prep solution.</p> <p>Be near a toilet once you start drinking the bowel prep solution. It can start working within 1 hour. You will have diarrhea or watery stools.</p> <p>If you are feeling sick to your stomach, stop drinking for 30 minutes. You can drink ginger ale to settle your stomach. Please tell your nurse if you are feeling nauseous. It is very important to keep drinking the bowel prep solution.</p> <p><i>Check mark each glass you drink</i></p>  <p>At the end, your stool should be liquid and clear: You should be able to see through it.</p>	<p>Goal: a clean intestine</p>  <ol style="list-style-type: none"> 1. Like pebbles Hard to pass Not ok 2. Lumpy Hard to pass Not Ok 3. with cracks Not Ok 4. Soft & smooth Better 5. Soft blobs Even better 6. Mushy Almost there 7. No solid bits Liquid & clear You are ready!
<p>The content of this guide is partly based on the bowel prep guidelines produced by the Alberta Colorectal Cancer Screening Program</p>					

Figure 1 Patient education paper placemat, used to help educate patients and track bowel preparation


 Tips & steps to help patients clean their bowels Nurse too 		
Each patient is unique, please adapt the process to their needs and preferences		
If patient...	When to consult physician	Physician may
1. Is nauseous / not tolerating		
Consult with patient drinking preferences	While patient is nauseous	Order Maxeran
Take a break (30 minutes) from bowel prep		Try different bowel prep
Encourage Ginger-Ale between glasses		Do 2L HS 2L in AM
Reposition patient, sit them up		NGT (if esophageal varices physician must insert tube)
Use a straw placed at the back of the mouth		
2. Is non-compliant		
Repeat education	When patient refuses to drink 2 hrs after initiating prep	Speak to patient
Involve the family if available		Cancel scope if continuing to refuse
Converse to understand causes		
Provide visual aids to encourage drinking		
Find a middle ground appropriate for patients & nurses		
3. Is difficult to prep / elderly, non-mobile, FCP room, confused		
Discuss early with physician team	Start conversation when order for prep is written	Try the 2L/2L split order if clinically appropriate
Encourage to drink frequently	Start using nursing interventions	Schedule procedure later in day to allow for more time
Involve the family if available		
Use whiteboard + Visual aides		
Start prep earlier in the day to allow		
Move patient room if possible		
4. Is non clear in AM		
Ensure all prep is completed	In early AM	Give more prep
		Order enema
		Delay scope
AM resource nurse: Call endo in AM to update endo triage nurse on the status of patients who are NOT ready (prep not completed).		



Figure 2 Educational tool for nurses to use when facing difficulties with patient bowel preparation

compared between poorly and well prepped patients in the post-intervention group using the Mann-Whitney *U* test. All statistical analyses were conducted using IBM SPSS v26 (IBM Corp. Released 2019. IBM SPSS Statistics for MAC, Version 26.0. Armonk, NY: IBM Corp).

Results

A total of 128 colonoscopies were audited prior to intervention and 66 colonoscopies post intervention. After removal of those with no comments on colonoscopy prep on the procedure notes, 99 colonoscopies prior to intervention and 47 colonoscopies post intervention were analyzed. Prior to the intervention, 44% (44/99) of inpatient colonoscopies reported poor prep, resulting in 10 repeat procedures (10%; 10/99). Of the repeated procedures, the most common indication for colonoscopy was lower GI bleeding (4/10) and the most common reason for repeated colonoscopy was poor prep (8/10 repeated procedures). The interventions did not have to be adjusted during the PDSA cycles. However, we did find that the standardized ordering label needed to be available in the Emergency Department for new GI admissions and we needed to provide education to rotating residents on the GI

unit and new nursing staff during the study period of May 14-August 31, 2018.

Post intervention, approximately 60% (28/47) of the colonoscopies used the standardized order label and 66% (31/47) of physician orders used the 2-L split prep. A total of 80% of patients were provided with the placemat at their bedside. Of the 47 colonoscopy reports audited post intervention, 27.7% (13/47) had poor bowel prep and 72.3% (34/47) had good prep (Table 1). There was a significant reduction in poor bowel preparation compared to pre intervention ($P=0.038$) (Table 1).

As regards the balancing measure, there was a reduction in the number of repeat colonoscopies from 10% (10/99) to 4% (2/47). Notably, only 1/2 repeated colonoscopies post intervention was due to poor prep, compared to 8/10 of the repeated procedures prior to the intervention ($P=0.27$). Lower GI bleeding was the most common indication for colonoscopy in the patients who had poor preparation but did not have a repeat colonoscopy.

There was no significant difference in Charleston comorbidity index scores, age or Schmid Fall Risk scores between patients with good or poor bowel preparation or pre/post intervention (Tables 1,2). However, on subgroup analysis comparing good and poor bowel preparation either pre or post PDSA intervention, there were significantly more men with poor preparation in the pre-PDSA group ($P=0.029$) and

Table 1 Comparative variables between pre and post PDSA (Plan-Do-Study-Act) cycles. All continuous variables are reported as median with interquartile range (IQR)

Variable	Pre-PDSA (N=99)	Post-PDSA (N=47)	P-value
Age (IQR)	67 (24.5)	66 (20)	0.811 [‡]
Sex			0.246 [†]
Male	56	23	
Female	43	24	
Carlson Comorbidity Index [11] (IQR)	4 (4)	4 (4)	0.465 [‡]
Schmid Fall Risk [12] (IQR)	0 (2)	0 (1)	0.847 [‡]
Bowel Prep			0.038 ^{*†}
Good Prep	55	34	
Poor Prep	44	13	

*Statistically significant. [†]Fisher's exact test. [‡]Mann-Whitney U test

Table 2 Comparison of variables between total patients with good prep and poor prep both pre- and post-intervention (total is 146 colonoscopies). All continuous variables are reported as median with interquartile range (IQR)

Variable	Good Prep (N=89/146)	Poor Prep (N=57/146)	P-value
Age (IQR)	64 (27)	70 (16)	0.058 [‡]
Sex			0.106 [†]
Male	44	35	
Female	45	22	
Carlson Comorbidity Index [11] (IQR)	4 (5)	4 (3)	0.257 [‡]
Schmid Fall Risk [12] (IQR)	0 (1)	1 (2)	0.118 [‡]

[†]Fisher's exact test, [‡]Mann-Whitney U test

Table 3 Comparison of variables between good and bad prep colonoscopies within pre and post PDSA (Plan-Do-Study-Act) cycles. All continuous variables are reported as median with interquartile range (IQR)

Variable	Pre-PDSA			Post-PDSA		P-value
	Good Prep (N=55/99)	Poor Prep (N=44/99)	Statistics	Good Prep (N=34/47)	Poor Prep (N=13/47)	
Age (IQR)	61 (26.5)	70.5 (15.5)	0.081 [‡]	64.5 (20.75)	68 (21)	0.378 [‡]
Sex			0.029 ^{*†}			0.288 [†]
Male	26	30		18	5	
Female	29	14		16	8	
Carlson Comorbidity Index[11] (IQR)	3 (5)	4.5 (4)	0.132 [‡]	4.5 (4.5)	4 (4)	0.943 [‡]
Schmid Fall Risk[12] (IQR)	0 (1)	0 (2)	0.509 [‡]	0 (1)	1 (3)	0.048 ^{*‡}

*Statistically significant. [†]Fisher's exact test. [‡]Mann-Whitney U test

significantly higher Schmid Fall Risk Score for patients with poor preparation in the post-PDSA group (P=0.048) (Table 3). A total of 59% of the surveyed patients found the placemat helpful, 100% of surveyed physicians indicated that they would use the standardized label, and 100% of surveyed nurses perceived the nursing tips sheet to be helpful.

Discussion

The patient-centered interventions described above significantly reduced the number of poor-quality colonoscopies and the number of repeated colonoscopies. Interestingly, other factors such as comorbidities, sex or age did not differ between colonoscopies with good or poor prep (Table 2). Empowering patients with easy-to-follow instructions improved the patient's experience during the bowel preparation process and many patients suggested that the use of the placemat would be helpful for future colonoscopies. Using a standardized prep order label with an option for a split preparation reduced physician order variability and promoted the use of superior bowel preparation [7]. This also increased the ordering of the international standard 2-L split prep by GI physicians (66% vs. 45%). Providing nurses with strategies to navigate preparation challenges and complications offered consistency in approaching education and management for bowel preparation.

Prior literature on optimizing colonoscopy preparation have highlighted patient education as a key and beneficial factor to support bowel preparation [5]. However, this study used a large booklet and an educational session, which was time-consuming and required greater effort to implement [5]. The point-of-care placemat used in our study was an easy-to-read single page paper document, placed on the patient's bedside table, offering simplified information about the bowel preparation process. The advantage of this approach is that it allowed for patient self-tracking during bowel prep and it standardized the explanation/teaching between nurses and patients. The novel nursing tip sheet provided nurses with

management plans to help patients during the bowel prep process, as prior literature identified that poor and variable nursing education was independently associated with poor bowel preparation [13]. The split bowel preparation of 2 L is superior to the 4-L prep, as outlined in a prior meta-analysis [7], and the increased use of the split prep with the standardized order sticker for physicians allowed for the optimized prep to be ordered more consistently.

We anticipate that these interventions can be easily adopted by other hospital units with less experience regarding colonoscopy bowel preparation. The placemat is easy to read for both patients and nursing staff, and is inexpensive to distribute. In addition, all prior literature on optimizing colonoscopy preparation has highlighted education as a key and beneficial factor to support bowel preparation.

Strengths of this project include the extensive pre-project information gathered to contextualize the problem of poor bowel preparation through surveys and chart audits. In addition, using a multidisciplinary team of physicians, nursing staff, managers and a QI specialist allowed for various perspectives and experiential knowledge to be shared regarding inpatient bowel preparation. The patient educational placemat was easy to introduce and the financial cost of implementing this project was low. Finally, our target unit was the GI units, which have more patients requiring colonoscopy compared to other units, and where staff are already more knowledgeable about this procedure compared to other units, such as internal medicine or cardiology.

Study limitations included a non-validated survey, the absence of bowel preparation rating in some colonoscopy reports (28.7% of the original cohort did not have comments on the prep post intervention and were excluded from analysis), and the lack of a pre-intervention patient satisfaction survey. In addition, while we noted whether the placemat was given or not, we did not evaluate any teaching the nurses provided around the placemat. Future studies will focus on the sustainability of the placemat for hospitalized patients, the nursing tip sheet as well as cost analysis. In addition, given the small sample size of this project, future studies with larger sample sizes would be worthwhile to validate these results.

Overall, by implementing these interventions targeting patient education, physician ordering and nursing management, we can improve both patient experience and health outcomes for the hospitalized patient population undergoing colonoscopy.

Acknowledgments

We would like to thank the University of Alberta Hospital and the University of Alberta Office of Lifelong Learning for the support of the development of the educational tools. In addition, we thank Dr. Mahmood Mohamed, Dr. Sander van Zanten, and the GI Unit Managers Hannah Rempel and Donna Perez for their help with conducting the project. This project was supported by the Alberta Health Services Quality Innovation Fund.

Summary Box

What is already known:

- Colonoscopy is essential for the diagnosis and treatment of ailments
- Proper inpatient colonoscopy preparation is difficult to obtain
- Patient-led education and standardized bowel preparation are key

What the new findings are:

- Poor colonoscopy preparation is independent of age, sex, comorbidities and mobility status
- Inpatient bowel preparation is improved by addressing concerns from physicians, patients and nurses
- An easily accessible placemat as an educational tool is a novel way to convey information to patients while they prep for a colonoscopy

References

1. Sullivan B, Zhang C, Wegermann K, Lee TH, Leiman DA. Standardizing inpatient colonoscopy preparations improves quality and provider satisfaction. *Int J Health Care Qual Assur* 2020;**33**:277-287.
2. Garber A, Sarvepalli S, Burke CA, et al. Modifiable factors associated with quality of bowel preparation among hospitalized patients undergoing colonoscopy. *J Hosp Med* 2019;**14**:278-283.
3. Hendry PO, Jenkins JT, Diamant RH. The impact of poor bowel preparation on colonoscopy: a prospective single centre study of 10,571 colonoscopies. *Colorectal Dis* 2007;**9**:745-748.
4. Guo X, Yang Z, Zhao L, et al. Enhanced instructions improve the quality of bowel preparation for colonoscopy: a meta-analysis of randomized controlled trials. *Gastrointest Endosc* 2017;**85**:90-97.
5. Ergen WF, Pasricha T, Hubbard FJ, et al. Providing hospitalized patients with an educational booklet increases the quality of colonoscopy bowel preparation. *Clin Gastroenterol Hepatol* 2016;**14**:858-864.
6. Restall G, Michaud V, Walker JR, et al. Patient experiences with colonoscopy: a qualitative study. *J Can Assoc Gastroenterol* 2019;**3**:249-256.
7. Martel M, Barkun AN, Menard C, Restellini S, Kherad O, Vanasse A. Split-dose preparations are superior to day-before bowel cleansing regimens: a meta-analysis. *Gastroenterology* 2015;**149**:79-88.
8. Langley GL, Moen R, Nolan KM, Nolan TW, Norman CL, Provost LP. The improvement guide: a practical approach to enhancing organizational performance. 2nd Edition. San Francisco, California, USA: Jossey-Bass Publishers; 2009.
9. Donabedian A, Wheeler JR, Wyszewianski L. Quality, cost, and health: an integrative model. *Med Care* 1982;**20**:975-992.
10. Hagen B, O'Beirne M, Desai S, Stingl M, Pachnowski CA, Hayward S. Innovations in the ethical review of health-related quality improvement and research: The Alberta Research Ethics Community Consensus Initiative (ARECCI). *Health Policy* 2007;**2**:e164-e177.
11. Charlson M, Szatrowski TP, Peterson J, Gold J. Validation of a combined comorbidity index. *J Clin Epidemiol* 1994;**47**:1245-1251.
12. Schmid NA. 1989 federal nursing service award winner. Reducing patient falls: a research-based comprehensive fall prevention program. *Mil Med* 1990;**155**:202-207.
13. Lee YJ, Kim ES, Park KS, et al. Education for ward nurses influences the quality of inpatient's bowel preparation for colonoscopy. *Medicine (Baltimore)* 2015;**94**:e1423.

Supplementary material

Supplementary Table 1 Squires 2.0 Checklist

Title and Abstract	
1. Title	Patient-Centered Approaches to Targeting Incomplete Bowel Preparations for Inpatient Colonoscopies
2. Abstract	<p>Background: A high-quality colonoscopy bowel prep is vital to completing the procedure. Adequate inpatient bowel preparation has been consistently difficult to achieve because of multiple factors. Incomplete bowel prep can lead to repeated colonoscopies, poor patient experience, increased costs, and prolonged hospitalization. This study aimed to develop patient-centered interventions to optimize bowel prep for inpatients undergoing colonoscopy</p> <p>Methods: The Model for Improvement and Donabedian frameworks guided this project. An interdisciplinary team compiled quality improvement tools that identified areas for improvement. Interventions development included a nursing tip sheet for troubleshooting symptoms, a standardized order label and a patient educational placemat. Plan-Do-Study-Act (PDSA) cycles were carried out to test and analyze the effects of the interventions. The project aim was a 30% reduction in incomplete inpatient colonoscopies from poor bowel prep. Process measures included the number of colonoscopy split prep order labels, and placemats used. The balancing measure was the number of repeat colonoscopies.</p> <p>Results: Prior to the intervention, 44% (44/99) of inpatient colonoscopies had poor bowel prep resulting in 10 repeat procedures (10%). Post intervention, 60% (28/47) of the colonoscopies used the standardized label, 66% of physician orders used 2-L split prep, and 80% of patients were provided with the educational placemat. Of the 47 colonoscopies audited post intervention, there was a significant decrease in poor prep (27.7% [13/47], $P=0.038$) for colonoscopies. The percentage of repeated colonoscopies decreased to 4% (2/47).</p> <p>Conclusion: Developing simple and easy-to-use patient-centered interventions can effectively improve colonoscopy preparation for hospitalized patients.</p>
Introduction	
3. Problem Description	In a randomized chart audit conducted from November 2018 to March 2019, we found that 34% (44/128) of all inpatient bowel preparations were rated as poor and 14 colonoscopies were repeated (11%; 14/128).
4. Available Knowledge	Poor-quality inpatient bowel preparation for colonoscopy has been well described and occurs in up to 50% of procedures
5. Rationale	The Model for Improvement and Donabedian conceptual evaluation framework guided this project. With the multidisciplinary team, and mapping we found three areas for improvement. Through surveys of physicians, nurses and patients and using outpatient colonoscopy booklets we created the three interventions for ease of education delivery and reassurance of proper split prep to be ordered.
6. Specific Aims	The aim of this quality improvement (QI) project was to decrease the number of incomplete inpatient colonoscopies as a result of poor bowel preparations, and to improve patient preparation experience through simple and easy-to-use interventions.
Methods	
7. Context	The ward targeted was the GI ward, where they are used to prepping patients for colonoscopy. Moreover, chart review and mapping found areas specific to the UAH where areas could be improved upon.
8. Interventions	<p>-A bowel preparation order label for a 2 L split prep of Golytely® was created to promote order consistency to international standards.</p> <p>-A patient educational paper “placemat” was developed to facilitate standardized education about colonoscopy preparation, including a self-tracking section with the paper placemat placed on the patient’s bedside table during bowel preparation. This tool was initially pilot tested with 6 patients and the feedback obtained was incorporated, resulting in a revised placemat.</p> <p>-To support nursing education a “Nursing Tip” sheet was created to provide strategies for patients who were having difficulty consuming the preparation fluid [Fig. 2]. Two unit managers helped design the nursing tip sheet based on issues that nurses commonly reported.</p>
9. Study of the Interventions	Plan-Do-Study-Act cycles were carried out to test and analyze the effect of the interventions. Surveys pre- and post-intervention were used to assess the attitudes of stakeholders.
10. Measures	The outcome measure was a 30% reduction in incomplete inpatient colonoscopies. The process measures included the monthly number of colonoscopy order labels and placemats used. The balancing measure was the number of repeated colonoscopies.
11. Analysis	Data were collected for analysis through retrospective chart audits, nursing notes, and colonoscopy reports. In addition, surveys were developed on a 5-point Likert scale and completed by patients, physicians and nurses to determine the feasibility and satisfaction of each intervention. Differences between pre- and post-intervention in the quality of preparation for colonoscopies were compared by Fischer’s Exact Test. Charleston Comorbidity Index score and Schmid Fall Risk score between poor and well prepped patients in the post intervention group were compared using the Mann–Whitney U Test. All statistical analysis was conducted with IBM SPSS v26.

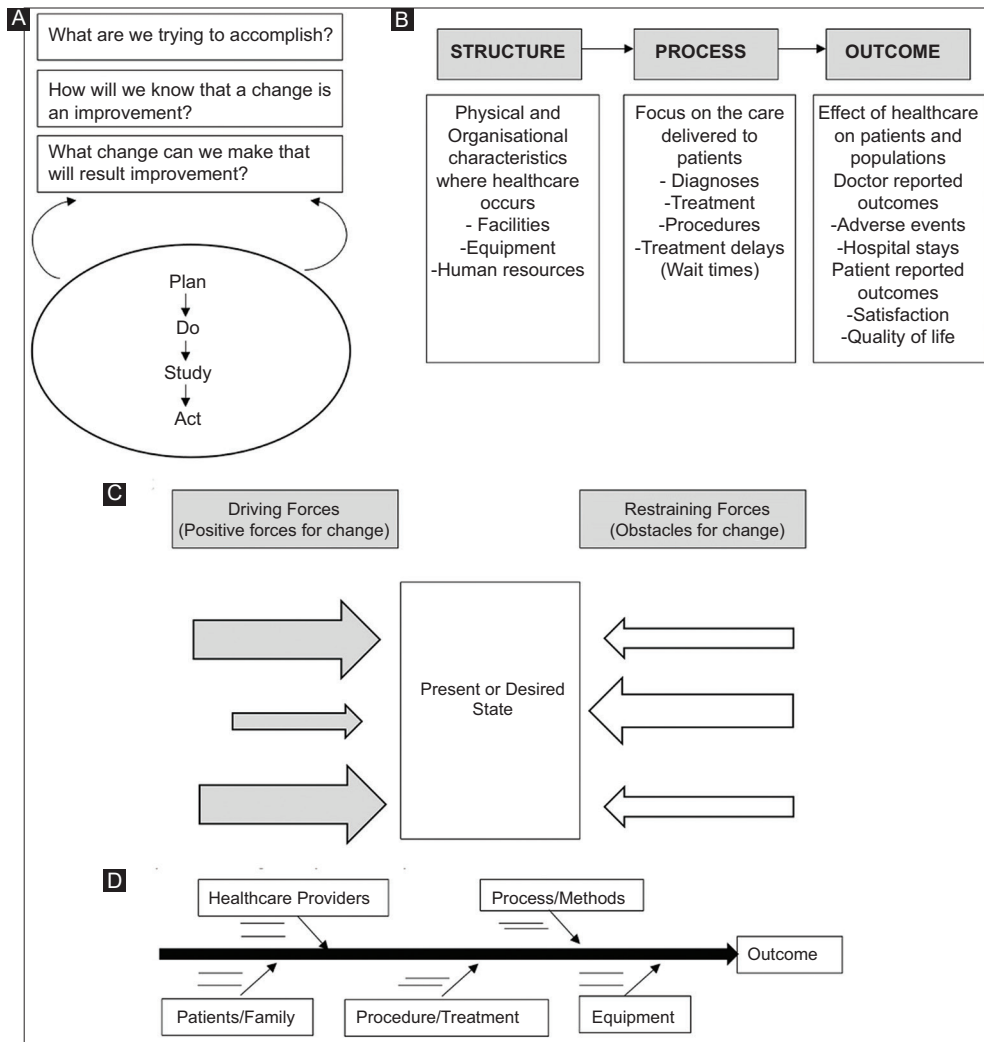
(Contd...)

Supplementary Table 1 (Continued)

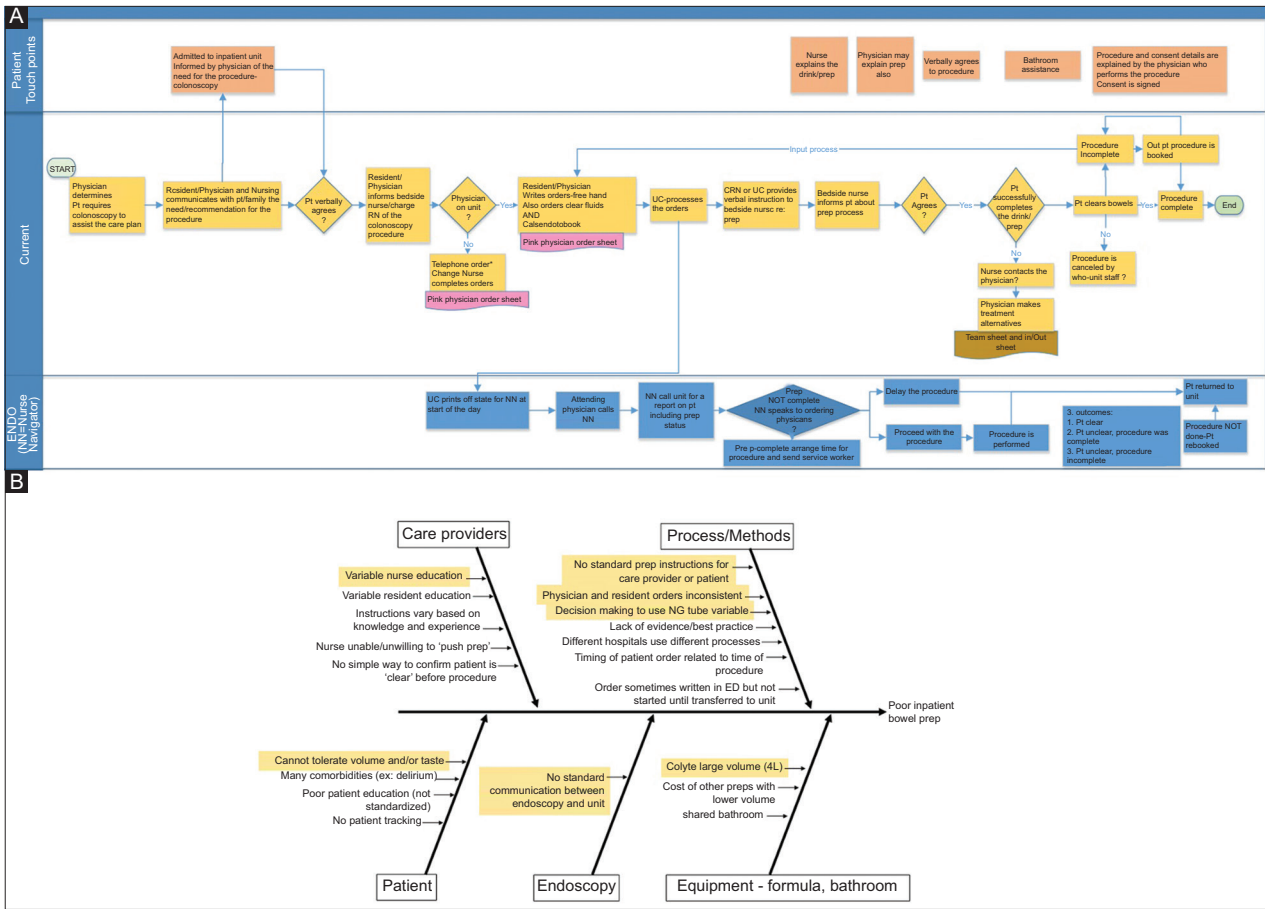
Title and Abstract	
12. Ethical Considerations	We completed the ARECCI ethics screening tool and the score was “minimal risk”; thus, no formal ethics board review was required as per local organizational policies.
Results	
13. Results	<p>A total of 128 colonoscopies were audited prior to intervention and 66 colonoscopies post intervention. After removal of those with no comments on colonoscopy prep on the procedure notes, 99 colonoscopies prior to intervention and 47 colonoscopies post intervention were analyzed. Prior to the intervention, 44% (44/99) of inpatient colonoscopies reported poor prep, resulting in 10 repeat procedures (10%; 10/99). Of the repeated procedures, the most common indication for colonoscopy was lower GI bleeding (4/10) and the most common reason for repeated colonoscopy was poor prep (8/10 repeated procedures). The interventions did not have to be adjusted during the PDSA cycles.</p> <p>Post intervention, approximately 60% (28/47) of the colonoscopies used the standardized order label and 66% (31/47) of physician orders used the 2-L split prep. A total of 80% of patients were provided with the placemat at their bedside. Of the 47 colonoscopy reports audited post intervention, 27.7% (13/47) had poor bowel prep and 72.3% (34/47) had good prep. There was a significant reduction in poor bowel preparation compared to pre intervention (P=0.038).</p> <p>As regards the balancing measure, there was a reduction in the number of repeat colonoscopies from 10% (10/99) to 4% (2/47). Notably, only 1/2 repeated colonoscopies post intervention was due to poor prep, compared to 8/10 of the repeated procedures prior to the intervention (P=0.27). Lower GI bleeding was the most common indication for colonoscopy in the patients who had poor preparation but did not have a repeat colonoscopy.</p> <p>There was no significant difference in Charleston comorbidity index scores, age or Schmid Fall Risk scores between patients with good or poor bowel preparation or pre/post intervention. However, on subgroup analysis comparing good and poor bowel preparation either pre or post PDSA intervention, there were significantly more men with poor preparation in the pre-PDSA group (P=0.029) and significantly higher Schmid Fall Risk Score for patients with poor preparation in the post-PDSA group (P=0.048) [Table 3]. A total of 59% of the surveyed patients found the placemat helpful, 100% of surveyed physicians indicated that they would use the standardized label, and 100% of surveyed nurses perceived the nursing tips sheet to be helpful.</p>
Discussion	
14. Summary	<p>The introduction of standardized label, nursing tip sheet and patient educational placemat led to a significant decrease in poorly prepared colonoscopies.</p> <p>Strengths of this project include the extensive pre-project information gathering to contextualize the problem of poor bowel preparation through surveys and chart audits. In addition, using a multidisciplinary team of physicians, nursing staff, managers and a QI specialist allowed for various perspectives and experiential knowledge to be shared regarding inpatient bowel preparation. In addition, our target unit was the GI unit, which has more patients who require colonoscopy compared to other units, and where staff are more knowledgeable about this procedure than those in other units, such as internal medicine or cardiology</p>
15. Interpretation	Implementing patient-centered education tools led to a decrease in colonoscopies with poor prep. Similar results have been reported with other educational tools.
16. Limitations	Study limitations included a non-validated survey, the absence of bowel preparation rating in the colonoscopy reports, as 27% did not comment on the prep, and the lack of a pre-intervention patient satisfaction survey. In addition, we measured whether the placemat was given or not and surveyed whether patients found it helpful; however, we did not evaluate any teaching the nurses provided around the placemat
17. Conclusions	<p>Future studies will focus on the sustainability of the placemat for hospitalized patients, the nursing tip sheet, as well as cost analysis. The UAH will implement an electronic medical record, therefore the bowel preparation physician order will become automated and standardized at the 2 L split prep.</p> <p>We anticipate that these interventions can be easily adopted by other hospital units with less experience regarding colonoscopy bowel preparation. The placemat is easy to read for both patients and nursing staff and is inexpensive to distribute. In addition, prior literature on optimizing colonoscopy preparation has all highlighted education as a key and beneficial factor to support bowel preparation. By implementing these interventions, we can improve both patient experience and health outcomes for the hospitalized patient population undergoing colonoscopy.</p>
Other Information	
18. Funding	This work was supported by Alberta Health Services Quality Innovation Fund

Supplementary Table 2 Carlson Comorbidity score [10] and Schmid Fall risk score [11]

Score	Carlson Comorbidity Score	Schmid Fall Risk Score
Components	Age- -50-59 (1) -60-69 (2) -70-79 (3) ->80 (4) 1- -Myocardial infarction -Congestive heart failure -Peripheral vascular disease -Dementia -Cerebrovascular disease -Chronic lung disease -Connective tissue disease -Ulcer -Chronic liver disease 2- -Hemiplegia -Moderate/severe kidney disease -Diabetes -Diabetes with complications -Tumor -Leukemia -Lymphoma 3- Moderate or severe liver disease 6- -Malignant tumor -Metastasis -AIDS	Mobility -Ambulates with no gait disturbance (0) -Ambulated or transfers with assistive devices (1) -Ambulated with unsteady gait and no assistance (1) -Unable to ambulate or transfer (0) Mentation -Alert, orientated X3 (0) -Periodic confusion (1) -Confusion at all times (1) -Comatose/unresponsive (0) Elimination -Independent in elimination (0) -Independent with frequency or diarrhea (1) -Needs assistance with toileting (1) -Incontinence (1) Prior Fall History (within 6months) -Yes (before admission) (1) -Yes (During admission) (2) -No (0) -Unknown (0)
Interpretation	Higher score equates to higher estimated 10-year mortality	Score 3 or more: Patient at risk for falls and fall prevention interventions should be implemented



Supplementary Figure 1 (A) Model for improvement- Adapted from Langley *et al* [8]. (B) Donabedian's framework for health care improvement- Adapted from Donabedian [9]. (C) Force field analysis indicating driving and restraining forces contributing to present or desired state. The size of the arrow for a specific force indicates the strength of that force's contribution. (D) Fishbone analysis provides a pictorial view of the key stakeholders, equipment and process measures that contribute to an outcome of interest. The goal of fishbone analysis is to identify areas to target for possible improvement



Supplementary Figure 2 (A) Process mapping of inpatient colonoscopy prep for this project. (B) Fishbone analysis of this project

Inpatient Bowel Prep Project Survey - Nursing

How easy is it to understand and follow colonoscopy prep orders?

1 2 3 4 5
Not easy Very easy

How comfortable are you explaining and education patients on prep?

How do you document how much prep a patient has taken?

- Teamsheet
- Verbal communication
- Nursing notes
- No where
- Other

If chose other, please specif method used:
Your answer _____

Do you know what to do if your patient is having a hard time prepping? (ie. nauseous, non-compliant, elderly, confused, etc.)

1 2 3 4 5
I don't know I definitely know

Did you find the placemat helpful to deucate the patient?

1 2 3 4 5
Not helpful Very helpful

How likely are you to use placemat resource in the future?

1 2 3 4 5
Very unlikely Very likely

Did you use the Bowel prep 'Tips' sheet?

Yes
 No

Did you find the Bowel prep 'Tips' sheet helpful?

1 2 3 4 5
Not helpful Very helpful

Inpatient Bowel Prep Project Survey - Patients

To improve our services, we would like your feedback regarding your bowel prep experience. We value your honest response. The information will be used for improvement purposes only. The survey should take approximately 3 minutes to complete. Your responses will be kept confidential and completely anonymous.

Do you agree to participate?

Yes
 No

Date
Day, month, year

Have you had a colonoscopy before?

Yes
 No

If yes, how many colonoscopies have you had?
short-answer text

How clearly did you understand the bowel prep process?

Clearly
 Somewhat clearly
 Unclear

Did you refer to the placement information during the bowel prep process?

Yes
 No

How easy is it to understand and follow the placemat guide?

1 2 3 4 5
Not easy Very easy

Did you that the placemat helped you with the bowel prep?

1 2 3 4 5
Not helpful Very helpful

After reading the placemat, do you understand what "being ready for a colonoscopy" or "being clear" means?

Yes
 No
 Somewhat

Do you think the placemat would be helpful if you needed to have a bowel prep again?

1 2 3 4 5
Not helpful Very helpful

Did you self-track the amount of colyte you drank on the placemat during the bowel prep?

Yes
 No

Did you feel like you were well supported during the bowel prep process?

Yes
 Somewhat
 No

Inpatient Bowel Prep Project Survey - Attending Physicians/Residents

What prep do you order typically?

Split 2L PO QHS and PO QAM
 4L PO QHS 11/20
 Other

If you chose other, please specify below:
Your answer _____

Please explain why this is your preferred prep order:
Your answer _____

Did you find the colonoscopy bowel prep order stiker easy to use?

Yes
 Somewhat
 No

How many pages (from the Unit staff) were received regarding complicated prep/misunderstandings with prep/incomplete prep?

<5
 5-10
 >10

How likely are you to use the colonoscopy bowel prep order sticker if it was available?

1 2 3 4 5
Very unlikely Very likely

Supplementary Figure 3 Surveys used for physicians/residents, nursing staff, and patients