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Readmissions with dehydration after Ileostomy Creation: Rethinking Risk Factors

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Abstract

BACKGROUND—29% of post-ileostomy discharges are readmitted, most commonly due to dehydration. However, there is a lack of detailed data specifically evaluating factors associated with readmission with dehydration. Additionally, patients with a history of an ileostomy have often been excluded from previous studies, and therefore represent a group of understudied ileostomates.

OBJECTIVE—To evaluate factors available at discharge associated with 30-day readmission for dehydration, rather than all-cause readmissions.

DESIGN—This was a retrospective cohort study.

SETTING—Study patients received ileostomies at a tertiary academic medical center from 2014–2016.

PATIENTS—Patients with a pre-existing ileostomy which was not recreated per the operative note were excluded, while those who received a new ileostomy were included.

MAIN OUTCOME MEASURE—30-day readmission for dehydration as defined by objective clinical criteria.

RESULTS—A total of 262 patients underwent ileostomy creation and were discharged alive. 25% were aged ≥65, 53% were male, 14% had a history of ileostomy, 18% had a creatinine >1.0 on discharge, and 26% had high ileostomy output at any time during the index admission. Among all ileostomates, the all-cause rate was 30%. Mean days to readmission for any cause was 8.5 while

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for dehydration it was 11.6 days. Of the readmissions, 37% were readmitted with a diagnosis of dehydration, and dehydration was the sole reason in 26%. Among those with dehydration, the most common length of stay was 2 days. In multivariable logistic regression, 30-day readmission with dehydration was associated with older age, male sex, history of an ileostomy, high ileostomy output during index admission, and a discharge creatinine >1.0.

LIMITATIONS—Retrospective design.

CONCLUSIONS—Ileostomy dehydration efforts have focused on new ileostomy patients; however, our data suggests that patients with a history of an ileostomy are actually at risk for readmission with dehydration. Further studies aimed at reduction of readmission with dehydration after ileostomy are warranted and should include patients with a history of an ileostomy. See **Video Abstract** at http://links.lww.com/DCR/A643.

Keywords

Colorectal surgery; Dehydration; ileostomy; readmission; risk factors

INTRODUCTION

Ileostomy formation, though effective in reducing morbidity related to colorectal complications, is associated with the highest readmission rates from colorectal procedures.[1–4] In fact, ileostomies matched kidney transplants for the highest 30-day all-cause readmission rate at 29.1% readmitted, placing a huge burden on the healthcare system.[5] In 2010, there were 23,392 index hospital stays with ileostomy creation in the United States (US). This presents an opportunity for substantial improvement.

Dehydration is the most common cause of readmission present in approximately 40% of post-ileostomy readmissions and has significant morbidity to patients.[6,7] Furthermore, ileostomy-related morbidity and readmissions can impact adjuvant treatment in cancer settings as it has been shown to be associated with delayed adjuvant chemotherapy in rectal cancer patients.[8] Therefore, preventing dehydration and subsequent readmission is a goal which can improve morbidity, healthcare utilization and even cancer survival.

Although there has been recent interest in understanding and preventing readmissions after ileostomy creation, there remain many unanswered questions. To date, predictors of readmission for dehydration rather than all-cause readmission are limited in the literature. All-cause readmissions have been predicted by factors that are not amenable to prevention post-discharge, such as serious in-hospital complications during the initial admission, while other predictors such as formation of loop versus end ileostomy and length of stay are more amenable to intervention and are more likely to be associated with dehydration.[7] As such, some factors that predict all-cause readmission may not be applicable for identifying patients specifically at risk for readmission with dehydration. Additionally, patients who have had previous ileostomies have been excluded in previous analyses. While it could be that patients who have had an ileostomy may feel experienced and knowledgeable with regards to stoma management and hydration, thereby being less likely to be readmitted, this has never been reported. Therefore, there are important questions that still need to be

addressed in an effort to understand which patients are at high risk of readmission with dehydration in order to develop targeted interventions to prevent this common event.

The goal of this study was to evaluate the factors associated specifically with 30-day readmissions with dehydration, rather than all-cause readmissions. The identification of dehydration-specific readmission predictors is warranted in order to create ileostomy-dehydration programs with evidence-based target patients which can lead to decreased ileostomy-related morbidity. We expected dehydration to be the leading cause of readmission, and a priori, we hypothesized that patient factors available prior to discharge would be associated with increased risk of readmission for dehydration, and that a history of an ileostomy would decrease the risk of readmission for dehydration.

METHODS

Study Cohort

All patients ages ≥18 who underwent creation of an ileostomy from January 1, 2014 through December 31, 2016 by surgeons within the Colorectal Surgery Division of our tertiary-care center were identified. Patients were all enrolled in standardized pathways for their post-operative care as well as had inpatient and outpatient WOCN (Wound, Ostomy and Continence Nursing) care. During the study period, an enhanced recovery after surgery (ERAS) protocol was implemented at our institution. Patients were identified from the division inpatient billing list (n=2,739) through the use of CPT codes and/or procedure names and ultimately verification through operative note review. Patients with a pre-existing ileostomy on the day of surgery which was not recreated during the procedure according to the operative note were excluded. Otherwise, patients with a history of an ileostomy, whether in the past or currently, were included if a new ileostomy was created (i.e., end ileostomy converted to loop or small bowel resection including existing ileostomy with new ileostomy creation). Of 273 patient identified, 10 died during the index admission, and therefore could not be readmitted within 30 days of discharge, and are excluded. One patient was excluded due to a missing laboratory value for a final cohort of 262 patients.

Data Collection

Each medical record was meticulously examined in chronological order by both a surgically trained reviewer and a research assistant. Study variables were captured using REDCap ™ (Research Electronic Data Capture, Vanderbilt University).[9] A methodical inquiry of each patient's chart was performed, including phone encounters and scanned-in documents from encounters at other institutions, to account for patient, operative, post-operative and, if present, readmission factors.

Patient factors captured were age, sex, Medicaid insurance at time of surgery, patient zip code, race, marital status, smoking status, presence of Charlson Comorbidities, body mass index (BMI), history of ileostomy, pre-operative creatinine, and use of chronic diuretics with or without discharge on diuretics. The date of surgery was the date of ileostomy creation, whether during the index procedure or as a return to the operating room for a complication from a previous procedure. Operative factors captured were elective surgery versus non-

elective, indication for surgery, operative approach, type of surgery, and surgical wound contamination classification. Elective admissions were planned prior to the admission; occasionally an elective patient was admitted 1–2 days prior to surgery. Non-elective surgeries included urgent and emergent cases which were not planned prior to admission. In the post-operative course, data capture included complication during the index admission (ileus/small bowel obstruction, superficial, deep or organ space surgical site infection, anastomotic leak, UTI, pneumonia, sepsis, blood transfusion, venous thromboembolism, acute kidney injury, return to the operating room, myocardial infarction (MI) or stroke/transient ischemic attack (TIA)), Alvimopan use (none, pre-operative use only, post-operative use only, or both), and creatinine (post-operative day 1 and on day of discharge). Days from surgery until ileostomy output was defined by output >250/24 hrs[7]. Alvimopan timing varied according to elective versus non-elective status as well as post-operative course. High ileostomy output was defined at as a recorded 24-hour output of ≥1500mL requiring medical intervention (intravenous fluid bolus, addition of anti-motility agents, and/or high output was the sole reason preventing discharge per surgical team note) at any point throughout the hospitalization, but not necessarily immediately prior (24 or 48 hours) to discharge. Length of stay (LOS) after ileostomy creation and discharge disposition location were also captured.

Readmission was defined as a readmission within 30-days of discharge from the index ileostomy creation admission; readmissions included both inpatient and observation stays which may be up to 2 midnights long. Days to first readmission was calculated from discharge and readmission date. The cause or causes of readmission was abstracted from the chart review and strict criteria were used to define dehydration. Dehydration was defined using strict and objective clinical criteria; a subjective patient report of dehydration without corresponding objective data was not recorded as dehydration. Dehydration could be diagnosed by urine electrolyte abnormality at readmission (urine sodium <20mEq/L, fractional excretion of sodium <0.5% or urine osmolality >450), or by clinical criteria by admitting physicians (diagnosis of dehydration, high stoma output described or poor oral intake or vomiting described) and an objective sign of dehydration at time of readmission (BUN/creatinine ratio >20, creatinine ≥ 150% of baseline, bicarbonate <20, hyperkalemia >5.0 or hypokalemia <3.4, hypernatremia >149 or hyponatremia <133, sinus tachycardia >110, mean arterial pressure <65, or documented orthostatic hypotension).[7]

Statistical Analysis

We opted to power for a small effect size given that this was exploratory and designed for quality improvement implementation. For regression equations using 6 or more predictors, approximately 30 participants per predictor are needed for sufficient power to detect a small effect size.[7,10] With a sample size of 262, we were powered to use up to 8 predictors.

Bivariate analysis was performed by comparing factors by outcome using the chi-square test and t-test as appropriate. Factors with a p value <0.1 were entered manually into the multivariable logistic regression for 30-day readmission due to dehydration. Analysis was performed using SAS Software (Version 9.3, SAS Institute, Cary, NC). The study was approved by the University of Rochester Medical Center Institutional Review Board.

RESULTS

Cohort characteristics

Patient characteristics are described in Table 1. 75% percent of patients were aged <65 (mean age 54), 53% were male, and 14% had a history of ileostomy. The most common reason for ileostomy creation was colorectal cancer (32%). 12 ileostomies (5%) were created as stand-alone procedures. A minimally invasive (MIS) approach was intended in 56% of cases. 34% of ileostomies were created as part of non-elective cases. As compared to elective cases, non-elective cases did not significantly vary in median age (55.6 vs 56.5, p-value 0.446), median number of comorbidities (1 vs 1, p-value 0.976), and having Medicaid insurance (14% vs 13%, p-value 0.821). High ileostomy output during the index admission was diagnosed in 26% of cases and 18% of all cases had a creatinine >1.0 on discharge day. All patients had 30 days of follow-up post-discharge.

30-Day Readmissions

Amongst all patients who underwent ileostomy creation, the rate of readmission with dehydration was 11% while the all-cause readmission rate was 30%. Characteristics of patients stratified by 30-day readmission with dehydration or not are described in Table 2. Mean days to readmission for any cause was 8.5 while for dehydration it was 11.6 days; although, the most common time to readmission in both groups was 3 days.

Of the readmissions, 37% were readmitted with a diagnosis of dehydration, and dehydration was the sole reason for readmission in 26% of all those readmitted (Table 3). Among all readmissions, the median readmission LOS was 6 days (interquartile range [IQR] 3–11) and the most common LOS was 3 days. Among those readmitted for dehydration, the median readmission LOS was 6 days (IQR 4–10) and the most common LOS was 2 days. Of patients readmitted, 22% had an intraperitoneal infection, 9% an extraperitoneal infection, and 10% an ileus/SBO. Amongst patients readmitted, 24% required interventional radiology drainage. Nine patients were readmitted with dehydration and another reason; most commonly, 5 patients had an intraabdominal infection underlying their fluid/electrolyte imbalance. One patient's dehydration was driven by abdominal pain in setting of pulmonary embolism with new extensive IVC thrombus in the setting of a pre-existing IVC filter. One patient had rib osteomyelitis and chest wall abscess as the reason for the index admission during which they happened to develop sigmoid volvulus; at readmission, the primary reason was persistent chest wall infection. One patient was discharged home with IV fluids through a central line and readmission was primarily due to a central line infection and secondary dehydration. Of these patients readmitted with dehydration and an additional reason for readmission, dehydration was the ultimate cause for 1 patient who had a subsequent demand-mediated myocardial infarction; this patient's index admission was due to obstructing colon cancer which was metastatic on pathology.

In bivariate analysis, age, sex, history of an ileostomy, a diagnosis of high ostomy output during the index admission, diuretics at home, and a discharge creatinine >1.0 were associated with readmission with dehydration. A change in post-operative creatinine >0.5mg/dL as compared to baseline was not associated with dehydration. While indication

for surgery was not significantly related with readmission for dehydration, some variation is seen across different surgery types. For instance 21% of ileal pouch-anal anastomosis (IPAA), 12% of partial colectomies and 25% of small bowel resections/lysis of adhesions (SBR/LOA) were readmitted with dehydration. On the other hand, 0% of total proctocolectomy with end ileostomy, 5% of low anterior resections (LAR) and 6% of total colectomies were readmitted with dehydration. Patients with history of an ileostomy were more likely to have specific procedures: 29% had a total proctocolectomy with end ileostomy, 25% IPAA, and 25% a SBR/LOA.

In multivariable logistic regression, 30-day readmission with dehydration was independently associated with older age (65+), male sex, history of an ileostomy, high ileostomy output during index admission, and a discharge creatinine > 1.0. If the analysis is performed with outcome as readmission only for dehydration (yes/no), similar results are obtained leading to the same inferences (Table 4).

DISCUSSION

After careful evaluation of 262 patients who underwent ileostomy creation, we found an all-cause readmission rate of 30% within 30 days of discharge. Among those readmitted, dehydration was the most common cause at 37% and was the sole reason for readmission in 26%. These findings are in concordance with data from the past decade demonstrating an overall post-ileostomy all-cause readmission rate of 28–35% and dehydration to be the most common reason for readmission present in 41–44% of patients who are readmitted.[7,11,12]

One of the most interesting findings was that a history of an ileostomy was not associated with a decreased risk of readmission with dehydration, which we had hypothesized, but was actually associated with an increased risk. Numerous studies have looked at readmissions after ileostomy formation and have excluded patients with a history of an ileostomy without established justification.[7,11–13] Although the reason for this may be that patients with history of an ileostomy are expected to be more knowledgeable and capable of managing stomas and hydration status, no direct evidence to support this exists. Meanwhile, other studies have not excluded such patients but have also not evaluated this risk factor.[8,14,15] Yet, a new ileostomy is likely to be more proximal which could lend to increased dehydration.[14] This is important to consider given that ileostomy dehydration programs and clinical practice guidelines are targeted towards new ileostomates only.[12,16]

Another compelling finding was that high ileostomy output at any time during the index admission was associated with a 3-fold increased risk of readmission for dehydration. This is meaningful because previous studies have looked at stoma output at 24 or 48 hours prior to discharge but have not found any significance.[7,14] Similarly, if we run our logistic regression model using continuous ileostomy output within 24 hours of discharge, this variable is not significant in our model. Yet, when high ileostomy output does occur it is usually addressed and decreased prior to discharge, thus, leading to what is expected to be a safe discharge. Hence, we believe that using the diagnosis of a high ileostomy output requiring an intervention during the index admission, which was present in 55% of readmissions with dehydration, better captures the ileostomy-related burden of each patient,

rather than the immediate pre-discharge volume which is expected to be safe. This could be used as a target for aggressive follow-up after discharge.

Male sex was also an independent predictor of readmission with dehydration. Although previous ileostomy-specific studies have not shown an association between male sex and overall or dehydration-specific readmissions, multiple studies have shown that of those readmitted a larger proportion are men at up to 59%.[7,14] Similarly, a study of 42,348 patients who underwent colectomy for cancer found that that male sex, as well as stoma formation, were independent risk factors for 30-day readmissions.[17] Although this may seem surprising, the fact that men tend to be have worse health outcomes than women resonates in the literature and worse outcomes in males are thought to reflect factors including behaviors associated with male norms of risk-taking and adventure, health behavior paradigms related to masculinity and the fact that men are less likely to visit a doctors whey are ill, and when they see a doctor, men are less likely to report symptoms of illness.[18]

Results from other papers vary widely (Table 5) and is likely due to small sample sizes, inconsistent variable definitions and capture, and various follow-up times. Given that patients are generally optimized prior to discharge, identifying those who are more likely to fail in the outpatient setting is of utmost importance to implement targeted interventions. Our data suggests that even with an enhanced recovery program, patients with ileostomies remain high risk for readmission. Active prevention of patients identified pre-discharge could change the natural history of ileostomy dehydration in the post-discharge period. Because of this issue, hospitals have begun implementing ileostomy care pathways to reduce readmissions due to dehydration. A recent single-center prospective study showed that by instituting a pathway consisting of preoperative teaching, standardized education materials, in-hospital engagement, observed management, and post-discharge tracking of intake and output, 30-day readmission rates in ileostomy patients dropped from 35.4% to 21.4% overall, and from 15.5% to 0% for patients readmitted with dehydration.[12] However, such markedly improved results have not been replicated. Another institution showed a decrease of 58% in their 30-day overall readmission rate for patients undergoing ileostomy formation after implementing a pathway consisting of regular home visits by a visiting nurse agency.[15] Both of these studies did not risk-adjust for patient and hospitalization characteristics. It is unclear what the best intervention is since existing program evaluations have been small, not risk-adjusted, and not replicated. Nevertheless, we believe the outpatient component of such programs is where the most improvement remains to be created and we have identified 5 risk factors to identify patients prior to discharge that may benefit from targeted programs. Perhaps engaging in telemedicine for close outpatient follow-up and intervention may be part of the solution.[19]

This study's strengths are founded on detailed data collection of contemporary patients with a priori definitions that can readily be replicated. This is the first study to include comprehensive patient-level information, including distance to hospital, marital status and a history of an ileostomy, all of which can impact stoma and hydration management. Of importance is the fact that the most common readmission LOS was 2 days; as such, a brief search of in-patient readmissions would not have captured the true burden of ileostomy complications and morbidity as many of these patients would be categorized as observation

status and may not be captured in basic readmission searches. However, observation stays are still a burden to the healthcare system, and even more importantly, to the patient experience.

Our study is not without limitations. Our retrospective data relies on the accuracy of the chart and its comprehensiveness; however, electronic medical record had been fully implemented in outpatient and inpatient settings for 2 years prior to study period start and completeness was only a problem for 1 patient. Readmissions to outside-institutions could have been missed if records of such encounters or related phone-conversations were not documented; nonetheless, phone-call documentation and scanned-in documents were queried for readmission information. Bias in classifying variables was limited by collection in chronological order; as such, study personnel did not know the outcome while capturing index admission variables. While our study addresses a ubiquitous issue, our specific effect estimates are limited in generalizability due to wide variation in care practices across hospitals and surgeons. Lastly, the data was collected primarily for quality improvement implementation but nevertheless yielded granular information.

Notwithstanding these limitations, our study does identify a history of ileostomy as a novel risk factor for readmission with dehydration. Such patients have often been excluded from readmission programs and evaluations, but our data suggests that they would benefit. The other risk factors identified, older age, male sex, high ileostomy output during index admission and a discharge creatinine > 1.0, are readily available, objective measures which can be used to identify patients at risk for readmission with dehydration and future quality improvement initiatives.

CONCLUSION

Readmissions are common after ileostomy creation and are most often due to dehydration. While dehydration efforts have focused on new ileostomy patients, our data shows that patients with a history of an ileostomy are actually at risk for readmission for dehydration. Further studies aimed at reduction of readmission with dehydration after ileostomy are warranted and should include patients with a history of an ileostomy.

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Table 1

Colorectal Patients who Underwent Ileostomy Creation (n=262)

Age	
<65	197 (75%)
65+	65 (25%)
Sex	
Male	138 (53%)
Female	124 (47%)
Medicaid	34 (13%)
Race	
White	226 (86%)
Black	27 (10%)
Other	9 (3%)
Marital status	
Married	139 (53%)
Not married	123 (47%)
Smoking status	
Never smoker	122 (47%)
Previous or current smoker	140 (53%)
BMI	
<30 (normal or overweight)	181 (69%)
≥30 (obese)	81 (31%)
Charlson Comorbidity Index	
0	112 (43%)
1–2	107 (41%)
3+	43 (16%)
Previous ileostomy (current or previous)	36 (14%)
Non-elective surgery	88 (34%)
Indication for Surgery	
Colorectal cancer	85 (32%)
IBD	80 (31%)
Diverticulitis	43(16%)
Other	54 (21%)
Minimally invasive surgery (ITT)	147 (56%)
Surgery	
Colorectal resection	228 (87%)

Other	34 (13%)
Type of ileostomy created	
End	96 (37%)
Loop	166 (63%)
Wound Class	
II or III	214 (82%)
IV	48 (18%)
High ostomy output during index admission	69 (26%)
Any complication (other than high ostomy output)	135 (52%)
Alvimopan	
No	86 (33%)
Pre-op only	18 (7%)
Post-op only	51 (19%)
Both	107 (41%)
Output day before discharge	
<1500mL	231 (88%)
≥1500mL	31 (12%)
# of anti-motility agents at discharge	
0	144 (55%)
1	86 (33%)
2–3	32 (12%)
Discharged to home	233 (89%)
Creatinine day of discharge > 1.0	48 (18%)
On Diuretics at Home	28 (11%)
Readmission (any reason)	78 (30%)
Readmission with + Dehydration	29 (11%)

Table 2

Colorectal Patients who Underwent Ileostomy Creation - Readmitted within 30 Days of Discharge for Dehydration or Not

	30-Day Readmission with Dehydration N=29 (11%)	No 30-Day Readmission with Dehydration N=233 (89%)	P value
Age			
<65	17 (59%)	180 (77%)	0.03
65+	12 (41%)	53 (23%)	
Sex			
Male	24 (83%)	114 (49%)	0.0006
Female	5 (17%)	119 (51%)	
Medicaid	3 (10%)	31 (13%)	0.65
Race			
White	25 (86%)	201 (86%)	0.99
Other	4 (14%)	32 (14%)	
Marital status			
Married	12 (41%)	127 (55%)	0.18
Not married	17 (59%)	106 (45%)	
Smoking status			
Never smoker	10 (34%)	112 (48%)	0.17
Previous or current smoker	19 (66%)	121 (52%)	
BMI			
<30 (normal or overweight)	20 (69%)	161 (69%)	0.99
30+ (obese)	9 (31%)	72 (31%)	
Charlson Comorbidity Index			
0	11 (38%)	101 (43%)	0.76
1–2	12 (41%)	95 (41%)	
3+	6 (21%)	37 (16%)	
Distance from home to hospital (median, IQR)	16.5 (4.3–49.7)	20.9 (3.8–54)	0.60
Previous ileostomy (current or previous)	9 (31%)	27 (12%)	0.004
Non-elective surgery	13 (45%)	75 (32%)	0.17
Indication for Surgery			
Colorectal cancer	7 (24%)	78 (34%)	0.28
IBD	7 (24%)	73 (31%)	
Diverticulitis	8 (32%)	35 (15%)	
Other	7 (28%)	47 (20%)	

	30-Day Readmission with Dehydration N=29 (11%)	No 30-Day Readmission with Dehydration N=233 (89%)	P value
Minimally invasive surgery (ITT)	12 (41%)	135 (58%)	0.09
Surgery			
Colorectal resection	23 (79%)	205 (88%)	0.19
Other	6 (21%)	28 (12%)	
Type of ileostomy created			
End	8 (28%)	88 (38%)	0.28
Loop	21 (72%)	145 (62%)	
Wound Class			
II or III	21 (72%)	193 (83%)	0.17
IV	78 (28%)	40 (17%)	
High ostomy output during index admission	16 (55%)	53 (23%)	0.0002
Any complication (other than high ostomy output)	19 (66%)	117 (50%)	0.12
Alvimopan			
No	12 (41%)	74 (32%)	0.32
Pre-op only	2 (7%)	16 (7%)	
Post-op only	2 (7%)	49 (21%)	
Both	13 (45%)	94 (40%)	
Output day before discharge			
<1500mL	21 (72%)	210 (90%)	0.005
≥1500mL	8 (28%)	23 (10%)	
# of anti-motility agents at discharge			
0	12 (44%)	132 (57%)	0.19
1	11 (36%)	75 (32%)	
2–3	6 (20%)	26 (11%)	
Any anti-motility agent at discharge			
No	12 (41%)	132 (57%)	0.12
Yes	17 (59%)	101 (43%)	
Discharged to home	25 (86%)	208 (89%)	0.62
Creatinine preop > 1.0	12 (41%)	57 (24%)	0.051
Creatinine day of discharge > 1.0	14 (48%)	34 (15%)	<.0001
On chronic diuretics at home	6 (21%)	22 (9%)	0.06
Discharged on diuretics	5 (17%)	20 (9%)	0.13

Table 3

Causes of Readmission Among Patients Readmitted within 30-Days (n=78)

Causes	Cause Present	Sole Cause
Dehydration	37%	26%
Ileus or SBO	10%	8%
Organ space surgical site infection	26%	18%
Non-organ space surgical site infection	7%	4%
Clostridium difficile colitis	0%	0%
UTI	4%	4%
Other infectious cause *	4%	0%
Post-operative pain	8%	5%
Stoma complication requiring revision	1%	1%
Cardiovascular event **	4%	0%
Other ***	19%	15%

* Other infectious causes included pneumonia and sepsis with unknown etiology

** Cardiorespiratory events included myocardial infarction and venous thromboembolisms

*** Other included heterogeneous causes such as acute cholecystitis, displacement of a percutaneous drain, failure to thrive, and management of other diseases (ie: ileostomy created due to non-colorectal-cancer but returns for issues related to other cancer organ system).

Table 4

Multivariable Analysis of Independent Factors Associated with 30-Day Readmission with Dehydration

	Readmission with Dehydration		Readmission only for Dehydration	
	OR (95% CI)	**P-value**	**OR (95% CI)**	**P-value**
Age				
<65	Reference		Reference	
65+	3.248 (1.15, 9.173)	0.03	3.710 (1.09, 12.6)	0.04
Sex				
Female	Reference		Reference	
Male	3.18 (1.05, 9.68)	0.04	5.02 (1.04, 24.2)	0.04
Previous ileostomy	7.58 (2.31, 24.86)	0.0008	6.80 (1.65, 27.96)	0.008
Minimally invasive surgery (ITT)	0.64 (0.26, 1.57)	0.33	0.79 (0.27, 2.27)	0.66
High ostomy output during index admission	2.98 (1.20, 7.38)	0.02	2.92 (1.03, 8.24)	0.04
Diuretics at Home	2.98 (0.88, 9.98)	0.08	1.41 (0.30, 6.53)	0.66
Discharge Creatinine > 1.0	3.34 (1.25, 8.93)	0.02	3.92 (1.28, 12.06)	0.02

Table 5

Previous studies reporting ileostomy readmission predictors in adult patients

Author Year	Study Cohort	Readmission Rate (All / Dehydration)	Follow Up	Variables Examined for Readmission Model		
				# examined/ included	Included Variables	Not Examined
All – Cause Readmissions Model						
Fish (2017)[7]	407 New Ileostomy Patients (2010–2012)	28% / 12%	60 Days	17 / 7	- Age ≥65 * - Lives alone - Charlson comorbidity index * - Loop stoma (vs end) * - Complication * - Length of stay * - Discharge on Lomotil	- Distance from home to hospital - Marital Status - History of previous or current ileostomy - Diagnosis of high ostomy output periop
Dehydration Readmissions Model						
Paquette (2013)[14]	201 Ileostomy Patients (2007–2011)	16% / 9%	30 Days	14 / 3	- BMI - Loop Ileostomy - IPAA *	- Distance from home to hospital - Marital Status - Elective surgery status - Comorbidities - Diuretic use - History of previous or current ileostomy - Diagnosis of high ostomy output periop - Complications
Hayden (2013)[11]	154 New Ileostomy Patients (2008–2011)	40% / 20%	Not defined	15 / 5	- Age >67 - Cancer diagnosis - Neoadjuvant chemoradiation * - Anti-diarrheal at discharge * - Serum potassium	- Distance from home to hospital - Marital Status - Elective surgery status - Comorbidities - Diuretic use - History of previous or current ileostomy - Diagnosis of high ostomy output periop

Author Year	Study Cohort	Readmission Rate (All / Dehydration)	Follow Up	Variables Examined for Readmission Model		
				# examined/ included	Included Variables	Not Examined
						- Complications
Messaris (2012)[6]	603 Loop Ileostomy Patients (1990–2010)	17% / 7%	60 Days	12 / 4	- Age (continuous) - Diagnosis - Renal Comorbidity - Chronic diuretic use *	- Distance from home to hospital - Marital Status - Elective surgery status - History of previous or current ileostomy - Diagnosis of high ostomy output periop - Discharged on anti-motility agents - Complications - Discharge renal function

* Significant at $p<0.05$