Management of Intestinal Failure: The High-Output Enterostomy and Enterocutaneous Fistula

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Abstract

This article provides an overview of the pathophysiology, causes, investigations, and management of high-output enterostomy and enterocutaneous fistula. High-output stoma and enterocutaneous fistula can result in intestinal failure and this is often fatal if not managed properly. The management involves reducing fluid losses, providing nutrients with fluids, and treating the underlying cause and sepsis. A multidisciplinary approach is required for successful management of patients with high-output enterostomy and enterocutaneous fistula.

Keywords

- intestinal failure
- parenteral nutrition
- enterostomy
- short bowel syndrome
- enterocutaneous fistula

Intestinal failure is the reduction of gut function below the minimum necessary for the absorption of macronutrients, water, and electrolytes such that intravenous supplementation is required to maintain health and/or growth.[1] Intestinal failure can be acute or chronic.[2,3] Acute intestinal failure typically lasts days to months and may arise from enterocutaneous fistula (ECF), high-output stoma, small bowel dysfunction (enteritis and ileus), postoperative ileus, and bowel obstruction. Intestinal failure lasting months to years is considered chronic and can be attributed to short bowel, gut bypass, small bowel motility disorders, or chronic persistence of any acute intestinal etiology.

Acute intestinal failure is the more common type of intestinal failure and accounts for more than 90% of cases of intestinal failure.[4] Although a majority of the patients with acute intestinal failure eventually recovery fully without any sequela, these patients may require parenteral nutrition support in the short term to maintain growth and development and to improve survival.[5]

The normal daily small bowel enterostomy output varies between 500 and 1,500 mL and this variation depends on the amount of enteral intake and remaining length of in-circuit small bowel. High-output enterostomies are considered to produce over 1,500 mL daily, although output becomes clinically significant as they approach 2,000 mL daily.[6] Causes of a high-output stoma include insufficient small bowel (i.e., less than 100 cm with no colon in continuity), intra-abdominal sepsis, partial bowel obstruction, Crohn's disease, prokinetic medications, and enteritis.[5,6]

An ECF is an abnormal communication between the bowel and the skin. It acts like a stoma and can also produce a high output especially when the fistula involves the proximal small bowel. Between 75 and 85% of ECFs occur following abdominopelvic surgery and arise from anastomotic leak or inadvertent unrecognized enterotomy.[7] Crohn's disease, advanced bowel cancer, and radiotherapy are other common etiologies of ECF.

Both high-output enterostomy and ECF can result in dehydration and malnutrition due to intestinal losses. The enteral intake and gut secretions bypass absorption from the small bowel through the enterostomy or fistula tract.[7] Skin excoriation and delayed wound healing may arise from difficult to pouch wounds.

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The management of high-output enterostomy and ECFs can be challenging, with some patients requiring prolonged periods of hospitalization.[5,7] This is due to the complexity of the cases and prolonged care of the patients, as well as the need for specialist stoma care. The clinical input and financial cost needed for care of these patients can be intensive. Specialist multidisciplinary care involving surgeons, gastroenterologists, nurses, enterostomal therapists, dieticians, and pharmacists is often required and can be costly.[8]

Physiology and Function of the Small Bowel and Large Bowel Stoma

The small and large bowel are involved in the digestion and absorption of nutrients and water that are required for growth and development. The small bowel digests and absorbs carbohydrates, proteins, lipids, vitamins, minerals, and water. The colon absorbs water, salt, and minerals and contributes to the synthesis of hormones such as peptide YY, glucagon-like peptide 1 (GLP-1), and GLP-2. Colonic bacteria ferment unabsorbed nonstarch carbohydrates to short chain fatty acids fueling colonocytes and contribute to colonic mucosal integrity.

In total, the combined volume of intraluminal secretions from the various segments of the gastrointestinal (GI) tract totals 5 to 8 L daily (►**Table 1**), with the volume dependent on the amount and type of oral intake.[7] Most of the GI tract secretions (e.g., biliopancreatic, gastric) are reabsorbed by the small bowel. Stoma creation can disrupt the physiology and function of the small or large bowel, depending on the level at which the stoma is formed.

The GI tract undergoes adaptation to compensate for the loss of continuity with the distal small bowel and/or colon. The following three phases of small bowel enterostomy adaptation are described[9]:

- *Hypersecretory phase*: the first phase of adaptation is characterized by large volume losses that can be bilious. This phase occurs at 1 to 3 days after stoma formation and can last for 1 to 2 months.
- *Adaptation phase*: the second phase is characterized by a decrease in output. This phase can start at 3 to 5 days following stoma formation and may last for up to 12 months. The degree of adaption depends on the patient's age, extent of underlying disease, and site of resected small bowel.
- *Stabilization phase*: the third phase is characterized by further decreases and eventual stabilization of stoma output. Stabilization of the stoma may take up to 24 months.

Small bowel transit time increases in patients with an enterostomy. In addition, the ileum has more capacity to adapt than the jejunum.[10] Conversely, there is no evidence of adaptation or change in transit time for a large bowel stoma.

Table 1 Gastrointestinal secretions by anatomic segment

Anatomic segment	Secretory volume (mL/d)
Mouth (saliva) and stomach	1,500
Pancreas	1,000
Hepatobiliary (bile)	1,000
Small bowel	2,000
Colon	Negligible
Total	5,500–8,000

Management of High-Output Enterostomy

As mentioned earlier, patients with a high-output enterostomy are prone to dehydration and malnutrition, which may culminate with acute renal failure and wasting. Nightingale and Woodward[2] state that the aims of management of patients with intestinal failure are to:

- Provide nutrients, electrolyte, and water necessary to maintain health and growth.
- Reduce the severity of intestinal failure.
- Prevent and treat complications due to intestinal failure.
- Achieve a good quality of life.

Management of high-output enterostomy involves identifying the cause and reducing the effect of dehydration and malnutrition.[4,11] Focused history taking and examination is therefore essential to determine the cause of the high-output enterostomy and any associated complications. High-output enterostomies arise from myriad causes, many of which are detailed in ►**Table 2**.

Investigations

Investigations are performed to determine or exclude the cause(s) of a high-output enterostomy. The investigations include the following:

- *Blood analysis*: white cell count, C-reactive protein, and platelet counts identify the presence of ongoing intra-abdominal sepsis. Serum sodium, potassium, urea, creatinine, magnesium, zinc, and selenium need to be monitored

Table 2 Causes of high-output enterostomy

Abdominopelvic sepsis/abscess
Bowel obstruction
Crohn's disease
Enteritis (e.g., *Clostridium difficile*)
Short bowel
Paralytic ileus
Medications (e.g., prokinetics)
Withdrawal from steroids
Malabsorption disorders

and replaced as necessary. Moreover, serum albumin and prealbumin serve as surrogate markers for long- and short-term nutritional status.

- *Urine analysis*: urine sodium and specific gravity can be very valuable in assessing sodium depletion and volume status. Urinary sodium concentration of less than 10 mmol/L suggests sodium depletion.
- *Stool analysis*: this can be performed to exclude *Clostridium difficile* when clinically indicated. Fecal calprotectin may be used in select situations to assess for ongoing colonic inflammation.
- *Radiological*: abdominal X-rays, small bowel contrast fluoroscopy, computed tomography (CT), and magnetic resonance imaging (MRI) are helpful adjuncts to identify bowel obstruction. Cross-sectional imaging scans such as CT and MRI can also identify intra-abdominal abscesses. CT and MRI enterography are particularly helpful in cases of Crohn's disease to stage local disease by evaluating for strictures and fistulas and provide rough estimates of pathological bowel segment lengths.

Management

In most cases, enterostomy output can be reduced and controlled with appropriate management.[2,4,5,12] Management involves restriction of fluids, medications, and dietary modification (►**Table 3**). Patient education plays a crucial role in reducing and controlling enterostomy outputs.[5]

Fluid and Electrolytes

Management of patients with intestinal failure initially involves reducing fluid losses from the enterostomy.[13] This will involve restricting oral fluid intake and replacing it with intravenous rehydration. Oral fluid intake may be restricted to approximately 1,000 mL of hypotonic fluid and 1,000 mL of hypertonic fluid per day and is best given with meals. If dietary and fluid restrictions fail to reduce stoma outputs, then patients can be further restricted to no oral fluid intake. Hypotonic fluids, including free water, should be avoided as they cause water and sodium to diffuse into the intestinal lumen, resulting in increased intestinal losses.[4]

Electrolyte solutions, such as World Health Organization (WHO) oral rehydration solution or St Mark's solution, can be given to replace electrolyte losses.[12,14] The WHO and St Mark's solution are made up of 3.5 g of sodium chloride, 2.5 g of sodium bicarbonate, 20 g of glucose in 1 L of water.[4] The solution can be sipped during the day with or without flavouring.[4] Oral magnesium can be given in addition to the electrolyte solutions when required. Since fluid balance is a dynamic process, particularly early in the postoperative course, judicious replacement of fluid and electrolyte losses requires careful monitoring of intake and outputs while judiciously titrating between oral and parenteral supplementation.

Pharmacotherapy

Medications may be used to reduce gut secretions and/or reduce stoma output. Antidiarrheal medications such as loperamide and codeine phosphate can be given to slow bowel motility.[15,16] High stoma output patients may often require dosing quantities that typically exceed over-the-counter ranges for loperamide. Antimotility agents should be administered before meals to counteract and preempt postprandial hypermotility for optimal effect.[4] Antisecretory medications such as proton-pump inhibitors, histamine blockers, and somatostatin analogue (octreotide) may be added in a stepwise algorithm to further reduce gut secretions and may be particularly useful when output from the enterostomy exceeds oral intake.[4,17–19] Beneficial evidence of the effects of somatostatin on high-output enterostomy is mostly anecdotal and is limited to the early postoperative period.

Nutrients

There is no consensus regarding the optimal route for providing nutrition in intestinal failure patients.[20,21] When possible, the enteral route is the preferred option for providing nutrition.[4,5,7,22,23] Enteral nutrition promotes gut function, gut adaptation, and maintenance of gut flora and reduces catheter-associated risks of infection and venous thrombosis. Enteral nutrition may not be possible in patients with obstructed or short bowel, where increasing oral intake causes GI hypersecretion and increasing output.[22] In high-output situations, efforts should be focused on implementing a high-calorie, low-fiber diet.[2] A low-fiber diet passes slowly through the small bowel, thereby increasing nutrient absorption.[5] Patients can be encouraged to adjust their diet while promoting hyperphagia.[24] Oral intake of nutrients may also convey psychosocial benefits for the patients and their support system. Parenteral nutrition may be required to supplement oral nutrition through peripheral or central venous access. If long-term parenteral nutrition is required, then central access through peripherally inserted central catheter or tunneled catheters is preferable. Although experience with parenteral nutrition has greatly improved since its introduction into clinical practice, the decision to initiate parenteral nutrition should be made thoughtfully and judiciously given high rates of long-term complications including venous catheter-related sepsis, and hepatic, renal, and bone side effects.[5,25]

Underlying Cause

Once a reason for the high-output enterostomy has been determined, it should be addressed with medical, radiological, endoscopic, behavioral, or dietary interventions. Inflammatory causes of high-output syndromes, such as Crohn's disease, may be treated medically. Infectious etiologies of high-output syndromes, such as *Clostridium difficile*, can be treated with antibiotics or fecal transplant. Steatorrhea arising from extensive ileal resection or radiation-induced ileal malabsorption may be treated with cholestyramine. Dietary and behavioral measures, as detailed previously, can be

employed in cases of short bowel syndrome. In extreme cases, surgical intervention may be required to treat the underlying cause of high outputs.

Management of Enterocutaneous Fistula

Initial efforts to manage ECF require multidisciplinary input pertaining to sepsis control, nutrition, wound care, medical, and psychological support. The success of definitive surgical treatment is reliant on the patient being in an optimal physical state, which includes control of sepsis. Psychological patient preparation is important to condition the patient mentally since inpatient management and eventual surgery may require several weeks or months. Initial management of ECF is similar to the management for high-output stoma described earlier (►**Table 3**). Early wound management, with specialized wound, ostomy, and continence nurse (WOCN) support is critically important to minimize effluent-associated skin excoriation. Management of ECF involves an approach described as SNAPP:

- *S*epsis control.
- *N*utrition.
- Determining *A*natomy.
- *P*rotection of skin (wound care).
- *P*lanned definitive surgery.

To avoid prohibitively intense obliterative intraperitoneal adhesions, definitive surgery should preferably be undertaken more than 6 months after any open surgery in the abdominal cavity.

Sepsis

Intra-abdominal sepsis often accompanies patients with ECF, and the presence of sepsis adversely influences outcomes. After initially diagnosing ECF, cross-sectional abdominopelvic imaging (e.g., CT or MRI) should be used to identify sequestered undrained intraperitoneal abscesses. Once identified, management of undrained sepsis includes appropriate antibiotics and percutaneous image-guided drainage. Reoperation for sepsis should be reserved for extremely rare situations where more minimally invasive approaches fail to provide septic source control since early reexploration conveys high risk of creating additional bowel injuries.

Nutrition

Following resuscitation, fluid and electrolyte requirements depend on fistula losses, and replacement is similar to the management of high-output stoma described previously. Initially, parenteral nutrition may be required; however, efforts to transition to enteral nutrition should begin once the patient is euvolemic and both hemodynamically and metabolically stable.[26] Enteral feedings are gradually introduced while the patient remains fluid restricted. Patients may also require oral electrolyte solution as well as gastric antisecretory and antidiarrheal medication. Long-term home parenteral nutrition may be required if nutritional and/or fluid and electrolyte needs are not adequately met by the enteral route alone.

Anatomy

Determining anatomy is an essential part of planning eventual definitive surgical correction of ECF. Not only does such anatomical mapping aid in restoring intestinal continuity, but understanding the location and lengths of remaining bowel can also predict postoperative outcomes including the need for long-term parenteral nutrition. Radiological investigations, such as cross-sectional imaging (e.g., CT and MRI), fluoroscopic contrast studies, tube/drain studies, and fistulograms/sinograms, may be required to delineate the origin, destination, and number of fistulas. Endoscopic evaluation through natural orifice, stoma, or fistula may also be a helpful preoperative adjunct for preoperative planning. Rarely, endoscopy may provide therapy with stent or endoscopic clip closure of the fistula. Preoperative investigations should be tailored to the individual and situation with a goal of providing assessments of bowel lengths, concomitant disease (e.g., Crohn's disease, radiation enteritis), ongoing sepsis, defunctioned bowel state, and the presence of strictures or obstructions in the bowel distal to the fistula.

Protection of Skin and Wound Care

The input from the specialist stoma nurse (e.g., WOCN) is a necessary requirement for the protection and care of the perifistula skin and wound. Toxic and caustic small-bowel output can cause painful skin excoriation, which can be quite unpleasant to the patient. Complex fistulas draining into the wound can also delay wound healing.[7,27] Topical barrier creams, wipes, sprays, pastes, wide-flanged bags, and protective dressings can be used to protect the skin and reduce skin excoriation. Adjunctive measures such as reducing output and using secondary drainage bags can reduce leakage and help maintain skin integrity.[5,7,27] Two-piece large stoma pouches, or "wound manager" type bags, are available for ECF with associated wounds.[5,27] Flange extenders are also available to provide extra security and help prevent pouch leakage as they provide extra adhesion of the flange to the skin.[5] Leakage under a flange should be addressed immediately to prevent peristomal skin excoriation.[5] Tubes, vacuum-assisted systems, and gravity drainage appliances may be used to expeditiously extract liquid fistula effluent away to promote a leak-proof seal at the stoma flange–skin interface.

Definitive Surgery

Approximately 30% of patients with ECF will experience healing of fistula following provision of nutrition, control of sepsis, and minimizing output from the fistula.[28] If nonoperative healing occurs, this will be within 4 to 8 weeks of starting nonoperative management. If healing does not occur within this period, then plans for definitive surgery should be initiated. Factors likely to determine persistence of fistula and the need for definitive surgery include large abscesses, complex fistula, active bowel disease, bowel obstruction distal to fistula, presence of foreign body, and patients older than 65 years.[7]

Table 3 Treatment algorithms for high-output ileostomy

Stage 1: Check for causes
Take a history and check medications
Review prior operative and pathological reports
Examine patient, paying special attention to signs of malnutrition (ascites, edema, temporal wasting), nutritional deficiencies (skin rashes), and vital signs (blood pressure, pulse, and weight)
Investigations: complete blood count, serum chemistry electrolytes and elements, C-reactive protein, albumin, prealbumin liver function tests, stool culture and clostridium difficile toxin, blood culture, urine culture, electrolytes, specific gravity, sodium, and abdominopelvic imaging
Stage 2: reduce fluid and electrolyte losses
Rehydrate with intravenous fluid
Restrict hypotonic oral fluid intake to 1,000 mL daily
Introduce hypertonic fluids as necessary
Commence loperamide 2 mg four times per day (QDS) ± codeine phosphate 30–60 mg twice a day (BID) when required (PRN)
The dose of loperamide can be increased until a satisfactory output is maintained (≥1,500 mL); dose range can be between 2 and 64 mg four times per day (QDS)
Start omeprazole 40 mg daily or twice daily to reduce volume of gastric secretions
Treat underlying causes of losses and stop medications that increase stoma output (e.g., metoclopramide)
Screen for malnutrition (including body mass index, % weight loss, and current or expected oral intake) and refer to a dietician as appropriate
Monitor the fluid balance, serum electrolyte (sodium, potassium, urea, creatinine, calcium, magnesium), and weight
Supplement electrolytes if required
Review stoma output in 48–72 h and if this settles oral fluid intake can be increased
Stage 3: ongoing high-output enterostomy
Continue oral fluid restriction. (If stoma output is >3,000 mL/d, consider placing the patient NBM for 24 h to assess gastrointestinal secretion.)
Commence WHO or St Mark's electrolyte solution 1,000 mL daily, orally, in addition to oral fluid restriction
Once IV fluids are stopped, check random urine sodium (aim >20 mmol/L)
Start omeprazole 40 mg once a day (OD) or twice a day (BID) to reduce volume of gastric secretions
Continue daily monitoring of fluid balance charts, serum electrolytes with twice weekly weights, and weekly magnesium levels
Continue to supplement electrolyte if required
Stage 4: high-output enterostomy persist
Review compliance with oral fluids
Increase loperamide dose slowly up to 40 mg daily
Refer to nutrition support team for further advice

Abbreviations: IV, intravenous; WHO, World Health Organization.
Note: Adapted from Baker et al.[6]

Definitive surgical repair of ECFs should be delayed for a minimum of 6 months since the last surgical intervention. Since postoperative adhesions tend to follow a fairly predictable course, early adhesions tend to be most tenacious 10 days to 3 months following laparotomy. Early operative intervention is associated with high rates of mortality, morbidity, and risks of fistula recurrence. Delaying surgery allows acutely intense adhesions to soften, thereby lowering risk of enterotomy and bowel injury. Early reoperation (<3 months from last open surgery) for fistula should be undertaken only in life-threatening situations. Indications for early surgery may include the following:

- Drainage of sepsis in rare instances where this cannot be achieved percutaneously.
- Excision of ischemic bowel.
- Laying open of abdominal wall abscess cavities.
- Construction of a proximal diverting stoma in rare circumstances.
- Uncontrolled catastrophic anastomotic failure.

No attempt should be made to repair bowel or perform an anastomosis in the early stages of intestinal failure. Since inadvertent enterotomy may require additional bowel resection, the timeliness of ECF repair cannot be overstated.

Patients must be fully optimized before any surgery since surgery risks further reduction of bowel length.

Definitive surgery is individualized and may involve adhesiolysis, resection of fistulas with reanastomosis, reversal of stomas, and abdominal wall repair. Abdominal wall reconstruction should be done with suture closure where possible, employing fascial release and component separation when necessary. If abdominal wall reconstruction requires mesh placement, favor should be given to absorbable mesh types due to theoretical concerns over mesh infection.

Distal Feeding

Distal feeding (or "fistulocylsis") is the use of the distal bowel downstream from a stoma or fistula as site for feeding and source of nutritional support. Fistulocylsis has been used for centuries, and though the technique is difficult, it is efficient, efficacious, and successful once established.[26] Nutrition can be given as chyme (effluent refed distally from a proximal fistula), elemental formula, or fluid. Studies have shown that distal feeding can provide adequate nutrition, water, and electrolyte balance, which can reduce or supplant parenteral nutrition requirements.[29,30] Prior to initiating distal feeding, the anatomy of the bowel and fistula must be established to ensure that there are no distal enterotomies or obstructions and that the remaining bowel is sufficiently long to absorb nutrients. While distal feedings can occasionally be used in chronic intestinal failure to reduce/replace parenteral nutrition, its use prior to surgical reconstruction may maintain distal bowel integrity and caliber.

Role of Teduglutide

Teduglutide (Gattex®, Revestive®) is a recombinant GLP-2 analogue that has recently been introduced into medical practice. This naturally occurring hormone analogue acts by stimulating the growth of small bowel mucosal cells causing mucosal hypertrophy.[24] The increase in small bowel mass results in an increase in absorption of nutrients, fluid, and electrolytes through the small bowel.[31,32] When patients are able to absorb adequate nutrients with teduglutide, parenteral nutrition may be even reduced or stopped.[24,33] Currently, teduglutide is most helpful in cases of short bowel and intestinal failure, and its effects in patients with ECF are not known. While effective, teduglutide requires life-long administration to remain effective, which conveys high costs. At this time, teduglutide is contraindicated in patients with history of GI, hepatobiliary, and pancreatic cancers. Since enterocyte stimulation has been associated with increased rates of colonic adenoma formation, teduglutide requires intensive colonoscopy screening.

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