An enteroatmospheric fistula (EAF) is an abnormal connection between the gastrointestinal (GI) tract and the outside environment — a feared complication of major abdominal operations. EAF pose a life-threatening risk to patients already weakened by surgical insult by altering fluid and electrolyte balance and fostering malnutrition. The authors describe a method of wound management for a 64-year-old morbidly obese woman with a history of coronary artery disease, diabetes mellitus, and bipolar disorder who developed a large abdominal wound containing multiple high-output EAF after an incarcerated abdominal hernia repair, wound infection, and subsequent laparotomy and lysis of adhesions followed by graft placement and negative pressure wound therapy. The volume, consistency, and location of the EAF caused commercial negative pressure devices to fail and simple gauze dressings were ineffective in maintaining a clean wound base and containing odor. Effluent collection and wound healing was achieved utilizing a modified method of EAF management that included two connecting rubberized catheter drains and continuous wound irrigation with wall suction and cotton gauze for debridement. Surgical EAF closure was successful after 6 months of care. This method provided a satisfactory balance between the diagnosis of EAF and the readiness to meet the physiologic demands of definitive surgical treatment.

The risk for developing this abnormal conduit increases with the presence of a wound infection, poor nutritional status, and sepsis. The mortality associated with EAFs ranges from 5% to 37% but can be as high as 54% to 60% in patients whose fistulae have outputs >500 mL per day and/or originate in proximal aspects of the GI tract, as well as in persons who have or develop sepsis. Although spontaneous fistula closure occurs in 70% to 90% of cases, closure is less likely in high-output fistulae and those that arise from the ileum or more proximal GI tract locations. Because higher mortality rates and lower rates of spontaneous closure have been attributed to the recurrent and compounding consequences of fluid and electrolyte imbalances, malnutrition, and sepsis, accurate quantification of fluid loss is essential.

EAFs are commonly classified by their output; >500 mL per day is classified as high, 200 to 500 mL per day is moderate, and 200 mL per day is low. EAFs are typically but not always located in an anastomosis; thus, anatomic localization of the intestinal...
aspect of the EAF can be helpful in guiding care, including pre-surgical planning, nutritional support requirements, and assessing the likelihood of spontaneous closure. Current standards of practice include the use of computed tomography (CT) scan, gastrointestinal radiographic contrast studies, ultrasonography, and fistulograms for mapping the EAF location. Following diagnosis, current management strategies focus on physiologic stabilization of the patient before proceeding to definitive management of the EAF. Early stabilization of the patient includes rapidly addressing sepsis and associated infections with antimicrobial therapy, fluid resuscitation, and drainage of related abscesses. Subsequent, long-term stabilization of the patient requires accurate replacement of fluid, electrolyte, and metabolite losses. Decreased endogenous protein synthesis and increased caloric demands created by the hypercatabolism of sepsis and food nutrient loss most often are supported by administering total parenteral nutrition (TPN). However, some evidence indicates that enteral nutrition, because of its nutritional superiority, may be an equally effective treatment for patients with low to moderate output fistulae who do not display feeding intolerance or have a difficult-to-access GI tract. Allowing patients food by mouth can increase fistula outflow volumes and TPN has proven to increase the rate of spontaneous fistula closure; therefore, most patients are not allowed anything by mouth (NPO). Additionally, adjuvant pharmacological therapy with H2 agonists, proton pump inhibitors, and octreotide often accompanies recommendations for nasogastric (NG) tube decompression to reduce and divert gastric secretions.

Wound management. Successful long-term patient stabilization also requires the provision of wound care in the presence of an active fistula. Maintaining wound and skin integrity through effluent containment and diversion is essential to prevent wound infection, cellulitis, and recurrent sepsis. Bedside wound and fistula management must not only take into account the myriad of physiological sequelae associated with wounds containing EAF, but also address psychological effects such as depression and poor patient self-esteem related to visual and olfactory alterations in body image.

Managing wounds that contain an EAF can be challenging for the clinician and frustrating for the patient. The ultimate goal of long-term stabilization is to promote spontaneous closure of the EAF or successful preparation of the patient for a fistula take-down procedure. The treatment period can be lengthy. Spontaneous closure most frequently occurs 4 to 6 weeks after fistula development, and surgical correction of the fistula is generally avoided for the first 6 months after its development to help reduce the risk of recurrence and complications.

The purpose of this case study is to describe the challenges of managing a patient with a high-output EAF and one successful collection and containment method.

Literature Review

Wound and ostomy nurse specialists, trauma surgeons, colorectal surgeons, and critical care surgeons tend to agree that functional bedside management to stabilize patients with EAF and abdominal wounds should include removing and quantifying fistula effluent, providing adequate care of the wound bed, and protecting surrounding skin. The most frequently described management method involves use of a commercial negative pressure wound dressing (NPWD), a system that uses a porous synthetic sponge-like material placed inside the wound and covered with an occlusive dressing. This closed environment system then is connected to negative pressure to collect fistula effluent and facilitate wound healing. According to manufacturer descriptions, most commercial NPWDs generate 75 to 125 mm Hg of suction pressure. However, while commonly described in the literature, NPWD can be prone to failure when used with high-output fistulas and new fistula formation, wound bed irritation, tissue erosion, or bleeding have been reported.

Before the advent of commercial NPWD, and less frequently noted in the literature, the use of simple gauze dressings has been shown to facilitate wound healing when fistula output is low. Frequent gauze dressing changes can effectively remove necrotic wound tissue and fistula effluent. However, gauze provides no barrier against odor and can become less effective for wound care when dressing changes are required more than every 4 hours. These dressing changes can consume a substantial amount of bedside nursing time. Additionally, enteric contents draining from the fistula are often malodorous, displeasing to patients, family, and hospital personnel, and can cause irritation of the surrounding skin.

The array of case reports regarding the bedside management of the abdominal wound with a problematic EAF confirms that when standard practice fails to be effective, clinicians must develop creative methods of achieving their wound care goals. Key in the provision of adequate skin and wound care is the diversion of fistula effluent. To accomplish this, several pouching procedures and tube diversion methods have been described. Layton et al describe diverting effluent away from wounds treated with a NPWD by placing a latex or silicone baby bottle nipple strategically over the EAF. The nipple is modified to accept drainage tubing at the nipple end to remove and quantify effluent. Others, such as Al-Khoury et al and Ramsay and Mejia, describe cannulating the fistula with rubberized catheters.
ischemia and subsequent tissue injury. Excessive or inappropriate negative pressure can cause clotted blood or loculations, leading the possibility of a successful fistula take-down procedure. Two weeks after her initial exploratory laparotomy, without fever or leukocytosis, Ms. N developed a high-output EAF along the right lateral margin of the wound. The fistula immediately produced approximately 2 to 3 L of enteric contents daily. The source of the fistula was assumed to be the proximal small bowel in the area of the anastomosis; this was confirmed with CT imaging within 24 hours of presentation of enteric contents in the wound. CT imaging also noted two small abdominal fluid collections, possibly indicative of abscesses. A follow-up contrast enema excluded colonic leak as the source of the intra-abdominal fluid collections but confirmed an additional EAF arising from the colon at the hepatic flexure. Repeat CT imaging 2 weeks after the development of the EAF showed the interval resolution of the abdominal fluid collections but persistence of the EAFs.

At the time the EAF was noted, Ms. N was made NPO and given intravenous antibiotics and resuscitative intravenous crystalloid fluids to compensate for and match her ongoing fluid and electrolyte losses. Additionally, she was placed on intravenous octreotide in an effort to minimize fistula output. TPN was initiated and tailored to her caloric and nutrient demands. With these measures, the daily EAF output continued to be 2 to 3 L per day. Ms. N frequently would ignore her NPO status and her family would bring food, further complicating matters. Ultimately, the TPN was supplemented with a modified liquid oral diet that provided some nutrition and psychological comfort. Despite the prompt administration of TPN and additional oral augmentation, Ms. N’s average serum albumin was 2.0 g/dL and never surpassed 2.6 g/dL. This made wound healing difficult and perpetually delayed the possibility of a successful fistula take-down procedure.

From the onset, the viscosity and large volume of effluent quickly taxed the ability of the NPWD to function properly; it had to be changed or repaired multiple times per day. The sponge frequently would clog, leading to the pooling and leakage of liquid enteric contents and causing severe wound and skin irritation. After repeated device failure, moistened cotton gauze dressings were instituted to manage the abdominal wound and soak up the patient’s copious fistula output. These dressing changes proved less labor-intensive than replacing the NPWD system multiple times per day but the simple gauze dressings quickly became saturated and provided little to no mechanical debridement of the abdominal wound when changed. Additionally, the

to divert and measure EAF effluent within an NPWD. Goverman et al24 report the outcomes of five patients whose abdominal wounds were managed by diverting effluent with suction directed solely at the EAF through urinary catheters while protecting the surrounding wound bed with petrolatum-impregnated gauze. Instead of tube diversion, pouching procedures also can be used to capture fistula contents — the pouches, or traditional ostomy appliances, are placed over an isolated EAF, which then is excluded from the NPWD.25-28 Despite methodological differences, all of the aforementioned authors describe the ability of their approach to divert and quantify fistula effluent in order to achieve optimal wound care and accurately measure fistula output.

Specific to wound care, most authors describe using a standard and unmodified commercial NPWD to manage wounds with a nonproblematic EAF.17 However, wounds with problematic EAFs often require clinicians to modify and titrate negative pressure values applied to the wounds.29 Most successful wound and fistula care has been reported with negative pressure values between 80 and 125 mm Hg, but some have reported pressures as high as 600 mm Hg.29,30 Absent from case report data is the mention of any formal alarm system that would notify the clinician or bedside staff to changes or unsafe levels of negative pressure. Excessive or inappropriate negative pressure can cause ischemia and subsequent tissue injury.30

Case Presentation

Ms. N, a 64-year-old morbidly obese woman with a history of coronary artery disease, diabetes mellitus, and bipolar disorder, presented to the authors’ institution with an acute onset of fever with abdominal pain, nausea, and vomiting. Her past surgical history included recent and multiple surgical repairs of a ventral abdominal wall hernia. Shortly following admission, Ms. N underwent an exploratory laparotomy with lysis of adhesions for a small bowel obstruction related to an incarcerated abdominal wall hernia. Postoperatively, Ms. N’s bowel was left in discontinuity after resection of 6 feet of small intestine and 3 feet of proximal colon. On the third postoperative day, she underwent surgical re-exploration and anastomoses of the interrupted bowel. Her abdomen could not be closed primarily due to body habitus and postoperative inflammation and ultimately required a delayed abdominal wall defect reconstruction with an AlloDerm (Life Cell Corporation, Branchburg, NJ) graft 5 days after her initial operation. The abdominal reconstruction resulted in a 20 cm x 15 cm x 4 cm deep midline abdominal wound that was managed in the postoperative period with continuous V.A.C. Therapy® (KCI, San Antonio, TX) at 125 mm Hg changed every other day.

Two weeks after her initial exploratory laparotomy, without fever or leukocytosis, Ms. N developed a high-output EAF along the right lateral margin of the wound. The fistula immediately produced approximately 2 to 3 L of enteric contents daily. The source of the fistula was assumed to be the proximal small bowel in the area of the anastomosis; this was confirmed with CT imaging within 24 hours of presentation of enteric contents in the wound. CT imaging also noted two small abdominal fluid collections, possibly indicative of abscesses. A follow-up contrast enema excluded colonic leak as the source of the intra-abdominal fluid collections but confirmed an additional EAF arising from the colon at the hepatic flexure. Repeat CT imaging 2 weeks after the development of the EAF showed the interval resolution of the abdominal fluid collections but persistence of the EAFs.

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Figure 1. A cut-away view of the wound device components, including the modified drainage tubing, the layers of cotton gauze, the modified irrigation tubing, and the occlusive-transparent dressing.
gauze dressings provided no odor barrier between the fistula effluent and the patient’s room environment or mechanical barrier between the effluent and the surrounding skin.

After two difficult weeks with both the NPWD and simple gauze dressings, focus shifted to alternative methods of wound and fistula care. The first step in managing EAF output was to develop a method of collecting and draining the fistula effluent. The authors’ healthcare system uses two modified 22 gauge Red Robinson catheters (C.R. Bard, Murray Hill, NJ); these were perforated with 5 to 10-mm oval-shaped cutouts. The catheters were laid inside dependent aspects of the wound in areas where the fistula effluent would collect. The catheters were placed on top of one to two layers of fluff cotton gauze to prevent direct wound bed contact. The catheter drains (two in this system) were linked together and connected to suction tubing, collection containers, and subsequently low wall suction. In order to maintain a dressing that would provide for mechanical debridement of the wound, unrolled Kerlix (Covidien, Mansfield, MA) cotton gauze premoistened with 0.9% normal saline was placed into all aspects of the wound. The moistened gauze roll filled the wound until flush with the surface of the skin.

Key to effectively removing fistula effluent from the wound was the addition of continuous wound irrigation. Normal saline irrigation was provided continually to the wound in order to dilute the fistula effluent and prevent the gauze dressings and the catheter drainage tubing from clogging. The irrigation was supplied to the wound dressing via standard IV tubing with the luer-lock end removed from the IV tubing. The cut distal end of the irrigation tubing was placed in the superior aspect of the wound and connected to normal saline irrigant via an infusion pump. A transparent occlusive dressing was used to cover the wound and maintain an airtight seal. After the dressing was placed and an airtight seal ensured, the rate of fluid irrigation and amount of wall suction was titrated to create a dynamic wound dressing. The rate of fluid irrigation varied between 80 and 100 mL per hour depending on the amount of fistula output. The level of suction, or negative pressure, applied to the wound dressing varied between 100 and 125 mm Hg. Great care was taken to ensure that the amount of suction applied generated only enough negative pressure to safely drain the fistula output and maintain the dressing’s seal against the skin and not become excessive to the point of generating bleeding or tissue damage. This dressing was changed twice daily to facilitate debridement and monitor the wound bed. Additionally, because no formal alarm system was in place to notify staff of an unsafe level of negative pressure, the wound dressing and patient hemodynamic status was assessed every 4 hours. In conjunction with this wound care, bedside nursing staff calculated daily fistula output by subtracting the amount of irrigant supplied to the wound from the total amount of fluid in the suction collection canisters.

This modified NPWD with drains remained a fixture of Ms. N’s wound care during her 6-month recovery from her initial laparotomy. At the time the modified negative pressure and irrigation wound system was created, the abdominal wound measured 20 cm x 15 cm x 4 cm deep. After 1 month of modified NPWD, Ms. N’s wound was 17 cm x 13.5 cm x 3 cm deep. The wound continued to heal and after 3 months measured 3 cm x 2 cm with no depth. By her fifth and sixth months of wound therapy, Ms. N’s wound size plateaued at 2 cm x 2 cm and remained flush with the surrounding skin surface. Despite the reduction in wound size, attempts at using the commercial NPWD failed because of the large volume of effluent. However, at the end of the sixth month of treatment, Ms. N’s wound was small enough that fistula care could easily be transitioned to a small, two-part ostomy appliance and pouch. After slightly more than 6 months of wound and fistula management, Ms. N underwent another exploratory laparotomy with lysis of adhesions and a fistula take-down procedure. At the time of the procedure, multiple small bowel and colonic fistulae were noted. She remained hospitalized for an additional 6 months. Ms. N was morbidly obese and had a psychiatric comorbidity. These conditions made getting out of bed difficult and she often would refuse her physical therapy treatments. She was not safe to be sent home alone. The problem was compounded by her limited access to healthcare funding and lack of family involvement. She had few, if any, rehab or skilled nursing facility options available, given her finances. The primary reason she spent 6 months in the hospital after her wound and fistula were managed with a simple ostomy device simply was extremely limited access to healthcare dollars. During her 6-month convalescence, no evidence of complications or fistula recurrence was noted.

Discussion

Addressing life-threatening complications such as malnutrition and sepsis are paramount in the management of patients with wounds and an EAF. The literature also supports aggressive resuscitation and treatment of concomitant sepsis.1 Support in the literature for allowing patients to meet their caloric demands orally versus withholding food while administering parenteral nutrition varies.5,6 The patient in this case study was made NPO in hopes that fistula output could be reduced as the literature suggests; however, no notable difference in fistula output was noted when the patient was allowed to have a modified diet.

Additionally, the adequate removal of effluent and provision of appropriate wound care are critical in patient management. There is evidence that commercially available negative pressure therapy at 125 mm Hg is associated with a risk of fistula development7 and it is a potential cause of the EAF in this case study. Despite this, the literature primarily supports using a commercial NPWD to treat wounds with higher output EAF versus using standard gauze dressings.2,7,10,13,17 The literature is also rife with anecdotal data supporting inventive and creative methods of wound and fistula care.21-23,25-28 No long-term data support any specific methodology on how to balance a patient’s physiologic stabilization and definitive surgical care with spontaneous EAF closure. In this case, conventional therapy was unsuccessful because of the effluent’s volume, viscosity, and caustic nature. The problematic characteristics of Ms. N’s EAF, her poor nutritional status, and the unlikely possibility of early surgical therapy dictated the

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implementation of an unconventional wound care method. Directly draining the fistulae via catheters or suction tubing as reported in the literature was considered; however, the effluent viscosity and particulate matter would quickly clog any drainage mechanism devised. Also, excluding the fistulae from the wound via a pouching procedure, as some authors suggest, was not practical given the number and physical locations of the fistulae within the wound.

The decisions regarding nutritional needs, the system of wound care, and fistula management were not made in isolation. The literature supports a multidisciplinary approach to managing wounds with EAF. Staff and resident surgeons, midlevel providers, registered nurses, wound and ostomy specialists, and registered dietitians all discussed with Ms. N the risks and benefits of the unconventional method described here. Significant risks such as potential underlying tissue injury, hemorrhage, and fistula formation were identified as known complications with other conventional methods of wound care as well as with the authors’ approach. All known and potential risks were disclosed to Ms. N, who after weighing the risks and benefits, opted to proceed with this unconventional plan of care.

Conclusion

A 64-year-old woman developed multiple EAF within a large abdominal wound shortly after undergoing repeated surgeries to treat a bowel obstruction caused by an incarcerated ventral abdominal hernia. Spontaneous closure was deemed unlikely and management of the wound with EAF was complicated by the volume and type of fistula output and the anatomical location of the EAF. Wound care strategies focused on control and removal of fistula effluent to minimize wound exposure, prevent wound infection, calculate nutrient loss, and minimize device failure. This was achieved by using a modified rubberized catheter drain system — two Red Robinson catheters modified with 5- to 10-mm oval fenestrations allowed for the rapid removal of fistula effluent thinned by an irrigant supplied to the dressing via modified infusion tubing. These modifications, not previously reported, facilitated adhesion drainage tubing, and negative pressure into a regulated and safe system for the patient with a difficult-to-manage wound with EAF.

References