



## Enterocutaneous Fistula: Evidence-based Management

Ryan P Dumas<sup>1\*</sup>, Sarah A Moore<sup>1</sup> and Carrie A Sims<sup>2</sup>

<sup>1</sup>Department of Traumatology, Surgical Critical Care & Emergency Surgery, Perelman School of Medicine at the University of Pennsylvania, Philadelphia, PA, USA

<sup>2</sup>Department of Surgery, Division of Traumatology, Surgical Critical Care & Emergency Surgery, Perelman School of Medicine at the University of Pennsylvania, Philadelphia, PA, USA

### Abstract

The management of Enterocutaneous fistula (ECF) is a clinical skill that should be in the armamentarium of every general surgeon. Although definitive treatment frequently relies on surgical closure, pre-operative care and diligence is paramount to ensure a successful outcome. Care of these patients should focus on four keys phases. The first phase is characterized by appropriate recognition and resuscitation. During the second phase, a complete nutritional assessment and plan is undertaken. Radiographic evaluation during the third phase helps to define ECF anatomy. Finally, the fourth phase is characterized by definitive closure should the fistula fail to heal spontaneously. This review will focus on the key aspects that define each phase and help the general surgeon maximize chances for a positive outcome.

### Introduction

The development of an Enterocutaneous fistula (ECF), defined as an anomalous connection between the bowel lumen and external skin, is a significant source of morbidity and mortality despite advances in both surgical and medical care. The overall incidence of ECF, however, is unknown with the majority of data regarding ECF coming in the form of large institutional retrospective or surgeon-specific series [1-7]. Remarkably, only 25% of all ECF's are secondary to inflammatory bowel disease, diverticular pathology, trauma, radiation and malignancy [8]. In contrast, nearly 75% of all ECF's are the direct result of either laparoscopic or open surgery with an astomotic leak following enterectomy being responsible for over 50% of these fistulas. Inadvertent iatrogenic injuries such as enterotomies or unrecognized thermal injury sustained during the course of an operation account for the remaining fistulas [8,9]. Because ECF is most commonly a surgeon-created problem, the onus of prevention as well as appropriate management, planning and definitive treatment rightfully falls onto the surgeon.

Morbidity and mortality following ECF is exceedingly high. An estimated 90% of patients will experience an ECF-related morbidity ranging from skin excoriation, to dehydration, to sepsis. Moreover, the mortality attributable to an ECF ranges anywhere from 5-20% and is dependent on number of factors including underlying infection and fistula location [1,3,10-12]. Because the leading cause of death in patients with ECF is sepsis, source control remains one of the cornerstones of therapy. In retrospective series, mortality was noted to increase 16-fold in the setting of sepsis and 22-fold in the setting of uncontrolled infection [11,13]. As such, early and definitive treatment of un drained collections in conjunction with short-term antimicrobials has the potential to significantly improve outcomes. In most series, mortality also appears to correlate with fistula output and location. Mortality increases from 26% in low output fistulas to 50% for high output ones given the fluid, electrolyte and nutritional challenges associated with ECF management [14]. Mortality also correlates with location and decreases with more distal fistulas. While jejunal fistulas have the highest mortality at 29%, and are significantly more challenging to manage, the mortality from colonic fistula is the lowest at 6% [11].

Beyond the patient impact, which ranges from both physiologic to psychological, [15] ECF management places a tremendous strain on healthcare resources. It is estimated that the cost of ECF management is well over \$500,000 and requires a multi-disciplinary team of nutritionists, wound care nurses and surgeons in order to ensure a good outcome [16,17]. The importance of high-expertise treatment centers should not be under-estimated and has been shown to significantly decrease mortality from 42% to 20% [18].

### OPEN ACCESS

#### \*Correspondence:

Ryan P Dumas, Department of Traumatology, Surgical Critical Care & Emergency Surgery, Perelman School of Medicine at the University of Pennsylvania, 51 N. 39th Street, MOB Suite 120, Philadelphia, PA 19104, USA, Tel: 215-662-9471; Fax: 215-243-3221; E-mail: Ryan.Dumas@uphs.upenn.edu

Received Date: 13 Jan 2017

Accepted Date: 19 Apr 2017

Published Date: 26 Apr 2017

#### Citation:

Dumas RP, Moore SA, Sims CA. Enterocutaneous Fistula: Evidence-based Management. Clin Surg. 2017; 2: 1435.

**Copyright** © 2017 Ryan P Dumas. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

**Table 1:** Classification.

Anatomic	Proximal or distal	Gastric, duodenal, jejunal, ileal, colonic
Physiologic	High, moderate, low output	High output >500 cc/day Moderate 200-500cc/day Low output < 200cc/day
Etiology	Iatrogenic vs. spontaneous Traumatic	Malignant Radiation Inflammatory Bowel Disease Diverticular

**Table 2:** ECF Prognostic Variables.

FAVORABLE	UNFAVORABLE
Nutritionally replete	Nutritionally deplete
•Albumin >3.0	•Low albumin, low transferrin
Long fistula tract (>2cm)	Short fistula, multiple, complex fistulae
Diverticular fistula	Large enteral defect (>1cm), visible mucosa
Low output	High output (>500cc/day)
Single fistula	Prior radiation
Intestinal Continuity	Multiple prior operations
Index operation performed at same center	External referrals to a high-volume center

## Classification

There is no universal or well-established classification scheme for ECFs. Fistulas are generally classified anatomically, physiologically or by disease process [8,19]. Fistulas can additionally be classified by the quantity of daily output. It is imperative that fistula output be accurately documented as the amount may dictate changes in management. Table 1 details three different classification paradigms.

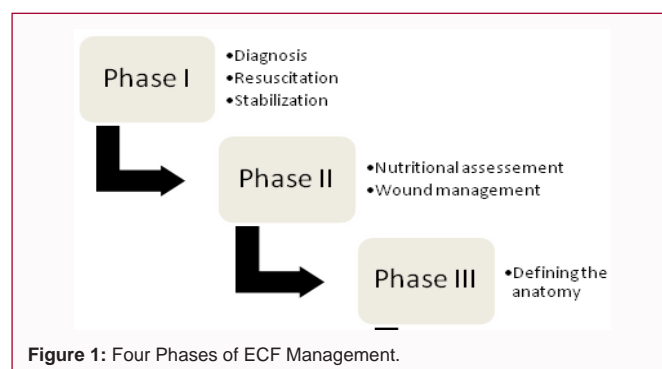
## Prognostic Factors for ECF

The prognostic factors for ECF have been very well described and are consistent with standard surgical dogma. Patients with a proximal, high output fistula accompanied with a low albumin (<3.0g/dl) have more complications and are less likely to close their fistula spontaneously [11]. Conversely patients with no comorbidities who have fistulas that are the result of a surgical procedure and are low output do more favorably with higher spontaneous closure rates [13]. Table 2 details many of the variables that may predict a successful outcome.

The importance of institutional support and multidisciplinary expertise as a positive prognostic factor cannot be over-emphasized. Multiple studies have confirmed institutional experience and volume as critical factors in decreasing morbidity and improving mortality [1,5,20]. Recently, the Canadian Association for Enterostomal Therapy codified the importance of multidisciplinary care by identifying nine essential team members in their "ECF Best Practice" recommendations. Ranging from surgeons to pharmacists to chaplains, this integrated team approach recognizes the expertise each specialty brings to caring for these complex patients [21].

## Diagnosis

A smoldering post-operative course complicated by ileus and the development of a post-operative wound infection is a harbinger for ECF. Once a fistula is suspected or has been identified on physical examination, radiologic studies are necessary adjuncts and 97% of all patients undergo some form of radiologic evaluation [1]. Contrast-enhanced CT scanning is essential as it evaluates for the presence of an associated abscess or un drained collection. Once source control



has been optimized, fluoroscopic fistulography plays an important role in defining the fistula anatomy. A fistulogram will help to locate the origin, determine the length, evaluate for the presence of distal obstruction and determine whether the fistula is in continuity with the rest of the bowel [22]. Once the diagnosis of an ECF has been confirmed, focus should shift to management.

## Management

The tenets of ECF management were first championed by Chapman and colleagues in 1964 [23] and to-date they remain the cornerstones of therapy. In their original article, Chapman et al. identified four key factors: fluid resuscitation, source control, effluent management and skin protection. The importance of nutrition has recently emerged as a fifth key element. An organized, systematic approach should be undertaken with every fistula patient in order to optimize chances of a successful outcome; and management can ultimately be broken down into the four phases (Figure 1).

## Resuscitation

Resuscitation of a patient with a newly diagnosed ECF follows many of the same principle as the resuscitation of septic patients and tenets of the Surviving Sepsis Campaign should serve as a frame work [24]. Initial care should focus on aggressive fluid resuscitation, rapid assessment and correction of electrolyte imbalances, and normalization of lactic acidosis. Patients with ECF are commonly hyponatremic, hypokalemic, and acidotic due to ongoing GI losses. Patients with high output fistulas should have fluid, electrolyte and bicarbonate losses replaced intravenously in order to avoid dehydration and profound metabolic instability during the initial stabilization period. Careful monitoring of urine output and targeted replacement of fistula effluent every 4 to 8 hours will prevent ongoing dehydration.

## Source Control

Once the patient is resuscitated, attention should shift to establishing source control. As previously mentioned, a contrast-enhanced CT scan is instrumental in identifying un-drained collections and abscesses. In post-operative patients, source control is most likely accomplished by interventional radiology. However, in the face of inaccessible collections or uncontrolled intra-abdominal sepsis, an operation may be unavoidable. Broad spectrum, empiric intra venous antibiotics should not be used routinely to treat ECF unless there is evidence of intra-abdominal collections or wound infection with an associated cellulitis. Whenever possible, antibiotics should be targeted toward specific culture data and limited to no more than 2 weeks.

## Effluent Management

The management of success effluent can have a significant impact on volume status, electrolyte balance, nutrition, and skin integrity. Adjunct medical management of ECF effluent has traditionally focused on two main areas: acid neutralization and volume reduction. The use of proton pump inhibitors can accomplish both goals and the dose should be titrated until the effluent's pH is greater than 6 and the volume of output is less than 1L/day [16]. Although psyllium can be extremely useful in bulking the effluent and increasing transit time, antimotility and antisecretory agents including loperamide, atropine-diphenoxylate, codeine, tincture of opium and even methadone, are the mainstay of volume reduction. Given its role as the universal gastrointestinal hormone inhibitor, a great deal of research has been spent studying the effects of exogenous somatostatin on patients with ECF. Despite a significant number of randomized controlled trials, significant conclusions are difficult to elucidate secondary to small sample size and inconsistent study design [7]. Octreotide, a longer lasting somatostatin analog, has also been investigated as an ECF adjunct with promising results. Octreotide 100 mcg three times [25] daily may reduce effluent volume and has been shown to decrease time to spontaneous closure in some studies [7,22]. As such, a trial of octreotide therapy for 72 h with close fistula output monitoring may be warranted, particularly in cases where other therapies have failed to decrease output volume [20]. Common side effects include hyperglycemia, headaches and cholelithiasis.

While the data is clear that low output fistulas have an increased rate of spontaneous closure, it is less clear that decreasing the volume of output will improve fistula closure. Nonetheless, decreasing the volume of output can significantly ease the burden of fistula management and positively impact patient wellbeing.

## Wound Care

Perhaps one of the more challenging and resource demanding aspects of ECF management is local control of effluent. *Success enteric* we can rapidly breakdown skin and cause irritation that is difficult to treat. As such, appropriate skin management with barrier creams, moisture barriers, pouching appliances and suction devices are paramount [21]. High output fistulas, in particular, often require an intricate network of drains, pouches, and suction to adequately control effluent. Highly specialized wound care teams and enterostomal therapists are invaluable for both wound management and patient comfort [22].

With the ubiquitous use of negative pressure therapy (NPT) for the management of wounds and open abdomens, it is not surprising that NPT has become part of the surgical armamentarium to deal with ECF. In the largest series to date, Wainstein et al. [26] reported their experience with 91 patients with high output fistulas treated with negative pressure ranging from -350 to -600 mmHg. In addition to significantly decreasing effluent output from an average of 1400 cc/day to 138 cc/day, spontaneous closure was achieved in 46% of patients. In 2016, Misky et al. [27] published a meta-analysis investigating the use of NPT in ECF. Using ten retrospective studies with a total of 151 patients, these authors found that the median rate of spontaneous was closure 65% (ranging from 7%-100%) with a median time to closure of 58 days. These investigators also reported a new fistula rate of 4.4% - a known complication that has given some practitioners pause. While more investigation is clearly necessary to determine if NPT can definitively improve ECF closure rates or decrease the time to

spontaneous closure, the positive benefits of these dressings should not be overlooked. At the very least, this technology may make the management of ECF easier by controlling effluent, protecting skin, and decreasing frequency of dressing changes.

## Nutrition

### Assessment

The nutritional status of an ECF patient is of paramount importance. Prior to the advent of peptide-based enteral formulas and total parenteral nutrition (TPN), retrospective historical series highlight the burden of malnutrition in ECF patients. In a series of 157 patients in the 1950s and 1960s, almost 75% of patients with proximal fistulas were malnourished. Similar results were reported by Chapman et al. [23] who found that only a small minority of patients had optimal nutrition; and that once nutrition was improved, ECF related mortality plummeted from 55% to 12-16%.

A complete nutritional assessment should be performed on every patient with an ECF. Although the Harris-Benedict equation provides a good starting place for calculating nutritional requirements, it is widely accepted that ECF patients are catabolic and hyper metabolic. In general, these patients require increased caloric support with at least 25-30 kcal/kg/day in carbohydrates and fat and 1.5 to 2 grams of protein/kg/day [22,28].

Nutritional status and progress should be reassessed on a regular basis. In addition to daily weights, regular nutrition labs such as, albumin, prealbumin, transferrin and CRP should be followed. Preoperative albumin, in particular, has been shown to be the strongest predictor of mortality and morbidity following general surgery [29] and hypoalbuminemia remains a significant predictor of poor outcomes in ECF patients [29,30]. Perhaps the most studied protein in ECF, however, is transferrin and levels greater than 140 have been associated with increased spontaneous closure rates and reduced mortality [28]. Although nitrogen balance can be a helpful tool, this standard measure can be difficult in patients with high output fistulas. Additional tests such as indirect calorimetry may be considered in more complex cases that do not respond to standard care.

### Parenteral vs. enteral nutrition

Parenteral nutrition has played a critical role in the management of ECF with its use being firmly established by Dudrick in 1969. In his sentinel article describing the optimal management of TPN, Dudrick concluded that: "with the exclusive use of parenteral hyperalimentation, weight gain, positive nitrogen balance, growth and development [was] regularly achieved" [31]. Since then, TPN has been universally adopted as a means of providing nutrition while promoting "bowel rest" and simplifying effluent management. While TPN reduce GI secretions by 30%-50%, thereby reducing the incidence of dehydration and electrolyte imbalances, there are no randomized studies addressing the impact of TPN on anabolic conversion, spontaneous closure rates, or mortality. Nonetheless, TPN remains a popular long-term treatment modality despite serious complications including infection and liver dysfunction.

More recently, however, the use of enteral nutrition in ECF has been gaining traction. The use of enteral nutrition has a number of benefits including decreased cost, fewer infections, and improved immunologic function when compared to TPN [32]. Moreover, even providing as little as 20% of calories via an enteral route can help to

**Table 3:** Timing to Definitive Management.

Investigators	Institutional Practice
Hollington	8 Months
Evenson	4 Months
Rahbour	12 Months
Datta	6 Months
Lynch	6 Months
Li	6 Months
Mcintyre	6 Months

maintain gut flora and decrease bacterial translocation [22].

Several series have reported surprising success with the enteral feeding in ECF patients. In a retrospective series by Li et al. [2] 86.4% of 1168 patients were managed effectively with enteral support. Enteral nutrition can even be successfully used in the setting of high output fistula when combined with elemental formulas, anti motility agents and fiber bulking agents. In a series of 335 patients with high output fistulas, Levy et al. were able to successfully achieve TPN independence in 85% of their cohort using enteral feeds. Interestingly, despite enteral nutrition and the lack of “bowel rest”, mortality and rates of spontaneous closure were similar to prior series.

In the setting of a high output ECF with a distal mucocutaneous limb, fistuloclysis can be an important adjunct to standard enteral feeding. The practice of fistuloclysis originated from the practice of refeeding of chyme in neonates and can refer to either the refeeding of success or supplementing additional enteral tube feeds via a catheter placed in the distal limb of an ECF. Teubner et al. [33] first described fistuloclysis as a therapy for ECF in 2004 in a case series of twelve patients with proximal fistulae. Since then, a number of case reports and small series have demonstrated the nutritional efficacy of this technique [34]. When compared to a matched cohort of patients receiving TEN without fistuloclysis, patients with high output fistulas treated with fistuloclysis had significantly improved liver function and nutritional parameters [35]. Fistuloclysis may be particularly helpful in patients that develop TPN-related complications including infections, venous access issues or hepatic failure. Complications however, can occur and may include obstruction should the peristaltic activity of the small bowel advance the fistula catheter distally into the small bowel.

Vitamins and minerals are often depleted in ECF patients. Deficiencies in fat-soluble vitamins are common, whereas deficiencies in water-soluble vitamins are rare unless the fistula is within the proximal jejunum. Moreover, because vitamin B12 is only absorbed in the terminal 50 to 60 cm of the ileum, injectable vitamin B12 may be required in many ECF patients. Magnesium is frequently wasted in high output fistulas and should be replete with either intravenous magnesium sulfate or oral magnesium chloride for improved enteral absorption. Finally, high dose repletion of both zinc and vitamin C has been recommended [22]. While Omega-3 and fish oil have been studied in the intensive care setting with some benefit, these supplements have never been evaluated in ECF patients and are not routinely used [36].

### Operative considerations

The rate of spontaneous ECF closure varies between 15 and 75% in the literature. This wide range of closure rates likely reflects differences in patient populations and institutional practice

patterns [1,5,11,36,37]. Fistulas are significantly less likely to close spontaneously beyond 4 weeks with only 10% of fistulas closing after two months [22,38]. Because the rates of spontaneous ECF closure are low, surgical intervention is often the only definitive management strategy.

The decision to operate on an ECF, however, should not be taken lightly as recurrence rates following ECF takedown range from 13 to 34% [20]. Although the principles of surgical intervention for ECF involve many of the core tenets of general surgery, the time to operation is perhaps the most important factor to consider. Fazio et al demonstrated the importance of expectant management when caring for ECFs patients. When surgery occurred less than 6 weeks from the time of ECF formation, mortality exceeded 20%. By delaying operative more than 6 weeks, however, mortality decreased to 11%. Furthermore, early operation possibly results in increased recurrence risk. In a series by Lynch et al., patients operated on between 2 and 12 weeks ECF formation had a recurrence rate of 28%, whereas a delay longer than 12 weeks decreased this rate to 15% [39]. Table 3 shows the length of time expert authors suggest waiting prior to considering operative intervention for a non-healing ECF.

Operative management should only be pursued with the full investment and understanding of both patient and surgeon. ECF closures are long, technically challenging cases with the risk of significant complications. Operations often require complete mobilization of the bowel from the Ligament of Treitz to the rectum. Given that 36% of recurrent fistulas are the result of injuries created during the ECF closure operation, great care should be taken throughout the lysis of adhesions to avoid any inadvertent injury to healthy bowel [40]. Management of the fistulous bowel should always entail a bowel resection and primary anastomosis. Over sewing or wedge resection of the fistula invariably results in a higher recurrence rate (36% vs. 16%) [39,41].

### Conclusion

Entero cutaneous fistula is one of the most challenging complications facing the general surgeon. Utilizing a careful, systematic and patient-centered approach will help to maximize successful clinical outcomes. Despite the consistency of the tenets of ECF management across patients, each fistula is unique and its management is defined in large part by its output as well as its location and patient co-morbidities. Surgeon-specific and institutional experience underscores the importance of delayed intervention. Although surgeons and patients alike may have a strong desire to proceed with surgical closure, patients are best served by at least 6 months of non operative management. Ultimately, the long-term care of ECF patients requires, multi-disciplinary often coordinated by the surgeon.

### References

- Hollington P, Mawdsley J, Lim W, Gabe SM, Forbes A, Windsor AJ. An 11-year experience of enterocutaneous fistula. *Br J Surg*. 2004; 91:1646-51.
- Li J, Ren J, Zhu W, Yin L, Han J. Management of enterocutaneous fistulas: 30-year clinical experience. *Chin Med J (Engl)*. 2003;116:171-5.
- McIntyre PB, Ritchie JK, Hawley PR, Bartram CI, Lennard-Jones JE. Management of enterocutaneous fistulas: A review of 132 cases. *Br J Surg*. 1984;71:293-6.
- Soeters PB, Ebeid AM, Fischer JE. Review of 404 patients with gastrointestinal fistulas. Impact of parenteral nutrition. *Ann Surg*. 1979;190:189-202.



5. Rahbour G, Gabe SM, Ullah MR, Thomas GP, Al-Hassi HO, Yassin NA, et al. Seven-year experience of enterocutaneous fistula with univariate and multivariate analysis of factors associated with healing: development of a validated scoring system. *Colorectal Dis.* 2013;15:1162-70.
6. Gonzalez-Pinto I, Gonzalez EM. Optimising the treatment of upper gastrointestinal fistulae. *Gut.* 2001;49 Suppl 4:iv22-31.
7. Lloyd DA, Gabe SM, Windsor AC. Nutrition and management of enterocutaneous fistula. *Br J Surg.* 2006;93:1045-55.
8. Berry SM, Fischer JE. Classification and pathophysiology of enterocutaneous fistulas. *Surg Clin North Am.* 1996;76:1009-18.
9. Fischer JE. The pathophysiology of enterocutaneous fistulas. *World J Surg.* 1983;7:446-50.
10. Draus JM, Jr., Huss SA, Harty NJ, Cheadle WG, Larson GM. Enterocutaneous fistula: are treatments improving? *Surgery.* 2006;140:570-6.
11. Martinez JL, Luque-de-Leon E, Mier J, Blanco-Benavides R, Robledo F. Systematic management of postoperative enterocutaneous fistulas: factors related to outcomes. *World J Surg.* 2008;3:436-43.
12. Misky A, Hotouras A, Ribas Y, Ramar S, Bhan C. A systematic literature review on the use of vacuum assisted closure for enterocutaneous fistula. *Colorectal Dis.* 2016;18:846-51.
13. Campos AC, Andrade DF, Campos GM, Matias JE, Coelho JC. A multivariate model to determine prognostic factors in gastrointestinal fistulas. *J Am Coll Surg.* 1999;188:483-90.
14. Levy E, Frileux P, Cugnenc PH, Honiger J, Ollivier JM, Parc R. High-output external fistulae of the small bowel: management with continuous enteral nutrition. *Br J Surg.* 1989;76:676-9.
15. Lundy JB, Fischer JE. Historical perspectives in the care of patients with enterocutaneous fistula. *Clin Colon Rectal Surg.* 2010;23:133-41.
16. Bleier II, Hedrick T. Metabolic support of the enterocutaneous fistula patient. *Clin Colon Rectal Surg.* 2010;23:142-8.
17. Teixeira PGR, Inaba K, Dubose J, Salim A, Brown C, Rhee P, et al. Enterocutaneous fistula complicating trauma laparotomy: A major resource burden. *Am Surg.* 2009;75:30-2.
18. Irving M, White R, Tresadern J. Three years' experience with an intestinal failure unit. *Ann R Coll Surg Engl.* 1985;67:2-5.
19. Schechter WP, Hirshberg A, Chang DS, Harris HW, Napolitano LM, Wexner SD, et al. Enteric fistulas: principles of management. *J Am Coll Surg.* 2009;209:484-91.
20. Gribovska-Rupp I, Melton GB. Enterocutaneous Fistula: Proven Strategies and Updates. *Clin Colon Rectal Surg.* 2016;29:130-7.
21. McNaughton V, Canadian Association for Enterostomal Therapy ECFBPRP, Brown J, Hoefloek J, Martins L, McNaughton V, et al. Summary of best practice recommendations for management of enterocutaneous fistulae from the Canadian Association for Enterostomal Therapy ECF Best Practice Recommendations Panel. *J Wound Ostomy Continence Nurs.* 2010;37:173-84.
22. Evenson AR, Fischer JE. Current management of enterocutaneous fistula. *Journal of gastrointestinal surgery: official journal of the Society for Surgery of the Alimentary Tract.* 2006;10:455-64.
23. Chapman R, Foran R, Dunphy JE. Management of Intestinal Fistulas. *Am J Surg.* 1964;108:157-64.
24. Dellinger RP, Levy MM, Rhodes A, Annane D, Gerlach H, Opal SM, et al. Surviving sepsis campaign: international guidelines for management of severe sepsis and septic shock: 2012. *Crit Care Med.* 2013;41:580-637.
25. Hesse U, Ysebaert D, de Hemptinne B. Role of somatostatin-14 and its analogues in the management of gastrointestinal fistulae: clinical data. *Gut.* 2001;49:iv11-21.
26. Wainstein DE, Fernandez E, Gonzalez D, Chara O, Berkowski D. Treatment of high-output enterocutaneous fistulas with a vacuum-compaction device. A ten-year experience. *World J Surg.* 2008;32:430-5.
27. Edmunds LH, Jr., Williams GM, Welch CE. External fistulas arising from the gastro-intestinal tract. *Ann Surg.* 1960;152:445-71.
28. Polk TM, Schwab CW. Metabolic and nutritional support of the enterocutaneous fistula patient: a three-phase approach. *World J Surg.* 2012;36:524-33.
29. Gibbs J, Cull W, Henderson W, Daley J, Hur K, Khuri SF. Preoperative serum albumin level as a predictor of operative mortality and morbidity: results from the National VA Surgical Risk Study. *Arch Surg.* 1999;134:36-42.
30. Martinez JL, Luque-de-Leon E, Ballinas-Oseguera G, Mendez JD, Juarez-Oropeza MA, Roman-Ramos R. Factors predictive of recurrence and mortality after surgical repair of enterocutaneous fistula. *Journal of gastrointestinal surgery : official journal of the Society for Surgery of the Alimentary Tract.* 2012;16:156-63; 63-4.
31. Dudrick SJ, Wilmore DW, Vars HM, Rhoads JE. Can intravenous feeding as the sole means of nutrition support growth in the child and restore weight loss in an adult? An affirmative answer. *Ann Surg.* 1969;169:974-84.
32. Elke G, van Zanten AR, Lemieux M, McCall M, Jeejeebhoy KN, Kott M, et al. Enteral versus parenteral nutrition in critically ill patients: an updated systematic review and meta-analysis of randomized controlled trials. *Crit Care.* 2016;20:117.
33. Teubner A, Morrison K, Ravishankar HR, Anderson ID, Scott NA, Carlson GL. Fistuloclysis can successfully replace parenteral feeding in the nutritional support of patients with enterocutaneous fistula. *British Journal of Surgery.* 2004;91:625-31.
34. Ham M, Horton K, Kaunitz J. Fistuloclysis: case report and literature review. *Nutr Clin Pract.* 2007;22:553-7.
35. Wu Y, Ren J, Wang G, Zhou B, Ding C, Gu G, et al. Fistuloclysis improves liver function and nutritional status in patients with high-output upper enteric fistula. *Gastroenterol Res Pract.* 2014;2014.
36. Schechter WP. Management of enterocutaneous fistulas. *Surg Clin North Am.* 2011;91:481-91.
37. Haffejee AA. Surgical management of high output enterocutaneous fistulae: a 24-year experience. *Curr Opin Clin Nutr Metab Care.* 2004;7:309-16.
38. Ross H. Operative surgery for enterocutaneous fistula. *Clin Colon Rectal Surg.* 2010;23:190-4.
39. Lynch AC, Delaney CP, Senagore AJ, Connor JT, Remzi FH, Fazio VW. Clinical outcome and factors predictive of recurrence after enterocutaneous fistula surgery. *Ann Surg.* 2004;240:825-31.
40. Runstrom B, Hallbook O, Nystrom PO, Sjodahl R, Olaison G. Outcome of 132 consecutive reconstructive operations for intestinal fistula--staged operation without primary anastomosis improved outcome in retrospective analysis. *Scand J Surg.* 2013;102:152-7.
41. Reber HA, Roberts C, Way LW, Dunphy JE. Management of external gastrointestinal fistulas. *Ann Surg.* 1978;188:460-7.