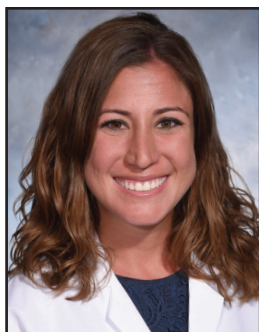


Carol Rees Parrish, MS, RDN, Series Editor

## High Output Ileostomies: Preventing Acute Kidney Injury



Gabriella C. Squeo



Carol Rees Parrish

Although most patients who undergo a total colectomy with a resulting end ileostomy do well in the post-operative period, as many as 16% to 50% of patients experience “high output.” High output ileostomies, defined as output >1500mL of effluent per day, can cause dehydration, electrolyte abnormalities, metabolic acidosis, and/or acute kidney injury (AKI), which may result in readmission and high health care costs. The best strategies to protect the kidneys involve preventing dehydration and subsequent injury from occurring in the first place. Preoperative patient education continuing through the postoperative and outpatient periods is of paramount importance, so patients are not only aware of normal ostomy output but are able to promptly recognize high output when it occurs, allowing for early treatment. Management includes fluid administration, pharmacologic interventions, and diet and beverage modification where appropriate.

### INTRODUCTION

Over 300,000 colectomies are performed each year in the United States; approximately 130,000 of which are total colectomies resulting in an end ileostomy.<sup>1</sup> The most common indications for a colectomy include toxic megacolon from *Clostridium difficile* infection, ulcerative colitis, diverticulitis, and colon cancer. Although most patients do well in the post-operative period, as many as 16% to 50% of patients experience “high output,” typically defined as greater than 1500mL of ostomy effluent in a 24-hour period.<sup>1,2</sup>

Some patients can maintain adequate hydration despite such high output, while others end up in an emergency department (ED) with dehydration, or worse, acute kidney injury (AKI) due to the severity of their dehydration, resulting in admission (Table 1). Not only are these ED visits or admissions an unpleasant inconvenience to patients, but they increase health care costs considerably. The purpose of this article is to provide an update on the earlier article: Bridges M, et al. High Output Ileostomies: The Stakes are Higher Than the Output,<sup>3</sup> and to describe one institution’s attempts to mitigate this burden to patients and decrease coinciding health care costs.

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## What To Expect After a Colon Resection/Ostomy Creation

The colon avidly resorbs water and electrolytes, and thus, when removed, can result in difficulty maintaining hydration and electrolyte adequacy.<sup>2,4</sup> It is of critical importance that a patient with a new ileostomy be educated on what is normal and abnormal in terms of both urine and ostomy output. This allows the patient, once they are discharged from the hospital, to recognize high output before AKI occurs. Normal ostomy output depends on the location of the stoma. For a patient with a colostomy, normal output is 200-600mL per day. In a new ileostomy, a patient can expect less than 1200-1500mL per day. This should decrease to 600-800mL once mature, which may take several weeks following surgery. A jejunostomy has the highest expected output due to its proximity and may put out as much as 6 liters per day.

Patients also need to be educated on normal urine output. Often the focus is on ostomy output alone, however, urine output is more a reflection of kidney function and adequate hydration. If the patient is not drinking enough, or not absorbing enough of what they drink, it often becomes the responsibility of the clinician to provide guidance and potential therapeutic interventions. Patients need to make at least 1200mL of urine each day to protect their kidneys; if they are a known kidney stone former, urine output should be higher at 1500mL/day. They should measure and record urine and ostomy output for 2 weeks after leaving the hospital, or until the first clinic visit and they are deemed “stable.” Note: patients will need to be given the tools to do this (stool hat or cylinder canister, male or female urinal – see Bridges citation).<sup>3</sup>

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**Table 1. Readmission for Dehydration and/or AKI in Patients with Ileostomies**

Year	Citation	N	Dehydration and/or AKI*
2001	Beck-Kaltenbach	107	19%
2002	Hallböök	222	32%
2012	Akesson	92	29%
	Gessler	250	18%
	Hayden	154	20%
	Messarís	603	7%
	Nagle	161	16%
2013	Paquette	201	17%
2014	Gessler	308	19%
	Glasgow	53	39/33%
	Phatak	294	11%
	Tyler	6007	9%
2015	Arenas Villafranca	43	30%
2016	Orcutt	104	14%
2017	Fish	23	65%
	Iqbal	113	41%
	Li	84	17%
2018	Justiniano	262	37%
2019	Vergara-Fernández	102	24%
2020	Fielding	561	17.3%
2021	Loria	262	19%

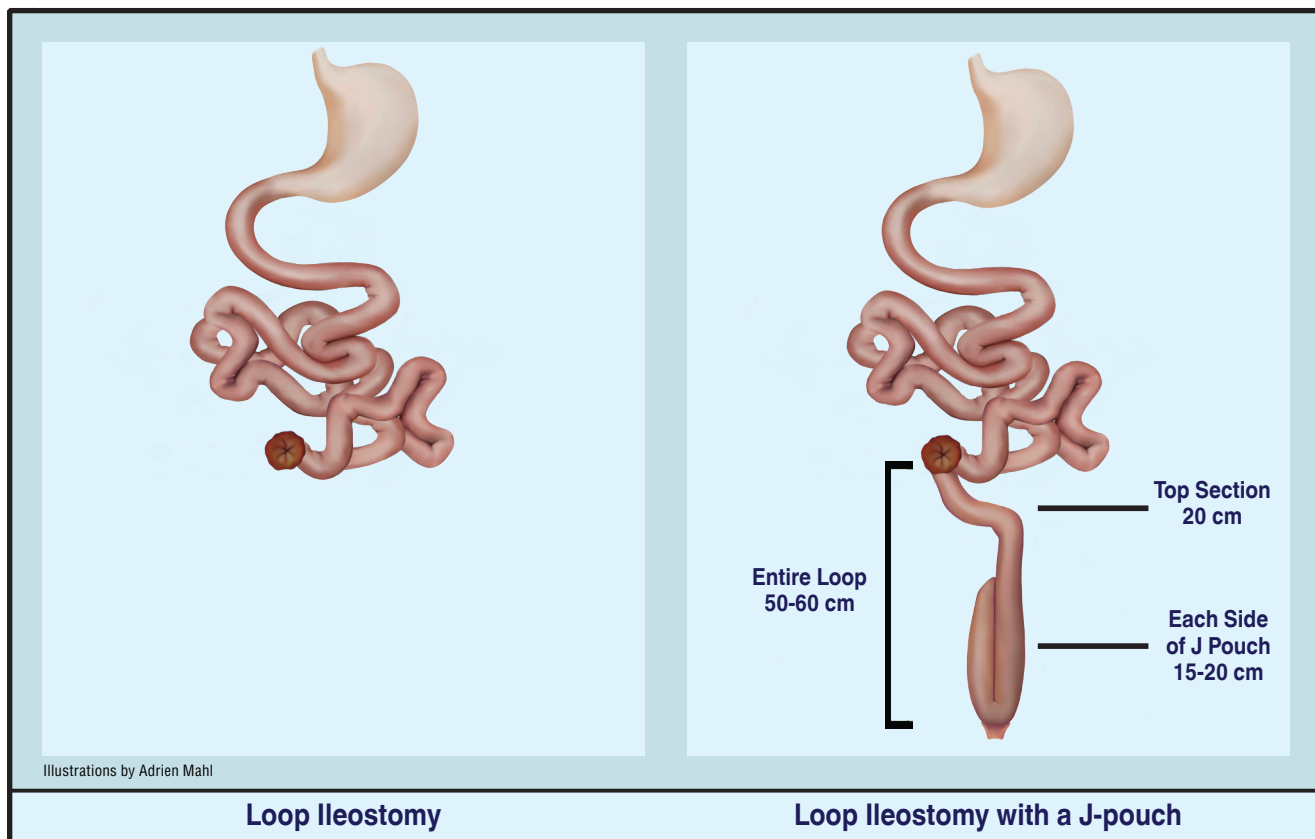
\*Does not include ED visits/admissions at outside facilities  
Adapted with permission from Bridges, et al.<sup>3</sup>

## Causes of High Ileostomy Output

There are many disease processes that may cause or contribute to high ileostomy output. These include enteric infections such as *Clostridium difficile* and Salmonella, carcinoid syndrome, recurrent or active inflammatory bowel disease, a new medication initiation or withdrawal, and intraabdominal sepsis.<sup>3</sup> High output may also be the result of “overflow” diarrhea from a stricture or obstructive process in the small bowel. Patients with less than 200 cm of small bowel with an end jejunostomy or ileostomy may suffer from short bowel syndrome.<sup>5,6</sup> Furthermore, proximal stomas, small bowel fistulas, and poor quality of remaining bowel may mimic short bowel syndrome and result in high ostomy or fistula output.

There are also physiologic mechanisms that can

Figure 1.



play a role in high ileostomy output. Colectomies result in loss of absorptive surface area, but the remaining small intestine compensates by increasing the efficiency of fluid and electrolyte absorption through a process termed adaptation.<sup>2</sup> Resection of 15-50 cm of terminal ileum increases daily ostomy volume by >300g/24 h when compared with controls with <15 cm removed.<sup>2</sup> Hence, loop ileostomies typically have higher losses than end ileostomies (Figure 1). Additionally, terminal ileal resections decrease peptide YY secretion (whose function is to slow gastric emptying and inhibit small bowel motility), resulting in rapid transit.<sup>7</sup> Small bowel transit is significantly faster in patients with greater lengths of ileal resections. Furthermore, extensive ileal resection (>100 cm) may also lead to bile salt deficiency resulting in steatorrhea.<sup>8</sup> There have also been case reports of adrenal insufficiency presenting as large increases in ileostomy output.<sup>9,10</sup> Acute adrenal insufficiency may present in response to stress and, when identified, is readily treatable with steroids. The mechanism by which this occurs is a result of glucocorticoid deficiency resulting

in fasting hypoglycemia, muscle weakness, and gastrointestinal disturbances, including nausea, vomiting, diarrhea, and abdominal pain. Additionally, high circulating gastrin levels have been observed after major intestinal resections; although this is still poorly understood, it may be due to loss of enteric hormones such as GIP and VIP.<sup>11</sup> This results in gastric acid hypersecretion, which may lead to impaired adaptation and nutrient absorption.<sup>5</sup>

There have been attempts to identify preoperative and intraoperative factors predictive of postoperative high output.<sup>12-14</sup> In one institutional study, 36 out of 151 patients (23.8%) developed high output.<sup>12</sup> Risk factors that were associated with high output were diabetes and total proctocolectomy, while patient age, gender, BMI, laxative use, total operative time, and blood transfusion were not statistically significant. In another retrospective review, also reporting a rate of high output around 23%, inflammatory bowel disease, diabetes mellitus, neoadjuvant chemoradiotherapy, total

(continued on page 32)

(continued from page 30)

colectomy, and abdominal infections were found to be risk factors for high output.<sup>13</sup> Another study examining predisposing factors for high ostomy output in patients with diverting loop ileostomies found American Society of Anesthesiologists (ASA) physical status classification (<https://www.asahq.org/standards-and-guidelines/asa-physical-status-classification-system>), elevated baseline creatinine, and open surgery to be risk factors for postoperative high output.<sup>14</sup> Although there is no consensus regarding risk factors, physicians treating patients with any of these characteristics should be aware of the potential implications.

### Readmission: Dehydration and/or Acute Kidney Injury (AKI)

Dehydration, with or without resulting AKI, is a common cause of hospital readmission in patients with an ileostomy.<sup>3</sup> Ileostomy formation is strongly associated with subsequent kidney disease. Smith et al. found that the odds of developing an AKI is four times higher within 3 months of an ileostomy creation when compared to patients who have undergone a small bowel resection without ileostomy creation.<sup>15</sup> Furthermore, odds of new-onset chronic kidney disease (CKD) were increased in the ileostomy group for both patients with previous AKI (OR~5) and without previous AKI (OR~2.5). Prevention and treatment are of utmost importance. Table 1 provides a summary of readmission rates by year for dehydration/AKI of patients with an ileostomy reported in the literature.<sup>16-36</sup>

### Intervention: Fluids and Diet

Common pitfalls and why they do not work:

1. Instructing the patient to “just drink more.” However, this often increases ostomy losses and further dehydrates the patient.
2. The patient may discover that if they drink less their stool output decreases, but unfortunately so does their urine output, further worsening kidney injury.
3. There is also the patient who decides on their own that they should drink a lot since they have so much output, and again, drives their output further.

4. Finally, there is the patient who is just not drinking enough, period.

The art of caring for these patients is to find that “sweet spot” of what, and how much, they can drink without making the ostomy output worse. There are some patients who will need IV fluids for a period of time, despite clinicians attempts at finding that “sweet spot.”

There is evidence to suggest that changes in diet may improve ostomy output. As the GI tract strives for isotonicity, if patients drink hypertonic fluids, water will be pulled into the small bowel lumen to dilute the higher osmotic fluid.<sup>6</sup> Hypertonic fluids to avoid include fruit juices/drinks, regular sodas, sweet tea, maple or other syrups, ice cream, sherbet, and sweetened commercial liquid supplements such as Boost, Ensure, or store brand equivalents. Conversely, hypotonic solutions are the lesser of the evils, but still not good choices. These fluids pull sodium, and along with it, water into the small bowel lumen to increase the osmolarity. Examples include water, tea, coffee, alcohol, and diet drinks. Clinicians must also be careful to guide their patients away from sugar free and “diabetic” foods and beverages that may contain sugar alcohols (sorbitol, mannitol, xylitol, maltitol, isomalt, erythritol, lactitol, hydrogenated starch hydrolysates [HSH]) as they are very diarrheagenic. Oral rehydration solutions (ORS) are beneficial to some patients.<sup>6</sup> These fluids do not decrease the quantity of output, but just result in better absorption of the ORS taken in, and hence, hydration of the patient. It is imperative that patients with new ileostomies receive some form of diet and specific hydration recommendations prior to discharge. Finally, there are some patients who just act like they have short bowel syndrome and it may be worthwhile to try a similar type diet, at least until the patient’s bowel adapts enough to absorb better. Make sure the patient understands they do not have short bowel, but that you are treating them as if they did for a period of time.

### Intervention: Pharmacotherapy

When considering medications to prescribe to decrease ostomy output, it is important to first make sure you are not prescribing medications that will worsen the output. Liquid medications are commonly used for a variety of reasons,



such as inability to swallow pills, dysphagia, and gastrostomy tubes. Despite the benefits of liquid medications, clinicians are often unaware of the possible sugar alcohols they can contain. Highly osmotic, highly fermentable, as well as cumulative, these drug additives can significantly contribute to ostomy output. While many clinicians are aware that liquid medications can contain sorbitol, a known laxative, many may not realize the other sugar alcohols used that can also contribute to diarrhea. See Table 2 for a select list of liquid

medications containing sugar alcohols.

Because patients with an ileostomy have no colon, this also means that the need for fiber as a substrate for fermentation in the colon is of less importance,<sup>37</sup> and that bile acid malabsorption and its sequelae is a non-issue. Therefore, cholestyramine, a medication indicated for bile acid malabsorption, has no role in the treatment of high ostomy output in those with an end ileostomy or jejunostomy. Fiber bulking agents may be utilized in stable, well-nourished patients to

**Table 2. Common Medications Prescribed and Sugar Alcohol Content**

Medication Oral Suspension	Sugar Alcohol Content
Acetaminophen (Tylenol) 160 mg / 5 ml	Sorbitol
Acyclovir (Zovirax) 200 mg / 5 ml	Sorbitol
Amantadine hydrochloride (Symmetrel) 50 mg / 5 ml	Sorbitol
Amoxicillin / clavulanate (Augmentin) 200 mg / 28.5 mg / 5 ml	Mannitol
Codeine 30 mg / 5 ml	Sorbitol
Diphenoxylate and Atropine (Lomotil) 2.5 mg / 0.025 mg / 5 ml	Sorbitol
Furosemide (Lasix) 10 mg / ml	Sorbitol
Gabapentin (Neurontin) 250 mg / 5 ml	Xylitol
Glycopyrrolate (Robinul) 1 mg / 5 mL	Sorbitol
Guaifenesin (Mucinex) 100 mg / 5 ml	Sorbitol
Lacosamide (Vimpat) 10 mg / ml	Sorbitol
Lansoprazole (Prevacid) 3 mg / ml	Mannitol
Levetiracetam (Keppra) 100 mg / ml	Maltitol
Magnesium Hydroxide (milk of magnesia) 1200 mg / 15 ml	Sorbitol
Magnesium Hydroxide (concentrated milk of magnesia) 2400 mg / 10 ml	Sorbitol
Metoclopramide (Reglan) 5 mg / 5 ml	Sorbitol
Mycophenolate mofetil (CellCept) 200 mg / ml	Sorbitol
Oseltamivir phosphate (Tamiflu) 6 mg / ml	Sorbitol
Pyridostigmine bromide (Mestinon) 60 mg / 5 ml	Sorbitol
Simethicone (Gas relief) 20 mg / 0.3 ml	Maltitol
Sodium polystyrene sulfonate (Kionex) 15mg / 60 ml	Sorbitol
Sodium citrate/citric acid monohydrate solution (Bicitra) Na Citrate 500 mg; Citric Acid 334 mg / 5ml	Sorbitol
Valganciclovir (Valcyte) 50 mg / ml	Mannitol
Valproic acid (Depakene) 250 mg / 5 ml	Sorbitol

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Prepared by: Julia Wen Scott, University of Virginia PharmD Candidate.

increase the viscosity of effluent if desired, which may improve quality of life in some patients. In patients with poor intake, this should be avoided as it may exacerbate water and electrolyte depletion and further decrease intake. It is important to note that these fiber bulking agents do not improve the hydration status of the patient.<sup>37</sup> See Table 3 for other agents used to decrease stool volume in ileostomates with little efficacy. A better approach is to enlist an antidiarrheal agent to slow motility allowing more contact time with the mucosa for fluid to be absorbed. Clinical considerations for using antidiarrheal agents and antisecretory agents are available elsewhere.<sup>3</sup> For one institution's proposed escalation guidelines when enlisting antidiarrheals and antisecretory agents for high output, see Table 4.

### Prevent and Protect

The best way to protect the kidneys is to prevent kidney injury from happening in the first place. There are several strategies in both the inpatient and outpatient settings to prevent dehydration and kidney injury. Patient education about what is normal for an ostomy and signs of dehydration should begin preoperatively and followed through

in the postoperative inpatient and outpatient settings. Furthermore, emphasis should be placed on early and continued patient follow-up.

In the inpatient setting, ideally, IV fluids should be discontinued two days prior to anticipated discharge to mimic the home plan and oral intake and urine output should be monitored. Prior to discharge, the patient should demonstrate a urine output  $\geq 1200\text{mL}/24$  hours off IV fluids. In the postoperative setting, patients should be weighed at least two times per week initially to evaluate fluid status. Periodic labs should also be considered if appropriate. Basic metabolic panels and magnesium should be considered at 3 months, 6 months, and annually. If a patient is found to have hyponatremia, a 24-hour or random urinary sodium should be checked for sodium depletion as patients lose about 100mEq/mmol of sodium (2300mg sodium or 1 teaspoon of salt) per liter of effluent lost.<sup>38</sup>

Patients play an important role in preventing kidney injury and dehydration, especially once discharged from the hospital. Patients should be instructed to measure both their 24-hour urine and ostomy output for at least the first few weeks following surgery. If a patient will only measure

**Table 3. Other Agents Tried in an Effort to Decrease Stool Volume (with little efficacy)**

Agent	Form	Clinical Considerations
<b>Cholestyramine</b>	Oral: tablet, powder, suspension	<ul style="list-style-type: none"> <li>• Bile acid binder</li> <li>• No indication nor evidence for use</li> <li>• Only for use in those with a colon/colon segment                             <ul style="list-style-type: none"> <li>➤ Without a colon, bile acid malabsorption (and its sequelae) is not possible</li> <li>➤ In those with &gt; 50-100cm of distal ileum lost, bile acid binders can cause fat malabsorption</li> </ul> </li> </ul>
<b>Fiber bulking agents</b>	Psyllium fiber (Metamucil), Banatrol, or other fiber bulking agents	<ul style="list-style-type: none"> <li>• No indication nor good evidence for use</li> <li>• Binds fluid in bowel</li> <li>• Unless the goal is to make a thicker stool</li> <li>• Does not improve hydration                             <ul style="list-style-type: none"> <li>➤ The need for fiber as a substrate for fermentation in the colon is of less importance</li> </ul> </li> </ul>
<b>Marshmallows</b>		<ul style="list-style-type: none"> <li>• No indication nor good evidence for use</li> <li>• Tastes good</li> <li>• Eat if you like</li> </ul>

**Table 4. Proposed High Output Ileostomy Medication Guidelines (continued on page 36)**

**IMPORTANT NOTES**

- 1) Allow up to 48 hours for each step to assess impact on ostomy output before advancing to next step if ileostomy output remains > 1500mL/day
  - Ensure patient has actually received all the medication doses ordered before advancing to next step
  - Once output is < 1500mL, no need to advance further
- 2) Total pill count below ONLY includes antisecretory/antidiarrheal agents (not ALL medications prescribed)
- 3) Unless specified otherwise: Schedule (not prn) ALL antidiarrheal medications to avoid mealtimes, examples:
  - TID at: 0600, 1400, 2200
  - QID at: 0600, 1100, 1600, 2200

STEP	DOSING	# Pills Per 24 Hours
Step 1	<ul style="list-style-type: none"> <li>• PPI: 30-40mg daily (ideally disintegrating tablets or solutabs) (1)                             <ul style="list-style-type: none"> <li>◆ &gt; 50cm of healthy jejunum needed to absorb</li> <li>◆ 40 mg IV PPI BID if &lt; 50cm jejunum remaining</li> </ul> </li> </ul>	1
Step 2	Continue • PPI: 30-40mg (1 tablet or capsule) daily (1)	5
	Add • Loperamide: 2mg (1 tablet) QID (4)	
Step 3	Increase • PPI: 30-40mg (1 tablet or capsule) BID (2)	10
	Increase • Loperamide: 4mg (2 tablets) QID (8)	
Step 4	Continue • PPI: 30-40mg (1 tablet or capsule) BID (2)	14
	Increase • Loperamide: 6mg (3 tablets) QID (12)	
Step 5	Continue • PPI: 30-40mg (1 tablet or capsule) BID (2)	18
	Increase • Loperamide: 6mg QID (3 tablets QID) (12)	
	Add • Diphenoxylate: 2.5mg / atropine 0.025mg (1 tablet) QID (4)	
Step 6	Continue • PPI: 30-40mg (1 tablet or capsule) BID (2)	22
	Continue • Loperamide: 6mg QID (3 tablets QID) (12)	
	Increase • Diphenoxylate: 2.5mg / atropine 0.025mg (2 tablets) QID (8)	
Step 7	Continue • PPI: 30-40mg (1 tablet or capsule) BID (2)	21
	Continue • Loperamide: 6mg (3 tablets) QID (12)	
	Decrease • Diphenoxylate: 2.5mg / atropine 0.025mg (1 tablet) QID (4)	
	Add • Codeine: 15mg (1 tablet) TID (3)*	
Step 8	Continue • PPI: 30-40mg (1 tablet or capsule) BID (2)	17
	Continue • Loperamide: 6mg QID (3 tablets QID) (12)	
	Stop • Diphenoxylate: 2.5mg / atropine 0.025mg (0)	
	Increase • Codeine: 30mg (1 tablet) TID (3)*	
Step 9	Continue • PPI: 30-40mg (1 tablet or capsule) BID (2)	14
	Decrease • Loperamide: 4mg (2 tablets) QID (8)**	
	Increase • Codeine: 30mg (1 tablet) QID (4)*	

**Table 4. Proposed High Output Ileostomy Medication Guidelines (continued from page 35)**

\*Some patients have an increased efficacy of codeine when crushed.  
 \*\*Loperamide can be tapered off while ileostomy volume is monitored, and adaptation occurs  
 Codeine “equivalents” for gut slowing if codeine not available (per 15mg codeine):

- ◆ Tincture of opium – 0.25mL
- ◆ Morphine – 2.5mg
- ◆ Oxycodone – 1.5mg

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When to consider Octreotide:

- ◆ If patient clearly not responding to above, make patient NPO x 24 hours; if ostomy volume remains > 500mL/24 hours while NPO, there is clearly a secretory component and octreotide may be beneficial. As this drug is quite painful to administer, would only use after taking PPI to maximum dose and proven ineffective.

**Table 5. Prevent Readmission & Protect Kidneys – Published Trials**

Author (Year)	Interventions and Key Findings
<b>Nagle (2012)</b>	Ileostomy pathway designed including education and patient self-monitoring Patients discharged with flow sheets, supplies for recording intake/output, and visiting nurse services Readmission rate for dehydration was 0% in study group
<b>Arenas Villafranca (2015)</b>	Protocol response to high output (defined as >1500mL/day) Protocol entailed diagnosis and treatment of the underlying cause of high output before pharmacological and nutritional treatment, and then stepwise treatment to reduce fluid and electrolyte loss Protocol achieved 100% effectiveness
<b>Hardiman (2016)</b>	Self-care checklist to indicate progress that must be completed prior to discharge Implementation of checklist was independent negative predictor of readmission
<b>Iqbal (2017)</b>	Ileostomy education and management protocol with daily phone call for 3 weeks after discharge Readmission rate decreased significantly from 65% before intervention to 16% after intervention
<b>Shaffer (2017)</b>	4-week step-down monitoring and education program by social workers/home-care RNs Reported 58% reduction in hospital readmission
<b>Migdanis (2018)</b>	1 liter ORT/day with restriction of all other fluids to 1 L per day total for 40 days post-discharge No rehospitalizations in intervention groups
<b>Grahn (2019)</b>	Ileostomy education and monitoring program (Education Program for Prevention of Ileostomy Complications) Tracked patients more closely, but did not result in decreased hospital readmissions
<b>Gonella (2019)</b>	Protocol with emphasis on preoperative personalized education, early recognition of dehydration, multidisciplinary counseling, and patient autonomy in stoma management 30-day readmission rate dropped from 9% to 3.9%
<b>Loon (2020)</b>	Key components of pathway were preoperative education, standardized teaching materials across service line, direct in-hospital patient engagement with emphasis on patient self-management, observation of the patients’ ostomy management, & postdischarge tracking of intake and output; antimotility agents were titrated as needed. Overall, 30-day postdischarge readmission rates decreased from 35.4% to 25.9%. Readmissions due to high output and/or dehydration dropped from 15.5% to 3.9%.

(continued on page 38)



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one of these, emphasis should be placed on urine output. Patients need to be provided with 24-hour ileostomy and urine output targets, as well as daily oral volume intake targets. The goal ileostomy output should be < 1200-1500mL per day. An adequate 24-hour urine output is  $\geq 1200\text{mL}$ , but this should be increased to 1500mL if a patient is prone to developing kidney stones. Furthermore, patients should try to drink at least 80 oz (2400mL) of fluid a day.<sup>2</sup>

Several institutions have implemented protocols aimed at patient education, follow-up, and/or treatment of dehydration, in attempts to decrease readmissions, all with varying levels of positive results.<sup>22,28,31,38-44</sup> See Table 5 for a summary of published trials aimed at the prevent and protect strategy.

### CONCLUSIONS

Dehydration, with or without resulting AKI, is common in patients who have recently undergone a total colectomy with an end or loop ileostomy, and often results in readmission. Strategies to prevent dehydration and educate patients on signs and symptoms of high output are imperative to reduce acute kidney injury, hospital readmissions, and decrease health care costs. ■

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