MANAGEMENT OF A HIGH OUTPUT ILEOSTOMY - AN EVIDENCE BASED REVIEW OF CURRENT CLINICAL PRACTICE

Gordon Cooper[*,1] **and Philip Chiang**[*]
[*]General Surgery Department, University Hospital Hairmyres, Glasgow, Scotland.

ABSTRACT Background: High output ileostomy is a commonly encountered condition in Medical and Surgical Gastroenterological practice. It is commonly seen after surgeries that involve defunctioning the large bowel and thereby largely bypassing a substantial segment of the intestinal tract that is involved with water re-absorption. The acute morbidity associated with a high output stoma ranges from delayed discharge from hospital and acute kidney injury (AKI) requiring closely monitored fluid and electrolyte replacement to life-threatening renal impairment and electrolyte imbalances requiring Intensive Care admission. There is significant evidence suggesting the progression of AKI to Chronic kidney disease (CKD), which can be a major contributor to long term morbidity and mortality. In our article, we review different validated management protocols in place in the various United Kingdom trusts for the same. Our aim is to provide readers with a clear, comprehensive and step-wise strategy to deal with acute kidney injury and high output stoma in patients with an ileostomy.

Methods of review: A systematic search was conducted through PubMed, Embase and Google Scholar for relevant articles using the keywords Ileostomy, High Output Stoma, Management and Acute Kidney Injury. Abstracts were then filtered by authors based on the relevance to our review, which is primarily focused on high output stoma following the construction of an ileostomy in an acute setting.

Conclusion: A systematic way of managing patients with high output stoma requires close liaising with nurses, dietitians and pharmacists as well as strict adherence to established protocols in conjunction with tight monitoring of renal, nutritional and biochemical parameters to improve outcomes. Wherever possible, reversing the stoma should be done to prevent morbidity associated with a high output stoma.

KEYWORDS High Output Stoma, Ileostomy, Stoma Management, Stoma Complications

Introduction

An ileostomy is commonly constructed in general surgical practice, and it is estimated that roughly 120,000 people in the United Kingdom currently have a stoma[1,2]. Its indications range from elective to emergency conditions (table. 1), including; as a defunctioning measure following rectal cancer surgery[3], to protect an ileoanal pouch following pan-proctocolectomy and also following sigmoid colectomy or reversal of Hartmann's procedure if there is any anxiety regarding the integrity of the distally anastomosed segment. With regards to the overall risk of HOS occurring, there appears to be no gross discrepancy between defunctioning and definitive ileostomies.

The procedure has gained increased acceptance over the years owing to an overall improvement in entero-stomal therapy. This has included the development of a dedicated team of stoma ther-

DOI:10.5455/IJMRCR.High-Output-Ileostomy
First Received: December 28, 2020
Accepted: March 11, 2021
Associate Editor: Ivan Inkov (BG);
[1]General Surgery Department, University Hospital Hairmyres, Glasgow, Scotland; gcwcooper@gmail.com

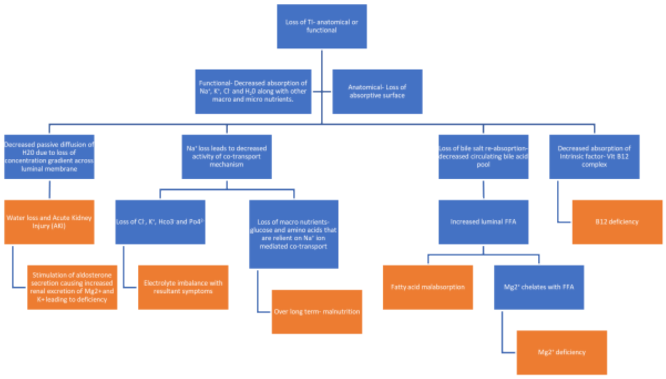

Figure 1: Shows the altered physiology associated with a high output ileostomy.

apists, technological advances of modern stomal appliances and also increasing awareness among the general public regarding the nature of the condition, resulting in greater involvement of stomates in social and physical activities, including maintaining an active sexual lifestyle[4].

From a technical perspective, the procedure has a shallow learning curve and is one of the more common operations performed during the early years of surgical training. Morbidity rates reported in literature following ileostomy construction shows wide variation depending on its nature [5-7]. The incidence of high output stoma (HOS) involving the Ileum has been quoted in literature to be around 20-30%[8]. However, this figure could be as high as 65% in more proximal stomas involving the jejunum. The management of a high output stoma should be multi-disciplinary, and the involvement of the surgical team with dietitians and stoma nurse specialists is often necessary to improve outcomes. In our review, we aim to elaborate on the current practices and the evidence available to support the practice and provide our recommendations to help improve the ongoing care of these patients.

Aims and Objectives

1. To provide a comprehensive clinical practice guideline for safe and thorough management of patients with a high output ileostomy.
2. To provide guidelines that are easy to translate to clinical practice.

Materials and Methods

This review of current practice is based on a thorough and comprehensive search on PubMed, EMBASE and Google Scholar using the keywords “High output”, “Ileostomy “, and “management”. Any article comprising information that falls under the domains as listed below (table. 2) were considered for review, and these were then individually studied and results collated to arrive at an easy-to-follow and step-wise strategy to deal with high output stoma.

Discussion

An overview of relevant GI tract physiology:

The GI tract secretes 9-10L of fluid every day. A majority of this comes from the proximal GI tract (table. 3), and the healthy small bowel is responsible for absorbing most of the fluid and

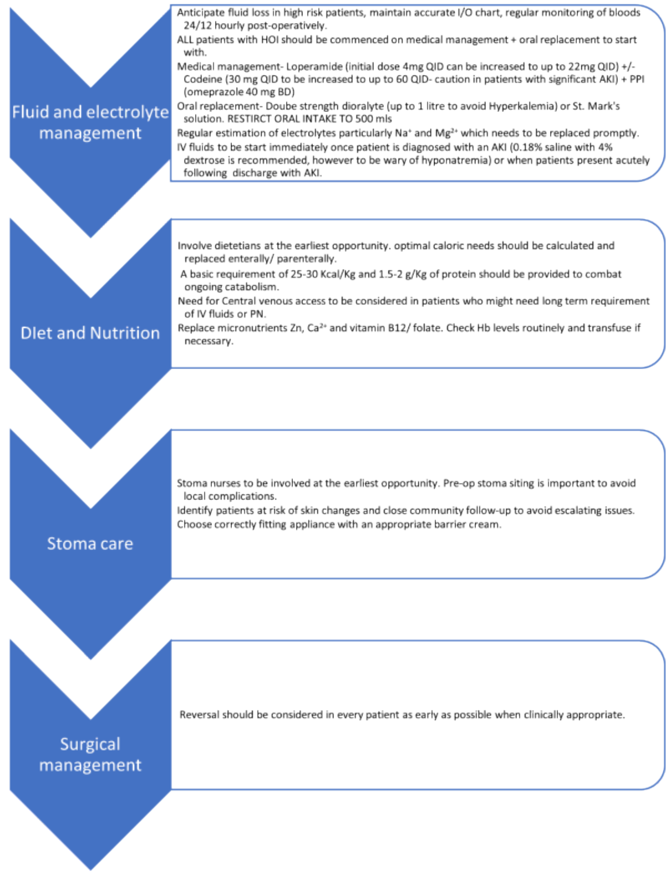

Figure 2: a practical flowchart for management of patients with a HOI.

nutrients (roughly 85-90% of the nutrients and 6-7L of fluid), leaving behind a relatively smaller volume to be re-absorbed in the colon (1.5-2L).

In the absence of a colon, the Terminal Ileal output would initially be in the order of 1-1.5L before the proximal small bowel adapts by improving re-absorption.

The average length of the ileum is approximately 300 cms. There is, however, wide variation in this based on body composition. The distinction between jejunum and ileum, although better appreciated radiologically by the presence of plicae circularis, is difficult from a surgical standpoint. Description of segments of small bowel resected, therefore, is highly subjective. However, for all practical purposes, in an average individual, if there is less than 200-250cms of the small remnant bowel, it could be safely assumed that most of the Ileum have been resected.

Fluid and electrolyte re-absorption:

As with any other region in our body, sodium tends to drive re-absorption of most of the electrolytes through a combination of active and passive mechanisms. A cellular transport system exists to move sodium from enterocytes in the GI tract through to circulation. This then creates a concentration gradient across the luminal membrane.

The sodium then enters cells by combining active and co-transport mechanisms driving several other ions and molecules like glucose, chloride and amino acids along with it. This results in a concentration gradient across the cell membrane, which then drives water’s movement across the lumen into the paracellular

Table 1: Indications of Ileostomy.

Emergency:

1. End Ileostomy-
   (a) Terminal Ileal resection following mechanical small bowel obstruction with an ischaemic segment.
   (b) Acute bowel ischaemia due to Superior Mesenteric Vessel emboli or thrombus
   (c) Following subtotal colectomy for toxic megacolon (Inflammatory Bowel Disease or Clostridium Difficle Colitis induced commonly)
2. Loop ileostomy-
   (a) Following resection of an obstructed colonic segment with primary anastomosis, as a means to "protect" the stoma and to reduce the morbidity from pelvic sepsis arising out of a leaked anastomosis.
   (b) As a temporizing measure in patients with metastatic or locally advanced colonic tumours (right, transverse or descending) who await systemic therapy or who are otherwise unfit for a major resection.

Elective:

1. End ileostomy-
   (a) Following subtotal colectomy for severe refractory Ulcerative Colitis/ Crohn's disease of the large bowel in whom an anastomosis is not appropriate on technical or clinical grounds[a].
   (b) Stricturing Crohn's disease of the terminal Ileum which is not amenable to endoscopic therapy and in whom an anastomosis is not deemed to be appropriate[b].
2. Loop Ileostomy-
   (a) Following an elective Panproctocolectomy with IPAA (Ileal pouch anal anastomosis) for severe refractory ulcerative colitis/ Familial adenomatosis polyposis coli (FAP) commonly.
   (b) Following rectal cancer resection leaving patients with a very low colonic anastomosis (within 5cm from the anal verge)[a]
   (c) Following any left sided colonic surgery (sigmoid or left colectomy) in patients who carry increased risk of anastomotic dehiscence[a].

[a] Usually done in patients on steroids, immunosuppressants including biologics and also in patients with a prior history of irradiation to the pelvis.
[b] Usually done in patients who have evidence of active Crohn's disease in the remaining Ileal segment.

Table 2: Domains considered for further analysis.

1. Fluid and electrolyte management.
2. Management of nutritional needs- enteral/parenteral.
3. Role of elemental diet.
4. Role of medical management.
5. Stoma care
6. Optimum time for reversal of stoma.

Table 3: Rough Approximation of Average Volume of GI Tract Secretions.

Saliva - **1-1.5**L
Gastric – **2-2.5**L
Bile - **1-1.5**L
Pancreatic - **1.5-2**L
Small bowel – **1**L
Total volume - **6.5-8.5**L
Average reabsorbed - **7-8**L
Total volume passed to colon for re-absorption - **1-1.5** L

spaces. It should be noted that although water-primarily diffuses across a concentration gradient, it can also be transported through specific channels (aquaporin)[8,9].

The net effect of loss of a segment of ileum is that sodium absorption is affected, which leads to loss of the concentration gradient leading to loss of water as well. Sodium loss, if prolonged, could lead to decreased absorption of other molecules, as mentioned above, leading to more deleterious effects.

Ileal brake

Ileum not only aids on-going water and sodium absorption physiologically but also supports it mechanically by means of providing a braking mechanism - the "Ileal brake"[10]. This was first described by Spiller et al. in 1984 and remains pertinent concerning the absorption of water and nutrients. Spiller and colleagues described slowing of small bowel transit following a nutrient-rich meal, primarily mediated through a neurohumoral pathway by break down products of macromolecules in the diet. The presence of valves in the Ileo-caecal junction also tends to slow down emptying into the colon, thereby enhancing absorption of the enteric contents in the terminal Ileum. In patients with terminal small bowel resection or Ileo-caecal resection, this could be expected to be dysfunctional, leading to accelerated transit and eventually HOS.

Proximal small bowel adaptation is usually prompt with the restoration of normal physiology in many patients. This could occur by means of functionally increasing the absorption or structurally means by increasing the absorptive surface mediated by an increase in the number of villi. However, certain factors might inhibit this process (acutely or chronically) and lead to HOS. These include age, body mass index (BMI), Diabetes, length of the small residual bowel, irradiation history, concomitant small bowel disease, etc[11]. However, despite multiple studies aimed at ascertaining a relationship/development of prediction models[12], there is a relative lack of scientific evidence to support the association with other variables.

A stoma is said to be 'high output' when the effluent volume exceeds 2000 mls[13]. There is no consensus on this, and the definition ranges from a volume of 1500mls in two consecutive days[14], to 2000mls in a single day or if the effluent is >1000mls in three consecutive days[15]. Even within a hospital, different teams (i.e. Surgeons, Gastroenterologists, Dietitians) use different definitions, leading to variation in the threshold used to trigger agreed treatment protocols. As it is not clear as to what constitutes the actual definition, there is a real possibility of either under/over-resuscitating patients with fluids, both of which are proven to have a negative effect on the outcome with under-resuscitation leading to progressive electrolyte and fluid loss while more early and more aggressive resuscitation potentially leading to paralytic ileus and prolonged hospital stay[16]. In our practice, we tend to err on the side of caution and use a 24-hour effluent volume of 1500mls as the threshold to diagnose a high output stoma.

Management principles:

1. Fluid and electrolyte management:

Step: 1- Anticipating the fluid loss

As explained above, in patients with terminal ileal resection, it is expected that the ileal effluent will, at least initially, be of high output until the proximal bowel adapts by improving its absorptive capacity[17]. In patients with the terminal ileal disease (e.g. Crohn's disease, intestinal tuberculosis etc.), extensive resection of TI (for, e.g., vascular conditions), previous irradiation small bowel etc., this adaptation could be impaired. It is important to anticipate a high stoma effluent in such cases with closer monitoring to diagnose and replace fluids and electrolytes at the earliest opportunity, thereby preventing an AKI. The below flow chart outlined the normal physiology and expected issues when altered (fig. 1).

Step: 2- Measure fluid loss

This is done by maintaining an accurate fluid balance chart, the importance of which cannot be over-emphasised. It is essential to have a close liaison with nursing staff to ensure consistency in documentation and accurate 24 hourly measurements to reflect underlying physiology accurately. Other clinical and biochemical parameters, including blood pressure, heart rate, capillary refill time as well as serum urea and creatinine measurements, can all aid in assessing the volume status of the patient. It is important not to read too much into the eGFR values as they are more useful in a community setting to predict the status of a chronically failing kidney rather than in an acute setting wherein a serum creatinine level is more reflective of the volume status. Acute Kidney Injuries can be graded using the AKIN classification18. Liaising with Nephrologists is encouraged whenever necessary.

Step: 3- Fluid replacement- oral and parenteral

Oral rehydration should be encouraged wherever possible. The ideal oral solution should be iso-osmolar with plasma and contain approximately 90 mosm of Na^+. The commonly used solutions are the St. Mark's electrolyte mix and 'double strength' solution of DioralyteTM. The World Health Organisation (WHO) replacement fluid for diarrhoea and other such solutions such as sports drinks and over the counter rehydration solutions should not be used as they contain excess K^+ or glucose. It is important to remember that K^+ loss is not usually a major issue with HOS, particularly in the early phase; therefore, aggressive replacement of K^+ might lead to a net K^+ excess. Given below (table. 4) is the composition of the commonly used solutions:

It was common practice to advocate a policy of "drink as much as possible" whenever such patients with HOS were encountered; however, it is of utmost importance to restrict intake of clear hypotonic fluids to 500-1000mls. This includes most of the commonly consumed beverages such as tea, coffee and milk. It is also important to avoid/restrict hypertonic fluids (e.g. fizzy drinks, juice) as much as possible. They have a net effect of increasing tonicity of the intestinal lumen and thereby increasing stoma output. The more severe the HOS is, the more important it is to adhere to strict fluid restriction strategies. Owing to the K^+ content in the double strength Dioralyte^{TM} solution, it is important to restrict oral intake to 1 litre to prevent hyperkalemia. Of note, hyperkalaemia could also be precipitated by an ongoing AKI.

Suppose the above fail, or more commonly as an adjunct to the above, parenteral fluid therapy is often required to correct the fluid loss. The choice of fluid varies, and although 0.9% saline was commonly used in most clinical settings, its effect in slowing down intestinal transit and associated paralytic ileus is well documented. A fluid comprising 0.18% saline and 4% dextrose is iso-osmolar and has less effect on bowel dysmotility. However, the net effect of using such a solution would be hyponatremia unless sodium is replaced orally (which is usually not difficult to achieve). If patients are also receiving oral replacement fluid, then the sodium loss tends to be less severe and could be managed by simply supplementing salt in the diet.

Step: 4- Monitoring for ongoing fluid and electrolyte loss

An accurate 24-hour urine output along with a regular assessment of serum urea, creatinine, Na^+, K^+, Mg^{2+} levels helps in monitoring volume and electrolyte status. Regular physical examination for signs of dehydration or volume overload and also for signs of tremor (which may perhaps raise clinical suspicion of hypomagnesaemia) is also necessary. This can serve to prevent further losses and also diagnose and manage volume and electrolyte loss at an early stage. Of particular note are patients with underlying cardiac conditions susceptible to both fluid loss and fluid overload and should be managed with significant caution.

2. Micro and macronutrient replacement:

Assessment of the individual's nutritional status and advice on adequate nutritional intake usually involves input from the dietetics team. There are various tools to assess nutritional status, and the BAPEN toolkit is commonly used in the UK[19]. Assessment should be carried out daily with the regular estimation of body weight and BMI. In the initial stages, the nutritional needs are met by means of oral diet; however, with chronic and particularly irreversible HOS, parenteral nutritional (PN) support becomes necessary. As long as there are>200 cms of small bowel left behind (in the absence of the colon), PN is usually not required, and oral, enteral nutrition serves to supply the necessary fuel[13]. In certain circumstances, however, even with a residual anatomically intact terminal ileum, refractory HOS can occur. In such cases, it is presumed the HOS is induced by a functional gut failure, and PN could be tried to rest and help the gut recover. In our experience, we have had two patients with functional gut failure and persistent HOS managed by means of salvage TPN followed by the slow build-up to enteral nutrition aided by carefully optimized fluid therapy, with the patients eventually responding by stabilizing the volume of their ileal effluent.

If standalone oral nutrition deemed adequate, it is imperative that the composition of the diet is low in fibre to slow down intestinal transit but also high in protein as fluid loss tends to be a catabolic state. General recommendation is 25-30

Table 4. Composition of oral replacement solutions.

	Na^+	K^+	Cl^-	Glucose
St. Mark's solution	90	0	60	111
Dioralyte^{TM}- **1** sachet to be reconstituted in **200** ml of water **(5** sachets in **1** litre of water**)**	60	20	60	90
'Double strength' Dioralyte^{TM}**. (2** sachets in **200** ml or **10** sachets in a litre of water**)**	120	40	120	180

kcal/Kg/day with 1.5-2 grams of protein/day[20]. Regular supplementation of vitamins, particularly vitamin B12 and folate, along with micronutrients like zinc, magnesium and calcium, is often necessary.

3. Role of elemental diet:

There is little evidence, but for sporadic case reports[21] to suggest elemental diet (ED) might help refractory HOI. As its name suggests, ED is thought to benefit as it is the simplest form of nutrition, making it easier to absorb in the gut. In addition, it incites less of an inflammatory response and, because it leaves no residue, the volume of the stoma effluent could potentially decrease as well. The osmolality of ED could vary[22], and it is important to remember not to administer a fluid that is hyper or hypo-osmolar to patients with an HOI as it could prove to be harmful due to reasons mentioned above. ED has been used in various GI conditions ranging from Chronic pancreatitis to Ulcerative Colitis, and further studies are needed before incorporating its routine usage in the treatment protocols of an HOI.

4. Medical management:

Drugs commonly used are:

a. Bulk-forming agents: Soluble fibre, like Psyllium, can delay gastric emptying, attract water, bulk up the chyme and make the ileostomy output more solid. The recommended dietary intake is 25-35g/day. Fibre could also shorten transit time in the intestine which should be considered in patients who complain of a hyperactive stoma.

b. Proton pump inhibitors: PPI's act by reducing gastric acid production. Considering normal 24 hours of gastric acid production exceeds 1.5l, it could prove useful in controlling stoma output. Of note, PPI's could theoretically result in hypomagnesemia which needs to be considered in patients with biochemical evidence of low magnesium.

c. Loperamide and codeine: Both act primarily as an agonist on μ opioid receptors located in the myenteric Auerbach's nerve plexus in the intestinal wall. Although its primary action is on the large bowel, it could also delay small intestinal transit and thereby enhance absorption of water from the luminal contents.

d. Octreotide: It is a synthetic analogue of somatostatin and acts by decreasing GI tract secretions and by slowing transit in the Upper GI tract. Currently, there is no strong evidence to advocate routine usage of octreotide in patients with HOI.

5. Stoma care in HOI

Routine stoma care in patients with HOI is not straightforward. Most patients develop peri-stomal skin changes due to the high volume alkaline content of the ileostomy effluent if not fitted properly. This further results in cellulitis if persistent and could worsen the seal obtained with the stoma appliance contributing to leak, furthering the skin changes. Also, with the increased frequency of appliance changes that is required, and the need for changing the appliance at night, frustration often leads to reduced compliance which ultimately proves to be deleterious for the patient.

Application of a PH balanced barrier cream and choosing the correct stoma appliance is vital in such situations. Community monitoring of discharged patients with an HOI is as vital as the routine stoma care offered whilst an inpatient. Procedural morbidity in the form of retracting stoma or stomas sited improperly (particularly in emergencies without prior stoma nurse input) may contribute to the skin changes and local sepsis, which can prove as difficult to manage as the HOI itself.

6. Reversal of ileostomy

There is no consensus on when it is ideal for reversing an ileostomy. Many studies have been conducted weighing the pros and cons of early vs late reversal[23, 24]. Although it is widely accepted that early reversal is ideal, particularly in patients with an HOI, no guidelines are offering a time frame for such a procedure to be carried out as this would vary widely based on the indication of the primary procedure, time is taken for recovery and other factors such as theatre availability etc.

Conclusion

HOI is a commonly encountered clinical condition. Safe and effective management primarily depends upon adherence to strictly established protocols, close liaison between members of a multi-disciplinary team and robust patient education. Wherever possible, the reversal should be considered to mitigate the morbidities associated with an HOI.

Funding

This work did not receive any grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest

There are no conflicts of interest to declare by any of the authors of this study.

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