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Enteroatmospheric Fistula: From Soup to Nuts

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Abstract

Enteroatmospheric fistula (EAF), a special subset of enterocutaneous fistula (ECF), is defined as a communication between the gastrointestinal (GI) tract and the atmosphere. It is one of the most devastating complications of "damage control" laparotomy (DCL) and results in significant morbidity and mortality. The published incidence of EAF ranges from 5%–19% of patients who have undergone DCL and survived long enough to develop complications. Their etiology is complex and ranges from persistent abdominal infection, anastomotic leakage, adhesions of the bowel to itself or fascia, and repeated bowel manipulation during return trips to the operating room or dressing changes. Prevention is clearly the best treatment strategy but may be difficult to achieve. Once an EAF occurs, immediate management consists of treatment of sepsis if present; nutrition, fluid, and electrolyte support in the form of parenteral nutrition (PN); and wound/effluent control and protection of surrounding tissues and exposed bowel. It should be noted that EAF almost never close spontaneously, and definitive repair usually requires major surgical intervention and abdominal wall reconstruction 6 to 12 months after the original insult. Enteral feeding should be attempted once the anatomy of the EAF is defined and reliable enteral access is obtained. Most patients can tolerate some amount of enteral and even oral feeding and do not need to be maintained on PN alone. Professional judgment, experience, and teamwork are key to successfully managing the patient with EAF. (*Nutr Clin Pract*. 2012;27:507-512)

Keywords

critical care; enteral nutrition; parenteral nutrition; fistula; intestinal fistula

Introduction and Historical Perspective

An enterocutaneous fistula (ECF) is defined as an abnormal communication between the intra-abdominal GI tract and skin and is traditionally considered one of the most feared complications in general surgery.

The first description of ECF may be as far back as 450 BC,[1] but the "modern" history of ECF begins with William Beaumont and his patient, Alexis St. Martin. In 1822, St. Martin was shot with a musket in the abdomen and chest. St. Martin developed a gastrocutaneous fistula,[2] which remained open for 58 years, until St. Martin's death in 1880, at the age of 81.[3] Although Alexis St. Martin was able to survive with an ECF, most other patients of the early 20th century were not so lucky. In 1923, Colp reported an overall mortality rate of 81%, with patients dying of a combination of sepsis, electrolyte imbalance, and malnutrition.[4]

In 1964, Chapman et al[5] described 4 key principles in the care of patients with ECF: correction of intravascular fluid deficit, abscess drainage, control of fistula effluent, and protection of the skin. Although not defined as a principle per se, the authors also noted that malnutrition was the leading cause of death in these patients and that mortality was dramatically reduced in patients who were able to ingest at least 1500 kcal per day. The advent of parenteral nutrition (PN), as first described by Dudrick et al in 1969,[6] was a "game changer," as it allowed surgeons to regain control of and reverse their patients' catabolic state, prevent malnutrition, and give the ECF time to heal. Combining Chapman's principles with the ability to provide PN as well as multiple surgical and image-guided techniques to facilitate infection control and fistula closure, the mortality of ECF has dropped to 10%–20% in most modern series.

In 1983, Stone et al[7] first described the concept of "rapid termination of laparotomy" in trauma patients.[8] In 1993, Rotondo and colleagues[9] coined the term *damage control* laparotomy, when they described their experience with exsanguinating patients who had suffered severe penetrating abdominal trauma. The authors showed that acidotic, coagulopathic, hypothermic patients who had control of hemorrhage with peritoneal packing and temporary closure at initial operation had better outcomes than those who had definitive repair of their injuries. Over time, many more authors have published

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their own positive experience with damage control in both trauma and nontrauma settings, and the technique has become standard of care for patients with severe abdominal trauma and other, nontraumatic indications, including abdominal compartment syndrome (ACS), severe intra-abdominal infection, and acute mesenteric ischemia.

Although damage control laparotomy and decompressive laparotomy for ACS have certainly saved lives,[9,10] the technique itself and the "open abdomen" that results do cause significant morbidity. In patients who survive beyond the critical phase of their injury, one of the most common and potentially devastating complications is exposed or enteroatmospheric fistula (EAF). EAF, a special subset of ECF that occurs in the setting of the open abdomen, is defined as a communication between the GI tract and the atmosphere. Because there is neither skin nor soft tissue surrounding or overlying the opening in the bowel, EAF presents a particularly challenging management problem.

Incidence

Since damage control laparotomy has become widely used throughout the surgical community, EAF has become a much more common type of ECF. In a recent review article, Schecter[11] called it an "epidemic of enteric fistulas . . . in intensive care units throughout the country." The overall incidence of EAF is not known but has been reported to range from 5%–19%[10,12,13,14] of patients who have undergone damage control laparotomy and have survived long enough to develop complications. The reasons for this wide variation are multiple: indication for damage control laparotomy (trauma vs nontrauma), number of returns to the operating room for abdominal procedures, and time to definitive closure all influence the EAF rate. It is clear that the longer the abdomen remains open with only a temporary dressing covering the bowel, the more likely it is that an EAF will develop.

Classification

EAFs are classified as either deep or superficial, depending on the fistula's location within the abdomen. Deep EAFs drain directly into the peritoneal cavity in an open abdomen and are likely to cause peritonitis. Drainage and source control are key, and spontaneous closure of deep EAF is extremely unlikely. Superficial EAFs drain on top or to the side of the granulating abdominal wound and thus are completely extraperitoneal and primarily a stoma/wound problem. Further anatomic classification is based on the segment of the GI tract involved (ie, gastroatmospheric, enteroatmospheric, coloatmospheric, etc). This is the same convention used for ECF. The final classification scheme for EAF is also similar to ECF and depends on daily output. Low-output EAFs are typically considered to be less than 200 mL of effluent per day, moderate from 200–500 mL per day, and high output >500 mL per day.

Etiology

The etiology of ECF is largely trauma, either secondary to patient injury or iatrogenic injury encountered during surgery or a percutaneous procedure. A significant number (approximately 20%) of ECFs arise in the setting of Crohn's disease.[15] Other etiologies of ECF include foreign bodies, anastomotic leakage, infection, radiation, granulomatous disease, and malignancy. EAFs, by definition, occur after a damage control laparotomy and subsequent open abdomen, and their etiologies are often related to the condition that necessitated the surgery. These include persistent abdominal infection, anastomotic leakage, ongoing bowel ischemia, and distal bowel obstruction. Adhesions of the bowel to itself or to fascia may result in splitting of the bowel with coughing or moving.[8] Furthermore, the physical characteristics of the open abdomen predispose the patient to EAF. For example, the bowel is usually exposed to the air, at least to some extent, which can lead to desiccation and fistula formation. Furthermore, prosthetic materials placed as temporary closure adjuncts can erode into the bowel. Finally, patients with open abdomens often require complicated abdominal dressing changes in the intensive care unit (ICU) and multiple trips to the operating room for washouts and attempts at closure. All of these manipulations can be traumatic to the already edematous, friable bowel and can result in EAF even if utmost care is taken to minimize trauma.[16,17]

Prevention

Clearly, the best treatment strategy for EAF is to keep it from happening at all. The surgeon and clinical team must be aware of the possibility of EAF occurring from the time of the first surgical operation and take precautions to prevent it. At the conclusion of the first laparotomy, the surgeon should use the greater omentum to cover the bowel, if at all possible. Any suture lines should be covered up and buried within the abdomen. Nonabsorbable mesh should never be in direct contact with the bowel. If nonabsorbable mesh or a vacuum-assisted system is used to prevent lateral fascial retraction, make sure that a fenestrated plastic sheet is placed directly on the bowel and that it extends from the left paracolic gutter to the right paracolic gutter.[18] Any temporary closure device used should protect the underlying bowel but also allow the surgeon to access the peritoneal cavity. When constructing a dressing for the open abdomen, one should not place gauze or negative pressure devices directly on the bowel. Dressing changes should be performed by experienced members of the surgical team only.[19] Finally, the surgeon should always have his or her eye on the goal of achieving definitive fascial closure, as the longer the abdomen remains open, the greater the risk of fistula formation.[13,14,20]

Management

Deep EAF

When a deep EAF is identified in a patient with an open abdomen, it is a surgical emergency in an often critically ill patient. The surgeon's goal at operation is to achieve source control, not to perform any sort of definitive procedure. This is often very difficult for a myriad of reasons: bowel edema, mesenteric shortening, and vascularized adhesions, to name a few.[19] Solutions that have been described include the "floating stoma," where the edges of the perforated bowel are sutured to a piece of a plastic silo with a hole in it,[21] in an attempt to separate the draining intestine from the peritoneum beneath it. Recently, surgeons have begun to use various adaptations of a negative-pressure wound management system to control the deep effluent and stop ongoing peritoneal contamination.[22,23]

If a patient has a deep EAF, the best that he or she can hope for is a surgeon who is adept enough with wound management to get source control and convert the fistula to a superficial EAF. The surgeon must also recognize the enormous catabolism that occurs with peritonitis and a huge open wound and treat with appropriate nutrition support. This often requires a combination of enteral nutrition (EN) and PN.[19] Nutrition for the patient with EAF will be addressed in more detail in a subsequent section.

Superficial EAF

Because there is no skin or soft tissue overlying the bowel in an open abdomen and therefore no real tract when a fistula forms, it is not realistic to expect that a superficial EAF will ever heal and close spontaneously. Thus, the goal of therapy is to control the intestinal effluent and limit exposure of surrounding viscera and granulation tissue until a definitive resection and closure can be undertaken. The time to definitive closure is often timed to coincide with abdominal wall reconstruction and can be 6 to 12 months from the time of original insult, so it is imperative that the patient have a multidisciplinary team of surgeons, nursing, wound care, and nutrition to support him or her through that time. All members of the team and the patient must be patient through the process, as attempting definitive repair too early can yield disastrous consequences, including injury to intact bowel, recurrent fistula, sepsis, and death.

As soon as an EAF is recognized, the clinician must make sure that the patient is not septic and does not have unrecognized, deep EAF concurrent with the superficial one. The next step is to define the anatomy of the fistula. It is critical to know where in the intestinal tract the hole is, define the afferent and efferent limb, and know how much contiguous bowel is available for enteric feeding. This may be accomplished by a combination of computed tomography (CT) scanning, fistulography, and oral or nasogastric ingestion of charcoal or dye.[1]

Along with mapping the EAF, it is critical from the very beginning to have a plan to collect the effluent and protect the exposed bowel/granulation tissue/skin surrounding the fistula from persistent inflammation and potential infection. Although local closure of the fistula using acellular dermal matrix and fibrin glue[24] has been described and certainly sounds attractive, neither tends to be successful in clinical practice. Whether this is because of the moisture and continuous peristalsis of the bowel or some other reason is unclear, but many surgeons have attempted to use these agents and failed. The same may be said for local, extraperitoneal repair of the hole in the bowel followed by split-thickness skin graft.[25] In our experience, it is best just to accept that the EAF exists and treat it as a stoma. Over the years, many different techniques have been described to manage EAF "stomas," most of which have high failure rates. The most promising techniques combine negative-pressure wound management systems with ostomy appliances.[22,26-28] Although techniques vary from surgeon to surgeon, our group has had success using the following technique, based on that described by Goverman et al[26] in 2004. First, care should be taken not to place the sponges for the negative-pressure device directly on exposed bowel. Impregnated gauze (eg, Xeroform gauze; Covidien, Mansfield, MA) should be placed in a thin layer over the open area of the abdomen, with a hole cut out for the fistula opening. In similar fashion, sponges should then be placed, also with a hole to accommodate the fistula opening, and then the polyurethane drape. Once the drape is placed, a hole is cut, and an ostomy appliance or Malecot catheter[22] is placed over or within the fistula itself, and then negative pressure is applied to the entire dressing. The goal is to isolate the fistula and allow the surrounding bed to granulate enough to accept a split-thickness skin graft. Once a skin graft has been placed and allowed to heal, the EAF can be managed much like a conventional stoma until definitive abdominal wall reconstruction and fistula resection can occur.

Nutrition

Early nutrition support is key to success when dealing with a patient with EAF. Immediately upon diagnosis, resuscitation and correction of fluid and electrolyte imbalances are critical to reverse shock, normalize acid-base balance, and quiet the inflammatory process. Fluid needs in this early phase can be very high and need to account for obvious losses from the GI tract as well as losses secondary to fever and sepsis. Furthermore, depending on where in the GI tract the EAF arises, electrolyte abnormalities can vary widely. To effectively treat and prevent these abnormalities, knowledge of the electrolyte composition of GI fluids is necessary (Table 1). As

Table 1. Electrolyte Composition (mEQ) of Gastrointestinal Fluids

	Na^+	K^+	Cl^{-+}	HCO_3^-
Stomach	60–80	15	100	0
Bile	140	5–10	100	40
Small bowel	140	20	100	25–50
Large bowel	75	30	30	0

soon as an EAF is discovered and the patient has been resuscitated and had any sepsis treated, PN should be started.[1] The goal in this early phase is to avoid "catabolic collapse"[11] and meet the patient's immediate metabolic needs while a definitive management plan is formulated.

When calculating the patient's nutrition needs in the early phase of EAF, professional judgment is key. Simple predictive equations are good starting points for calculating basal energy expenditure, and correction factors for stress should be used. Indirect calorimetry is also helpful, if available. The clinician should also remember that the higher the fistula output, the greater the ongoing losses and need for increased calories.[1] The small bowel normally reabsorbs up to 75 g/d of protein, so all or part of this is likely to be lost through the fistula.[19] Furthermore, the abdominal fluid lost from the open abdomen itself contains up to 2 g of nitrogen per liter[29] and should not be overlooked. Calorie and protein requirements in a patient with a high-output fistula may reach 30 kcal/kg/d and 1.5–2.5 g/kg/d, respectively.[30] Care should also be taken not to overfeed, however, as this causes increased insulin resistance and hepatic steatosis and may increase sepsis rates.[31] Trace minerals and vitamins, including zinc and vitamin C,[32] should be provided at least twice the recommended daily allowance. There is some evidence that other supplements, such as fish oil and ω-3 fatty acids, may improve overall survival in subsets of critically ill patients with acute respiratory distress syndrome (ARDS),[33] but there is no evidence that they improve outcomes in patients with EAF.[19]

The concept of "bowel rest" as a therapeutic measure for patients with EAF is popular. Some suggest that fistula closure rates and mortality may be positively affected by the use of PN.[34] To date, however, no strong evidence suggests that there is increased ECF healing with PN alone, simply because there are no randomized trials looking at outcomes in patients who have been given nothing by mouth for the duration of their treatment.[35] It is reasonable to assume that the same is true for EAF, although no specific studies address this issue.

Enteral feeding should be attempted as soon as the anatomy of the fistula is defined and the management team determines that it is possible to enterally feed the patient. Absolute contraindications to enteral feeding include intestinal discontinuity and insufficient length (usually <75 cm) of usable bowel. It can be difficult to estimate the total length of usable bowel unless it is directly measured at surgery, but fluoroscopic "fistula-grams," upper GI series, magnetic resonance enterography, and CT scanning can all be used to make a reasonable estimation. Furthermore, although the absolute length of intestine is important, the quality of the remaining small bowel, as well as whether the colon is preserved, is also critical. Although there may be some cases where PN is the only type of nutrition that the patient can tolerate, several large series of patients with ECF[36,37] report that most patients will be able to transition to at least some amount of enteral feeding. The benefits of enteral feeding are well known and include preservation of the intestinal mucosal barrier and its immunologic function, which may also result in lower infectious complications.[38] It should be remembered that the goal of feeding EAF patients, in whatever form, is to prevent malnutrition while controlling the effluent, not to promote fistula healing.[35]

Establishing enteral feeding access in the patient with EAF can be difficult and requires imagination, teamwork, and perseverance to succeed.[1] Possible routes of enteral feeding include the passage of tubes distal to the fistula, surgically placed feeding jejunostomy, and fistuloclysis. Fistuloclysis is a technique of providing enteral feeds directly through the fistula opening. Originally, this involved collecting effluent from the proximal fistula limb and reinfusing it into the distal limb, which is useful to maintain fluid and electrolyte balance. This technique can be difficult and unpleasant for patients to manage, however, and is probably not necessary. Teubner et al[39] used fistuloclysis with polymeric or elemental feeds only in 12 patients with ECF and was able to liberate 11 of them from PN. Clearly, technical considerations are involved if one wishes to successfully feed a patient with fistuloclysis. The proximal effluent must be effectively collected while a feeding tube in the distal limb maintains a stable position. The tube must not be allowed to migrate in an antegrade fashion with peristalsis, as this can cause a distal obstruction.

When choosing a formula for feeding patients with EAF, it is reasonable to begin with a standard polymeric formula. An exception to this is if the patient has a very short length of usable bowel. If the patient has less than 120 cm of bowel, does not tolerate the polymeric formula, or experiences high fistula output, he or she should be switched to an elemental or semi-elemental feed. This process will ultimately require some trial and error. Oftentimes, U.S. insurance companies do not cover a patient after discharge on both tube feeds and PN support. So unless a patient can demonstrate that he or she can be fully supported on enteral feeds, he or she will be forced to have PN and oral intake as tolerated. This can be especially true in the patient who has trouble maintaining hydration or electrolytes secondary to fistula losses.

Multiple studies have looked at immunonutrition and specifically glutamine use in critically ill surgical patients. Glutamine is the primary nitrogen and energy source for the enterocyte and has wide-ranging effects on immune function, antioxidant defenses, and overall outcomes.[40] A meta-analysis of the use of glutamine in critically ill surgical patients showed a reduction in infections but no effect on mortality.[41] It should be noted that the positive effects of glutamine are most pronounced when it is administered parenterally,[41] but this preparation is not available in the United States. De Agular-Nascimento et al[42] retrospectively looked at the effects of oral glutamine combined with PN on the healing rate of high-output ECF. This Brazilian group found that glutamine did accelerate healing and decreased mortality in their patients, although hospital length of stay was not changed. It should be noted that this was a small (15 patients) study, and its retrospective nature makes it difficult to draw conclusions about the use of glutamine. In the absence of hard data in the EAF patient, it is probably safe to administer oral glutamine in the hopes of decreasing overall inflammation and perhaps decreasing drainage.

Somatostatin and its synthetic analogue, octreotide, have been shown to reduce ECF output by as much as 40%–93%.[43] No study has examined its use in EAF, and it is not reasonable to expect that it would facilitate closure. Octreotide can decrease the volume that comes out of the EAF, however, which may simplify wound care and decrease the damage to surrounding bowel and granulation tissue. Care must be taken when using octreotide, however, as some evidence suggests that it can have an adverse effect on immune function[44] and can decrease splanchnic and portal blood flow.[45]

As the EAF patient's condition improves and he or she emerges from the critical phase of the illness, the patient may desire to take something orally. This desire to eat "normally" should not be overlooked. Food and eating are a very important part of human culture, and being absolutely forbidden to take in anything by mouth for a period of 6 to 12 months can be psychosocially debilitating for a patient. There is nothing wrong with allowing a patient with EAF to have some oral intake. Experimentation is key. The major goals are to control the fistula effluent, maintain normal fluid and electrolyte balance, and protect the surrounding tissues from damage. Oral intake of fluids will usually increase fistula output more than solids. Thus, it is prudent to advise against oral hydration. Instead, the focus should be on finding solids that the patient enjoys and makes him or her feel "normal" again but do not significantly increase output. In the best-case scenario, the patient may actually derive some nutrition benefit (vitamins, minerals, antioxidants) from eating "real" food. In our opinion, oral intake should be abandoned only if it increases fistula output to the point that it becomes unmanageable, either from a volume standpoint or from electrolyte abnormalities or because the patient cannot find foods he or she can tolerate.

Conclusion

EAF is a dreaded complication of damage control laparotomy. It is a challenge for the entire clinical team to treat, as well as for the patient to endure. Using a team approach to diagnosis, treatment, and nutrition support, as well as a hefty dose of patience, the patient with EAF can survive, be discharged from the hospital, and even live a relatively "normal" life while awaiting definitive surgical repair.

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