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

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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

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**Introduction**

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

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**Conflict of Interest:** None

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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\textsuperscript{®}. 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
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 “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

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

**Table 1** Colonoscopy Preparation Quality:

| Quality Measurement | Pre-Intervention | Post-Intervention | P-value |
|---------------------|------------------|-------------------|---------|
| Good bowel prep (%)  | 75               | 90                | <0.05   |
| Patient satisfaction | 80               | 95                | <0.05   |

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**Table 2** Survey Results:

| Question                           | Pre-Intervention | Post-Intervention | P-value |
|------------------------------------|------------------|-------------------|---------|
| Difficulty consuming prep fluid    | 30               | 10                | <0.05   |
| Satisfaction with preparation guide | 60               | 80                | <0.05   |

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**Table 3** Nursing Tip Sheet Usage:

| Intervention | Pre-Intervention | Post-Intervention | P-value |
|--------------|------------------|-------------------|---------|
| Use of tip   | 10               | 40                | <0.05   |
| Feasibility  | 70               | 90                | <0.05   |

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**Table 4** Statistical Analysis:

| Variable                     | Median | IQR   | P-value |
|------------------------------|--------|-------|---------|
| Age                          | 65     | 50-75 | <0.05   |
| Carlson Comorbidity Index    | 2      | 1-3   | <0.05   |
| Schmid Fall Risk Score       | 5      | 2-8   | <0.05   |

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**Figure 2** Nus-Tip-Sheet: A 5-point Likert scale for patient satisfaction with bowel prep guide.
Approaches for incomplete bowel preparation

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

| 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 |
|                                   | Reposition patient, sit them up        | Encourage Ginger-Ale between glasses               | Do 2L HS, 2L in AM |
|                                   | Use a straw placed at the back of the mouth |                                           | NGT (if esophageal varices physician must insert tube) |
| 2. Is non-compliant                | Repeat education                       | When patient refuses to drink 2 hrs after initiating prep | Speak to patient |
|                                   | Involves the family if available       | Converse to understand causes                     | Cancel scope if continuing to refuse |
|                                   | 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 |
|                                   | Use whiteboard + Visual aides          | invole the family if available                    |                            |
|                                   | 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 |
|                                   |                                        |                                                      | Delay scope |

*AM resource nurse: Call endo in AM to update endo triage nurse on the status of patients who are NDT ready (prep not completed).*

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

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

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 |
|                                   | Reposition patient, sit them up        | Encourage Ginger-Ale between glasses               | Do 2L HS, 2L in AM |
|                                   | Use a straw placed at the back of the mouth |                                           | NGT if esophageal varices physician must insert tube) |
| 2. Is non-compliant                | Repeat education                       | When patient refuses to drink 2 hrs after initiating prep | Speak to patient |
|                                   | Involves the family if available       | Converse to understand causes                     | Cancel scope if continuing to refuse |
|                                   | 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 |
|                                   | Use whiteboard + Visual aides          | invole the family if available                    |                            |
|                                   | 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 |
|                                   |                                        |                                                      | Delay scope |

*AM resource nurse: Call endo in AM to update endo triage nurse on the status of patients who are NDT ready (prep not completed).*
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

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**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                               |                |                 |         |
| Male                              | 56             | 23              | 0.246†  |
| 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                        |                |                 |         |
| 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                               |                      |                      |         |
| Male                              | 44                   | 35                   | 0.106†  |
| 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 | Statistics |
|-----------------------------------|----------|-----------|------------|
| Age (IQR)                         | 61 (26.5)| 70.5 (15.5)| 0.081†    |
| Sex                               |          |           | 0.029**   |
| Male                              | 26       | 30        |           |
| Female                            | 29       | 14        |           |
| Carlson Comorbidity Index [11] (IQR) | 3 (4)  | 4.5 (4)   | 0.132†    |
| Schmid Fall Risk [12] (IQR)       | 0 (1)    | 0 (2)     | 0.509†    |

*Statistically significant. †Fisher’s exact test. ‡Mann-Whitney U test

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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.

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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

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Patient-Centered Approaches to Targeting Incomplete Bowel Preparations for Inpatient Colonoscopies

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.

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
- A bowel preparation order label for a 2 L split prep of Golytely® was created to promote order consistency to international standards.
- 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.
- 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.

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.

Supplementary Table 1

| Title and Abstract |
|-------------------|
| 1. Title | Patient-Centered Approaches to Targeting Incomplete Bowel Preparations for Inpatient Colonoscopies |
| 2. 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. |

(Contd...)


### 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

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.

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).

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 prior to or 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.

#### Discussion

The introduction of standardized label, nursing tip sheet and patient educational placemat led to a significant decrease in poorly prepared colonoscopies.

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.

#### Interpretation

Implementing patient-centered education tools led to a decrease in colonoscopies with poor prep. Similar results have been reported with other educational tools.

#### 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.

#### Conclusions

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.

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.

#### 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- | Mobility |
| | -50-59 (1) | - Ambulates with no gait disturbance (0) |
| | -60-69 (2) | - Ambulated or transfers with assistive devices (1) |
| | -70-79 (3) | - Ambulated with unsteady gait and no assistance (1) |
| | ->80 (4) | - Unable to ambulate or transfer (0) |
| | 1- | Mentation |
| | - Myocardial infarction | - Alert, orientated X3 (0) |
| | - Congestive heart failure | - Periodic confusion (1) |
| | - Peripheral vascular disease | - Confusion at all times (1) |
| | - Dementia | - Comatose/ unresponsive (0) |
| | - Cerebrovascular disease | - Independent in elimination (0) |
| | - Chronic lung disease | - Independent with frequency or diarrhea (1) |
| | - Connective tissue disease | - Needs assistance with toileting (1) |
| | - Ulcer | - Incontinence (1) |
| | - Chronic liver disease | Prior Fall History (within 6 months) |
| | 2- | - Yes (before admission) (1) |
| | - Hemiplegia | - Yes (During admission) (2) |
| | - Moderate/severe kidney disease | - No (0) |
| | - Diabetes | - Unknown (0) |
| | - Diabetes with complications | Prior Fall History (within 6 months) |
| | 3- | - Yes (before admission) (1) |
| | - Tumor | - Yes (During admission) (2) |
| | - Leukemia | - No (0) |
| | - Lymphoma | - Unknown (0) |
| | 4- | Moderate or severe liver disease |
| | 5- | Malignant tumor |
| | 6- | Metastasis |
| | - AIDS | | |

**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

| Question                                                                 | Options                                                                 |
|-------------------------------------------------------------------------|-------------------------------------------------------------------------|
| How easy is it to understand and follow colonoscopy prep orders?      | Not easy 1 2 3 4 5 Very easy                                           |
| How comfortable are you explaining and educating 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 specify method used:                           | Your answer                                                            |
| Do you agree to participate?                                           | Yes  No                                                                 |
| Have you had a colonoscopy before?                                     | Yes  No                                                                 |
| If yes, how many colonoscopies have you had?                          |                                                                        |
| 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 placement guide?         | Not easy 1 2 3 4 5 Very easy                                           |
| Did you find the placemat helpful to educate the patient?             | Very helpful  Not helpful                                               |
| How likely are you to use placemat resource in the future?            | Very unlikely  Very likely                                              |
| Did you use the Bowel prep 'Tips' sheet?                               | Yes  No                                                                 |
| Did you find the Bowel prep 'Tips' sheet helpful?                      | Not helpful 1 2 3 4 5 Very helpful                                      |
| What prep do you order typically?                                     | Split 2L PO QHS PO QAM 4L PO QHS 11/20 Other                            |
| If you chose other, please specify below:                             | Your answer                                                            |
| Did you find the colonoscopy bowel prep order sticker easy to use?    | Yes  No  Somewhat                                                     |
| 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? | Very unlikely  Very likely                                              |

### 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 placement guide?  
- Not easy  
- Unclear  
- Somewhat  
- Very easy  

Did you find the placemat helpful to educate the patient?  
- Yes  
- No  

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

Did you use the Bowel prep 'Tips' sheet?  
- Yes  
- No  

Did you find the Bowel prep 'Tips' sheet helpful?  
- Not helpful  
- Very helpful  

Did you feel like you were well supported during the bowel prep process?  
- 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 placement guide?**  
- Not easy  
- Unclear  
- Somewhat  
- Very easy  

**Did you find the placemat helpful to educate the patient?**  
- Yes  
- No  

**How likely are you to use placemat resource in the future?**  
- Very unlikely  
- Very likely  

**Did you use the Bowel prep 'Tips' sheet?**  
- Yes  
- No  

**Did you find the Bowel prep 'Tips' sheet helpful?**  
- Not helpful  
- Very helpful  

**Did you feel like you were well supported during the bowel prep process?**  
- 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 placement guide?**  
- Not easy  
- Unclear  
- Somewhat  
- Very easy  

**Did you find the placemat helpful to educate the patient?**  
- Yes  
- No  

**How likely are you to use placemat resource in the future?**  
- Very unlikely  
- Very likely  

**Did you use the Bowel prep 'Tips' sheet?**  
- Yes  
- No  

**Did you find the Bowel prep 'Tips' sheet helpful?**  
- Not helpful  
- Very helpful  

**Did you feel like you were well supported during the bowel prep process?**  
- Yes  
- No

### Inpatient Bowel Prep Project Survey - Attending Physicians/Residents

- What prep do you order typically?  
  - Split 2L PO QHS 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 sticker easy to use?  
  - Yes  
  - 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?  
  - Very unlikely  
  - Very likely  

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